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IRAN'S POTENTIAL AS A LANDBRIDGE FOR FORMER USSR REPUBLICS: A SCENARIO APPROACH

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IRAN'S POTENTIAL AS A LANDBRIDGE FOR FORMER USSR REPUBLICS: A SCENARIO APPROACH

by

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ABSTRACT

Iran's potential as a landbridge for Former USSR republics: a scenario approach

PARVIZ BAVARSAD AHMADI

The concept of a landbridge refers to different types of integrated origin-destination international movements of shipments (in various combinations of sea, land and air) under a single waybill. There are different examples of landbridges with different characteristics related to transport supply facilities, organisational structure and managerial skills. Certain limitations of existing landbridge studies are discussed. They include the failure of a comprehensive academic study to account jointly for both demand and supply of landbridge services. Most articles on landbridges discuss the Trans-Siberian Railway or east-west coast landbridges of the United States of America. No comprehensive academic studies of landbridges in general were found.

The main features of the research can be summarised as:

* A comprehensive review of literature related to landbridges
* An investigation and analysis of Iranian transport supply and demand including both domestic and foreign trade.
* An investigation and analysis of the demand of the Central Asian and Caucasus countries (Former USSR republics) for transport
* The development of a demand and supply model related to an Iranian Sea-landbridge (ISLB) for eight Central Asian and Caucasus countries and Iran.
* Evaluation of the impacts of demand on landbridge supply.
* A comprehensive review of the scenario approach and its application to the Iranian Sea landbridge study using a regression technique.

Three scenarios are developed (optimistic, most probable and pessimistic). The main result of the scenario modelling suggests that the transport system of Iran requires considerable improvement to compete effectively with other landbridges, given an increase in trade from Iran and the Central Asian and Caucasus countries.

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List of Abbreviations

Abbreviation	Description
a	Intercept (unexplained dependent variable)
ANOVA	Analysis of Variance
BASIC	Battle Scenario Inputs to Corporate Strategies
BSECOG	Black Sea Economic Co-Operation Group
b (*B*)	Regression coefficient (explained dependent variables, coefficient of impact)
bn	Billion
b/l	Bill of lading
CACFT	Central Asian and Caucasus Foreign Trade
CAC	Central Asian and Caucasus Countries
CD ROM	Computer Disk Run On Memory
CP	Canadian Pacific
CN	Canadian National
CIS	Commonwealth of Independent Sovereign Countries
COFC	Container On Flat Cars
CIM	Cross-Impact Matrix
CIA	Cross Impact Analysis
DOMTI	Domestic Trade of Iran
dwt	Dead Weight Tonnage
EQ	Equation
E.I.U	Economist Intelligent Unit
ECO	Economic Co-operation Organisation
FSU	Former Soviet Union
GATT	Group Agreement on Tariffs and Trade
GOPFT	General Cargo and Oil products of Foreign Trade of Iran
GDP	Gross Domestic Product
GNP	Gross Net Product
HGVs	Heavy Goods Vehicles
IRU	International Road Transport Union
IRIRC	Islamic Republic of Iran Railway Company
IRISL	Islamic Republic of Iran Shipping Line Company
ISO	International Standard Organisation
I-O	Input-Output analysis
INTERAX	Interactive Cross-Impact
ISLB	Iranian Sea-Landbridge
IMF	International Monetary Fund
km	Kilometre
LASH	Lash Aboard Ships
LGVs	Light Goods Vehicles
m	metre
MRT	Ministry of the Roads and Transport
NAFTA	North American Free Trade Agreement
NITC	National Iranian Tanker Company
NOVCCs	Non-Vessel Operating Common Carriers

NVO-MTO	Non-Vessel -Operating Multimodal Transportation Operators
OPEC	Organisation of the Petroleum Exploration Countries
O/D	Origin/Destination
PSO	Ports and Shipping Organisation
PBO	Planning and Budgeting Organisation
PAS	Productivity of Agricultural Sector
PSD	Port Staying Days
RA	Regression Analysis
r^2	Coefficient of determination
RO/RO	Roll On Roll Off
Rb	Rouble
SDEP	Societal Discussion on Energy Policy
SOTRA	Soyz Venesh Transit
sq.	Square
$	United States of America's Dollar
TOFC	Trailer On Flat Cars
TEU	Twenty-Foot Equivalent Unit
TSR	Trans-Siberian Railways
TCR	Trans-Chinese Railways
TIR	Traffic International des merchandises par Route
TAR	Trans-Asian Railways
TECG	Trans-Europe-Container-Express
TEEM	Trans-Europe- Express-Merchandises
TDI	Turkish Maritime Organisation
TCDD	Turkish Comhuriyeti Develt Demiryollari
ULCC	Ultra Large Crude Carrier
USSR	Union of the Soviet Socialist Republics
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UK	United Kingdam
US	United States
USA	United States of America
VAA	Value Added of Agricultural Sector
WTO	World Trade Organisation

Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award.

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A programme of advanced study was undertaken, two papers prepared for publication and external contacts made.

Publications:

* Transport development in Iran: a new role as a landbridge country
* Long term demand and supply planning, forecasting, and evaluation for a landbridge: a scenario approach

External Contacts:

* Ministry of Roads and Transport of the Islamic Republic of Iran (Tehran)
* Central Bank (Bank Markazi) of I.R of Iran (Tehran).
* Programming and Budgeting Organisation of I.R of Iran (Tehran).
* Statistical Centre of I.R of Iran (Tehran).
* Embassy of the Republic of Azarbaijan (London)
* Embassy of the Republic of Armenia (London)
* Embassy of the Republic of Georgia (London)
* Embassy of the Republic of Kazakhstan (London)
* Embassy of the Republic of Russia (London)

Signed [illegible]

Date 13/6/1997

1. Statement of the problem and objectives

1.1 Background

This research investigates the potential of Iran as a landbridge country for the eight new independent Caucasus and Central Asian countries of the Former Soviet Union (FSU). The concept "landbridge" refers to the different types of integrated origin-destination international movements of shipments (in various combinations of sea, land and air) under a single waybill.

The collapse of the Soviet Union in 1991 has changed greatly the geo-political environment of the world and has introduced new opportunities for all the former Soviet republics and also for neighbouring countries including Iran. Prior to the collapse, the economy and trade of all former republics had been centrally controlled by the Soviet Union, and decisions were based, not on specific requirement of the republics, but on the Soviet Union's objectives, often of a military nature.

The Central Asian and Caucasus (CAC) countries are eight republics of which four (Armenia, Uzbekestan, Tadjikestan and Gyrkyzestan) are landlocked. Three, bordering the Caspian Sea, (Azerbaijan, Turkmenistan and Kazakhestan) have summer access through the Volga-Don rivers to the Baltic and Black seas.

After the collapse of the former Soviet Union, the landlocked CAC countries, which are rich in raw materials and cotton, have created new opportunities in world trade and need reliable access to new trading outlets and routes (Tat 1995, Sajadpour 1994). For these countries, located far from international waters particularly for southward trade, the transport costs are high and there are difficulties in developing or attracting large scale trade or manufacturing activities (Reitsma 1980).

1.2 Significance of the problem

Iran has an ideal location as the closest maritime country to the south and west of the CAC countries. The port of Imam in the South of Iran is about 1800 km to the Azerbaijan and Armenian capitals, and the port of Abass about 1600 km from the nearest Central Asian capital in Turkmenistan. Iran, with direct land and sea access covering more than 800 km of borders with three of these countries (Azerbaijan, Armenia, and Turkmenistan), is well placed to serve as a landbridge using different modes, routes and border crossings (Stone 1993, Herzig 1995).

Iran has common interests with the CAC countries in terms of culture, religion, history and national security. According to Garabaghi (1994, p. 115):

> "Iran represents at once a source of cheap energy for those republics lacking energy resources, and a transportation routes to the Persian Gulf for those who seek to export oil and gas in order to earn much needed foreign currency".

Iran is more likely to develop close links with several smaller neighbouring countries with such common interests, than with a super-power which is ideologically different (Herzig 1995). A significant issue is the future trade of these countries, newly released from the tight planning control of the former USSR, and in particular, the likely long-term routes for their foreign trade. Iran has potential for such routes with its reasonably developed transport infrastructure compared with neighbouring countries. Until independence the CAC countries had not made use of Iranian transport services.

1.3 Purpose of the study

In the light of the preceding discussion, the main purpose of this study is:

> To review the landbridge concept and practices and to develop a model appropriate to Iran and the CAC countries. This model will assess the potential of the transport system of Iran, and identify influential variables affecting its volume and supply. It will evaluate the implications of Iran acting as a landbridge between the CAC countries and the rest of the world.

The study focuses on the domestic and international trade of Iran as well as the predicted future trade of the newly independent Central Asian and Caucasian Republics of the former Soviet Union. In particular, it examines whether Iran has a role to play as a landbridge.

1.4 Previous research

Although there is some published literature directly relevant to this study, and included in the literature review, there is a lack of systematic studies of landbridge systems, and none on the potential of Iran in this context.

1.5 Thesis structure

The Iranian Sea landbridge study consists of ten chapters. Chapters two and three review in detail Iran and the eight CAC countries in terms of information relevant to this research. Therefore, it looks at the economy, the transport infrastructure, the physical and vehicular network and operational characteristics of modes and interfaces. For the CAC countries the economy and the composition, value and direction of international and inter-republic trade is examined.

Chapter four reviews the landbridge concept, with examples. Different bridge concepts are identified and the most important examples assessed and compared under the four broad headings of geographical, political, technical, and organisational aspects.

Chapter five compares the potential of the Iranian Sea landbridge (ISLB) model with potentially competing landbridges and routes, also under the four broad headings outlined above.

Chapter six introduces the scenario approach as an analytical tool and the characteristics of the scenario approach are studied. The key issues related to the ISLB project are identified and developed as the conceptual model of the research.

In chapter seven, an operational model is developed, requiring the selection of appropriate time periods, units of measurement and levels of accuracy.

The ISLB scenario analysis and forecasting is carried out in chapter eight. By means of a multiple regression analysis applied to the data prepared in chapter seven, three models of demand for the ISLB are developed in a preliminary analysis. These are based on the general cargo and foreign trade of Iran (GOPFT), domestic trade of Iran (DOMTI), and Central Asian and Caucasus foreign trade (CACFT). Three ISLB scenarios are then developed according to most probable, optimistic, and pessimistic assumptions.

Chapter nine assesses the potential and requirements of the ISLB transport supply from a base year of 1993 up to the year 2005 for each of the three scenarios. Conclusions related to the research are drawn in chapter ten and several recommendations are made for further research.

2. Iranian trade and transport

2.1 Introduction

The aim of this chapter is to examine the main trends in the economy and transport demand and supply of Iran in the context of the potential for an Iranian landbridge. It describes recent economic developments in both domestic and foreign trade and in transport within the Islamic Republic of Iran. It is directed particularly to changes after 1979 which occurred during and since the war with Iraq.

2.2 The Iranian context

2.2.1 Geographical features

The Islamic Republic of Iran is a maritime country located in the south-west of Asia between the South Caspian Sea in the north and the Persian Gulf and Oman Sea in the south. Mountains cover about 90% of its land mass with a vast plain in the south west. Iran has a land area of 1,648,000 sq./km which is approximately equal to the size of Britain, France, Germany, Switzerland, Belgium and Denmark combined. It supports a population of about 55 million with a density of 37 people per square hectare and is the sixteenth largest country in the world.

The coastline of 2700 km accounts for some 2043 kms on the Persian Gulf and Indian Ocean, and 657 km on the Caspian Sea. The country is characterised by three distinctive geoclimatic regions. The semi-arid region has two-thirds of the land mass and one-third of the population, and contains most of the economic and industrial activities. The moderate mountainous region lies mainly from the north west to the central part, and the moderate Caspian region covers a strip along the Caspian Sea.

Iran borders seven countries as shown in Figure 2.1. There is all-season access to ports in Russia, Kazakhstan, Turkmenistan and Azerbaijan to the North through the Caspian Sea, and during the summer through the Volga, the Don, the Baltic and the Black Sea (Badiyee 1993).

2.2.2 Demographic and administrative characteristics

The Islamic Republic of Iran is divided into 24 administrative territorial provinces called Ostans (see Figure 2.3) with 229 major towns, 47 of which have a population of more than 100,000.

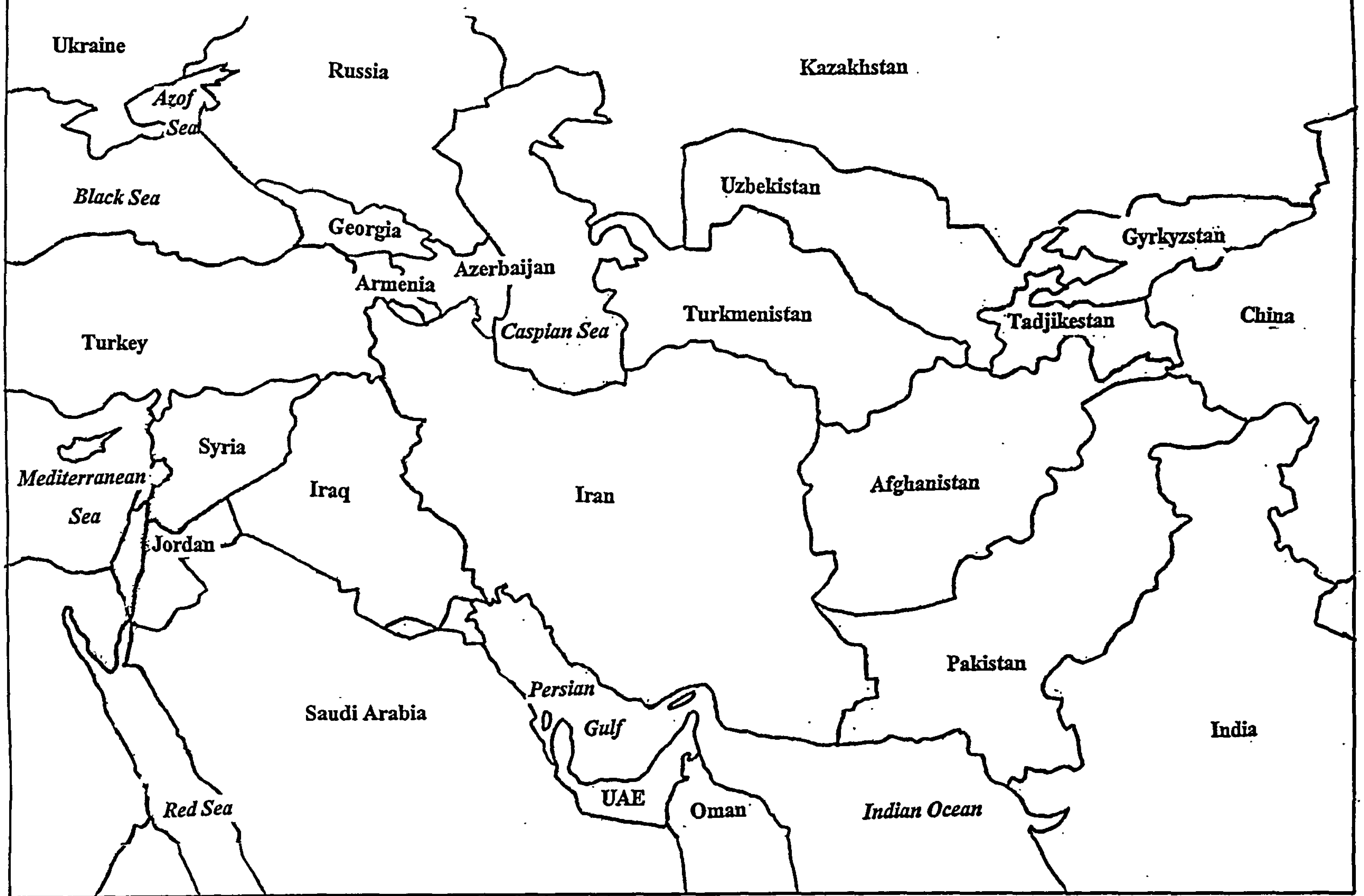
Iran had a population of about 55 million in 1991 (SCI 1993, p. 44) of which 57% live in urban districts and 17.9% live in greater Tehran. The other major populated provinces are Khorasan, East Azerbaijan and Esfahan with populations of about 6 million, 4.4 million, and 3.7 million respectively.

2.2.3 Economic background and composition

Iran is a mineral-rich country, and one of the biggest oil and natural gas producers in the world with considerable reserves. The oil reserves are about 88 billion barrels with gas reserves of about 400 trillion cubic feet. Iran is also substantially rich in other undeveloped mineral deposits e.g., copper, iron ore, copper lead, manganese, coal, sulphur and chromate. It is the world's largest producer of turquoise and fifth largest producer of zinc and copper.

The economy of Iran, like that of many of its neighbours, is tied strongly to the income from the oil industry as shown in Table 2.1. The macroeconomy of the pre-revolutionary period was damaged because of the revolutionary process during 1978-79. Oil production fell by 85% in 1979, and again in 1980-81 at the beginning of the war with Iraq. But the economic and monetary reserves after the Islamic revolution and during the eight years' war with Iraq

Figure 2.1 Location and political administration of Iran in south west Asia.



The borders on this Figure are for illustration purposes only.

were strong enough to resist the cost burden of the war (Herzig 1995).

Table 2.1 Share of oil and gas, and tax in revenues in Iran (%).

Year	1989	1990	1991	1992	1993
Oil & Gas	46.9	59.8	51.1	52.0	72.5
Tax	37.4	30.1	39.9	38.2	20.1
Others	15.7	10.1	9.0	9.8	7.4

Source: Based on the Central Bank (Bank Markazi) National Accounts Reports for 1989-1993 various pages.

Political factors, including unresolved problems with the U.S.A, the eight year war, and the fall in oil prices, caused the economy to have low rate of growth, especially in industry and in oil which were the main war targets. High inflation, the falling value of the currency, increased unemployment, shortage of hard currency, low productivity and the closure of some industries, the lack of raw materials, spare parts, etc. were among the main results of the war, and weakened the economy during 1979-1988.

Since 1988, many light and heavy industries have been privatised to increase their efficiency and reduce the role of oil in the economy, and also to reduce the close relationship between imports and the value and volume of crude oil exports (Ehteshami 1995).

In terms of Gross Domestic Product (GDP), as presented in Table 2.2, the major contributors to GDP on average for 1979-1993 (excluding the service sector) were agriculture (23.5%), industry and construction (19.8%) and oil (16.9%).

The principal economic aim of the government since the war with Iraq has been to free the economy from strict controls, and to repair the damage caused to the country's over-stretched infrastructure, especially to its petroleum and transport facilities. This has been attempted by the promotion of the private sector.

Table 2.2 Sectoral contributions in the economy of Iran, 1982 fixed prices (bn. Rials).

Year	Agricultural	Mine	Industry & Construction Gas, Elec. & Water	Oil	Services	Final GDP *	GNP
1979	1851.2	51.7	1722.0	2535.2	4964.4	10551.3	10574.1
% GDP	17.6	0.5	16.4	24	47.1	105.6	
1980	1914.9	53.9	1820.5	866.1	4855.0	9555.5	9559.6
% GDP	20	0.7	19.1	9.1	50.8	99.7	
1981	1952.7	55.6	1819.5	882.6	4507.2	9320.7	9345.7
% GDP	21	0.6	19.5	9.5	48.4	99	
1982	2091.4	65.2	1818.8	1947.7	4543.4	10539.8	10539.8
% GDP	19.8	0.6	17.3	18.5	43.1	99.3	
1983	2193.0	71	2183.6	2006.3	5135.6	11934.7	11939.0
% GDP	18.4	0.6	18.3	16.8	43	97.1	
1984	2353.7	74.1	2290.2	1625.6	5269.5	12043.8	12047.8
% GDP	19.5	0.6	19	13.5	43.8	96.4	
1985	2537.6	71.6	2160.6	1644.4	5373.2	12072.3	12057.6
% GDP	21	0.6	17.9	13.6	44.5	97.6	
1986	2650.5	62.3	1970.4	1403	4654.7	10248.9	10250.7
% GDP	25.9	0.6	19.2	13.7	45.4	104.8	
1987	2715.8	65.5	2018.6	1598.7	4340.5	10368.1	10359.2
% GDP	26.2	0.6	19.5	15.4	41.9	103.6	
1988	2648.0	56.6	1921.5	1754.0	4030.2	9468.0	9451.1
% GDP	28	0.6	20.3	18.5	42.6	110	
1989	2746.0	58.6	2050.5	1889.5	4146.5	9781.5	9797.0
% GDP	28.1	0.6	21	19.3	42.4	111.4	
1990	2967.5	63.1	2328.7	2264.7	4499.6	10930.2	10997.5
% GDP	27.2	0.6	21.3	20.7	41.2	111	
1991	3120.2	68.4	2733.6	2516.7	4945.9	12181.2	12377.9
% GDP	25.6	0.6	22.4	20.7	40.6	109.9	
1992	3351.6	72.2	2860	2553.5	5343.5	12477.8	12985.6
% GDP	26.9	0.6	22.9	20.5	42.8	113.7	
1993	3535.7	76.8	2923.2	2645.3	5743.7	13101.0	13400.8
% GDP	27	0.6	22.3	20.2	43.8	113.9	

Source: Based on the Central Bank (Bank Markazi) various National Accounts reports for 1974-1987, 1988-1990, 1991, 1992 and 1993.
* : Final GDP after adjustment by the Central Bank which makes the total higher or lower than 100%.

2.3 Transport

2.3.1 Organisation

The administration of Iranian Transport is distributed among the ten different ministries of Road and Transportation, Constructive Jahad (mainly rural regions), Oil, Agriculture, Interior, Defence, Industry and Mining, Commerce, Finance and Economy, and Justice. Figure 2.2 shows the flow chart of all the ministries and organisations involved in roads and transport in Iran, of which the Ministry of Roads and Transport (MRT) has the largest role, with responsibility for all modes (except merchant and tanker fleets). They are also not responsible for border- crossing terminals. MRT has different internal and external roles, both in the national capital, and in all 24 provincial capitals; the internal body of this ministry is mainly responsible for road construction, maintenance and supervising the traffic management of both passenger and freight movements and vehicles on roads. The external bodies include Rail, Road Developments, Ports and Shipping (Maritime) Administration, Airlines, Airports and their relevant industries, and are responsible to the government and parliament for the functioning of management, operation, construction and maintenance of all transport activities.

2.3.2 Road transport

2.3.2.1 Road networks and standards

The construction and maintenance of roads within a country like Iran is not only difficult, but also costly and time-consuming. A total road network of 167,156 km connects all provinces, cities, towns and villages, excluding roads between small villages, making a road density of about 10.14 km per 100 sq./km.

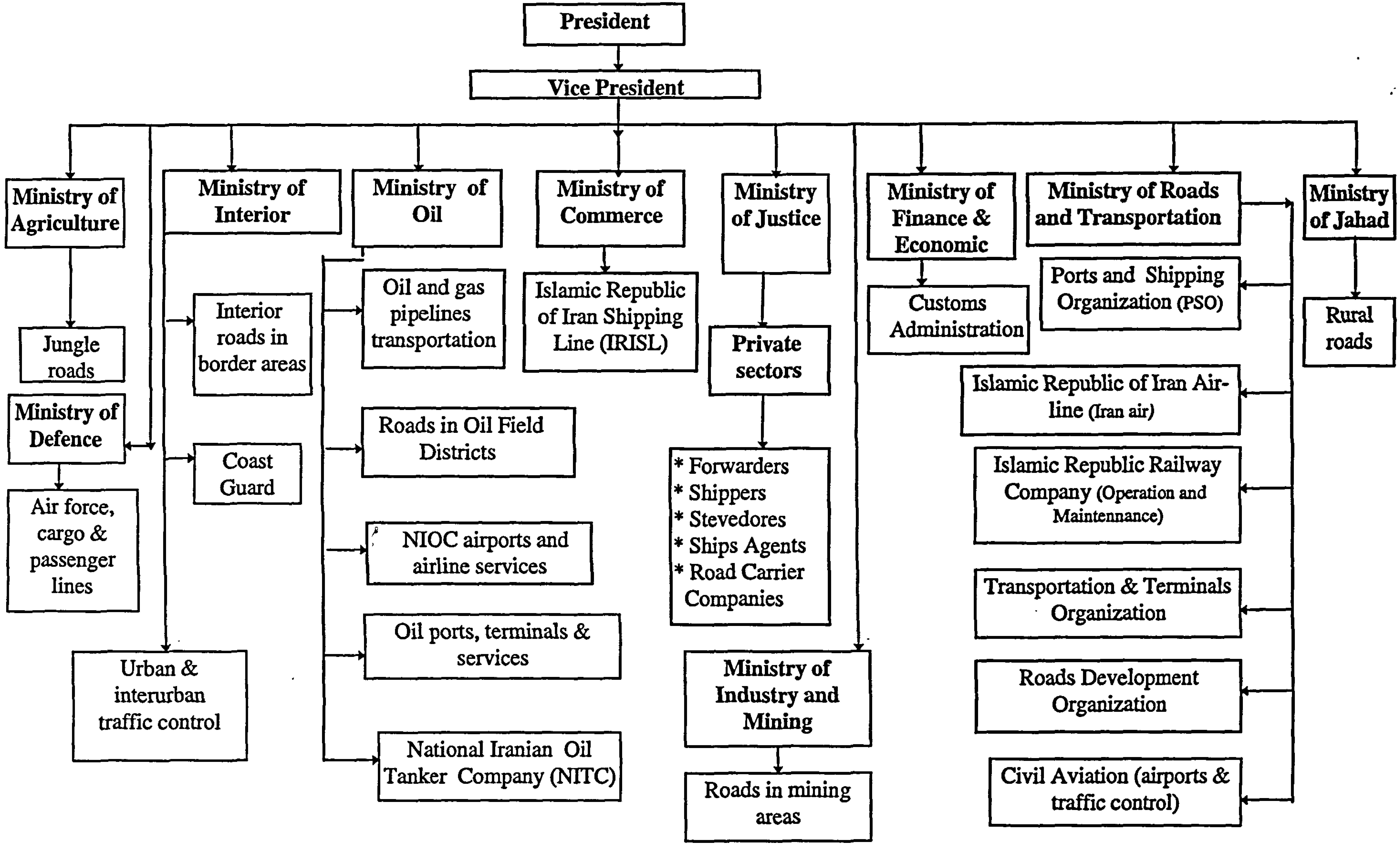
The national and provincial roads which are under the supervision of MRT are mainly distributed on the basis of economic activity, maritime connections, strategic locations, and size of the provinces. Table 2.3 shows the details of national and provincial roads under the supervision of the MRT. National roads are asphalt and connect 24 provincial capital cities and some major industrial towns. Provincial roads are those which link minor towns within each province.

Table 2.3 National and provincial roads of Iran under the supervision of Ministry of Roads and Transport in 1992 (km).

Type of roads	Main	Secondary	Access	Total MRT
Road length	20130	39589	12938	72656
%	28	54	18	100

Source: Statistical Centre of Iran (SCI) (1993), Iran Statistical Yearbook for 1992, p. 388.

Figure 2.2 The state structure of transport in the Islamic Republic of Iran 1995.



The quality of roads ranges from ungraded dirt roads to the modern multi-lane divided highways. Highways and expressways constitute only 1.3 % of the total road networks. Freeways as shown in Table 2.4 form 2.36% of the total and 33% of them originate from Greater Tehran; Ordinary and second class roads constitute the structure of the secondary roads (see Table 2.5).

Table 2.4 Composition shares in main roads of Iran in 1992.

Type of roads	Free ways (6 lanes)	Express roads (4 lanes)	Wide roads (13-13.3m)	Ordinary roads (11m)
%	2.36	4.97	20.9	71.71

Source: Same as Table 2.3, p. 388.

Table 2.5 Composition and length of the secondary roads of Iran in 1992 (km).

Type of roads	Wide paved (9m)	Ordinary paved (8m)	Second class (7m)
Length	6049	18624	14916

Source: Same as Table 2.3, p. 388.

Khorasan as the largest province, and Khosestan as an important industrial centre hold the highest proportion of total roads in the country. Table 2.6 shows the provincial and national share of roads (SCI 1993) among the 24 states of Iran under the supervision of MRT.

The main objective of the first ten years of the Islamic government (1979-1988) was to develop rural roads. Therefore, all types of roads were increased from 92,353 km in 1979 to 167,156 km in 1987. During the same period only 4,831 km of main road and 401 km of freeways were constructed.

Table 2.6 Share of 24 provinces in all national and provincial roads under the supervision of the Ministry of Roads and Transport (MRT) 1992.

Provinces	Tehran	Markazi	Gilan	Mazandaran	East Azerbaijan	West Azerbaijan
%	2.76	2.11	2.3	4.7	6.57	4.42
Provinces	Kerman-shahan	Khosestan	Fars	Kerman	Khorasan	Esfahan
%	3.18	10.48	8.23	6	10.9	5.11
Provinces	Sistan & Baluchestan	Kurdestan	Hamedan	Chahar-Mahal	Lorestan	Ilam
%	6.97	2.96	2.21	2.21	2	1.66
Provinces	Koh-Giloyeh	Bushehr	Zanjan	Semnan	Yazd	Hormozgan
%	1.3	2.16	4.16	2.35	2.06	3

Source: SCI of Iran (1993), Iran Statistical Yearbook for 1992. P.388.

2.3.2.2. Road surfaces in Iran

Road surfaces considerably affect the operating costs of vehicles, particularly the cost of fuel, spare parts, tyres, maintenance and safety. There were restrictions on the maintenance of roads during the war with Iraq, but they have been maintained to a reasonable standard to match economic services and provide a faster transit time for trade. Table 2.7 shows an estimate of the conditions of four classes of paved road surfaces at the end of 1988.

Table 2.7 Paved road surface conditions in Iran after the war in 1988.

	Type of Roads	% Quality of roads			
		Good	Fair	Poor	% Total
1	High-ways	40	40	20	100
2	National roads	50	20	30	100
3	Provincial	50	30	20	100
4	Others	30	40	30	100

Source: Ministry of Finance and Economics (1992), unpublished report, annex 4, p. 5.

2.3.2.3. Road fleets: ownership and use

Transport services are provided by both the private and public sectors. Different types of private ownership contribute widely to the movement of both passengers and freight throughout the Iranian road network.

The proportion of trailers and lorries to vans and private cars is low and carriers mainly pull single trailers only (with a maximum weight limit of 38 tonnes, length of 16, and height of 4.5 metres). In terms of types of commodity, road freight fleets mainly carry agricultural products, followed by minerals (construction) and industrial products. There has been a sharp increase in the number of motor vehicles since the mid-1960s when the first Iranian car assembly plant was established. Table 2.8 shows the growth in road vehicles registered since 1979. The dramatic changes in 1987 result from the official count of existing lorries by the Islamic Republic Iranian Disciplinary Forces, and take into account out-of-service vehicles.

The supply of lorries or heavy goods vehicles (HGVs) has not coped with the demand, resulting in periodic congestion in ports. Restricted supply has resulted from restrictions on imports, insufficient foreign exchange for purchasing HGVs, the limitations of heavy goods manufacturing factories, and increases in the purchase price of all types of vehicles, particularly goods vehicles.

Table 2.8 Development of different types of motor vehicles in Iran.

	Sedan & Ambulance	Goods vehicles	Buses & Minibuses	Vans	Motor cycles	Total
1979	1367953	260829	42324	27830	290346	1989282
1980	1463406	271510	44825	36999	372675	2189737
1981	1539915	280828	48342	42355	435309	2347125
1982	1604118	293229	50802	48375	472138	2469092
1983	1687985	306225	55550	56702	571287	2678259
1984	1778826	345010	62462	75643	604226	2866167
1985	1884489	355065	68502	118554	633728	3060338
1986	1923937	362295	72716	141051	662919	3162918
1987	1916612	260089	102455	490439	966466	2810929
1988	1977289	262068	103475	496189	979864	3818885
1989	1996674	263781	105528	500409	993242	3859634
1990	2008504	265511	106374	505229	1000280	3885898
1991	2074130	280600	113720	534860	1024615	4027925
1992	2148903	299554	120749	575898	1062924	4208028

Source: Data for 1979-1981 is based on SCI (1982), Iran Statistical Yearbook for 1981, p. 588; for 1982 SCI (1990), English version No. 6, p. 125; data for 1984-1987 is based on SCI (1989), No. 7, pp. 142-144; for 1988-1989: SCI (1991), No. 9, p. 136; for 1990: SCI (1992), No. 10, p. 154; for 1991-1993: SCI (1995), No. 13, p. 125.

Table 2.9 shows the age of the goods fleet in Iran during 1963-1987. The average age of the Iranian heavy goods vehicles fleet is over 15 years, suggesting that 94% of vehicles are not economically viable.

Table 2.9 Growth of road goods vehicles in Iran during 1963-1987.

Type	1963-67	1968-73	1973-77	1978	1979	1980	1981	1982
Lorries	2435	6879	24071	3653	1719	2130	2357	2238
Road tankers	572	1322	5174	563	207	266	404	1017
Trailer	485	1414	7961	445	208	244	239	777
Dump	1452	3513	13965	1746	832	857	883	1128
Reefer	14	68	430	69	25	51	165	88
Vans	1219	10572	89964	27602	101155	11128	13601	16267
Others	254	695	2094	457	169	185	251	293

Type	1983	1984	1985	1986	1987
Lorries	3726	4014	3403	1695	392
Road tankers	2161	935	557	363	125
Trailer	2856	2144	627	442	164
Dump	2455	2108	2015	903	349
Reefer	156	226	102	54	21
Vans	48841	45661	36543	17196	5521
Others	533	683	426	270	125

Source: SCI (1991), Statistical reflection of Iran, No. 9. p. 138.

According to the MRT, HGVs which are engaged in long distance domestic and international trade are categorised on the basis of higher and lower than 10 tons capacity (i.e. heavy or light goods vehicles).

Table 2.10 Number and types of all heavy goods vehicles in Iran in 1987.

Heavy goods vehicles	Lorries	Road tankers	Trailers	Dump	Reefer	Vans	Others	Total
Number	63472	14851	19748	34717	1672	345683	7718	487861
%	13	3	4	7.1	0.34	70.9	1.9	100

Source : SCI (1991), Statistical reflection of Iran, No. 9. p. 138. Inconsistency is due to different sources

The most detailed available published data about composition and capacities (load limits) of the Iranian heavy goods fleet was issued by MRT in 1987 and 1991 (see Table 2.10, 2.11 and 2.12). These generally indicate that there were 97,964 operating vehicles of which 10-20 tonne vehicles at 58% of the total number are the backbone of the fleet, followed by 20-30 tonne vehicles at 26%.

Table 2.11 The number of heavy goods vehicles of greater than 10 tonnes according to type and carrying capacity in Iran in 1987 (unit: tonnes).

Type/ carrying capacity	10 to 20	20 to 30	Others	30-38	38 & more	Total type
Trailers	1614	15165	630	476	1863	19748
Lorries	28865	1772	10144	-	-	40781
Road tankers	5944	5414	122	151	1084	12715
Dump	19045	1395	483	-	-	20923
Reefer	254	713	24	19	54	1064
Others	1239	561	818	39	106	2763
Total in capacity	56961	25020	12221	685	3107	97994

Source: Same as Table 2.10.

Table 2 .12 Composition and number of road vehicles in Iran in 1991.

Vans	Van-taxi	Taxi	For-hire	Mini-bus	Bus	Heavy goods vehicles	Total road vehicles
249370	241091	46202	18046	59706	24374	170370	809129

Source: Sanate-Hamlo-Naghl, (1993a), 809 thousand vehicles in service for road transport of Iran, Farvardin, 1993, No. 116, p. 19.

The most recent statistics of the road transport fleet of Iran (Atrchiyan 1995) as shown in Table 2.13 indicate that 50% of the total is devoted to vans with less than one tonne capacity while the HGVs of 13.5-22.5 tonnes capacity moving over long distances have 48% of the total.

Based on SCI (1994a, p. 311), applying the growth of 1992 (18,954 HGVs) and 1993 (9,651 HGVs) to the total number in 1991 (see table 2.12) the number of HGVs was estimated for 1993 as about 198,975. The distribution of the domestic trade mainly takes place by trucks of lower than 13.5 tonnes carrying capacity. HGVs of 13.5-22.5 tonnes carrying capacity have a significant role in the import/export of foreign trade through ports and border crossings (Atrchian 1995). Assuming the share composition in 1993 is similar to 1994, the number of these trucks was about 95508 in 1993.

Table 2.13 Share of different HGVs fleet capacities in 1994 (capacity: tonnes).

Capacity	1.75	5.75	9.5	13.5	18	22.5	27.5	over 30	Total
% of total	7	19	22	18	7	23	1	3	100

Source: Atrchian, (1995), Sanate-Hamlo-Nagle, No. 140, Tir, p. 23.

The road freight industry (Sanate-Hamlo-Naghl, 1993a), has about 958,623 employees equal to 6.42% of the total 14,934,000 employed population of the country in 1993 (Central Bank of Iran, 1993); about 78,1457 persons or 81.5% of the total employees in the road freight industry run their own vehicles.

The road census in 1993 indicates that 48.1% (769,849 vehicles) of the total traffic, can be accounted for by freight transport, whilst 47.2% (755,754 vehicles) is passenger transport, and the remaining 4.7% being of other types. The composition of inter-urban freight traffic is limited to vans (47.6%), lorries with two axles (24.4%), lorries with three axles or more (13.3%), road tankers (6.2%) and trailers (8.5%) (MRT 1994).

2.3.2.4 Road freight rates and financing

MRT is responsible for the preparation and enforcement of the freight tariffs for all the transport network, while the National Economic Council is in charge of the ratification and final approval of all transport tariffs in Iran. This Council consists of the President and Vice President, the Head of Planning and Budgeting Organisation and almost all ministers of the Cabinet.

At present tariffs are based on the combination of two systems. The list system is based on a few tables which determine the tonnes/km rate, and explain different categories of goods. In this system, cargoes and goods are categorised into four broad classes of metallic cargoes and containers, perishable and bagged, bulk cargoes, and dangerous goods. In the second system which was established in 1992 the freight rates are a function of the capacity of the goods vehicle, distance travelled (extracted from a standard table), and a tonnes/km rate of 14-18 Rials. Therefore:

Freight Rate = Vehicle Capacity x Distance x (14-18) Rials

The Ministry of Finance and Economy is responsible for collecting all the state income originating from oil, gas and related products, while the Programming and Budgeting Organisation (PBO) as an affiliated body to the Finance Ministry is in charge of national expenditure.

Transport policies are determined and issued by the Supreme Transportation Council and the Cabinet. Port dues and charges (i.e. tariffs) are prepared and approved by the Council of Ministers and Parliament, but inland freight and passenger fares through the Council of Transportation. All national and provincial long and medium term plans and projects are made in collaboration between the Ministry of Finance and Economy and the PBO.

2.3.2.5 Importance of transport modes to GDP

The importance of the transport sector to Iran's economic and social life can be measured on different bases and levels such as the contribution to GDP, employment, balance of payments and the investment created by the sector. Relevant statistics are published annually by the Central Bank of Iran (Bank Markazi) and the Statistical Centre of Iran (SCI).

Iran, as a big country, has road goods vehicles mainly for long distances of above 1000 km for imports and exports, but domestic traffic (particularly associated with farms) varies with the seasons. Shipments by manufacturers are more stable but from Tehran and the central provinces to all other parts of the country are mainly increasing as a result of wholesale provincial delivery or direct delivery to small dealers in major cities and towns. The type of vehicle used for this kind of trade depends on volume, but usually small goods vehicles and vans of up to 10 tonnes are used. The pattern of demand for goods and passenger movements in Iran is based mainly on the uneven geographical distribution of population and industrial activities in the country. The country's geographical features have caused transport costs to be rather high. Long distance haulage requires high initial goods vehicle depreciation and intensive use of spare parts. This is particularly important for fleets which are continuously engaged in imports of foreign trade between the southern ports and other areas, where there are likely to be empty return journeys. Both domestic and foreign trade flows are carried out over long inland distances as a result of the geography of the country.

2.3.3 Rail transport

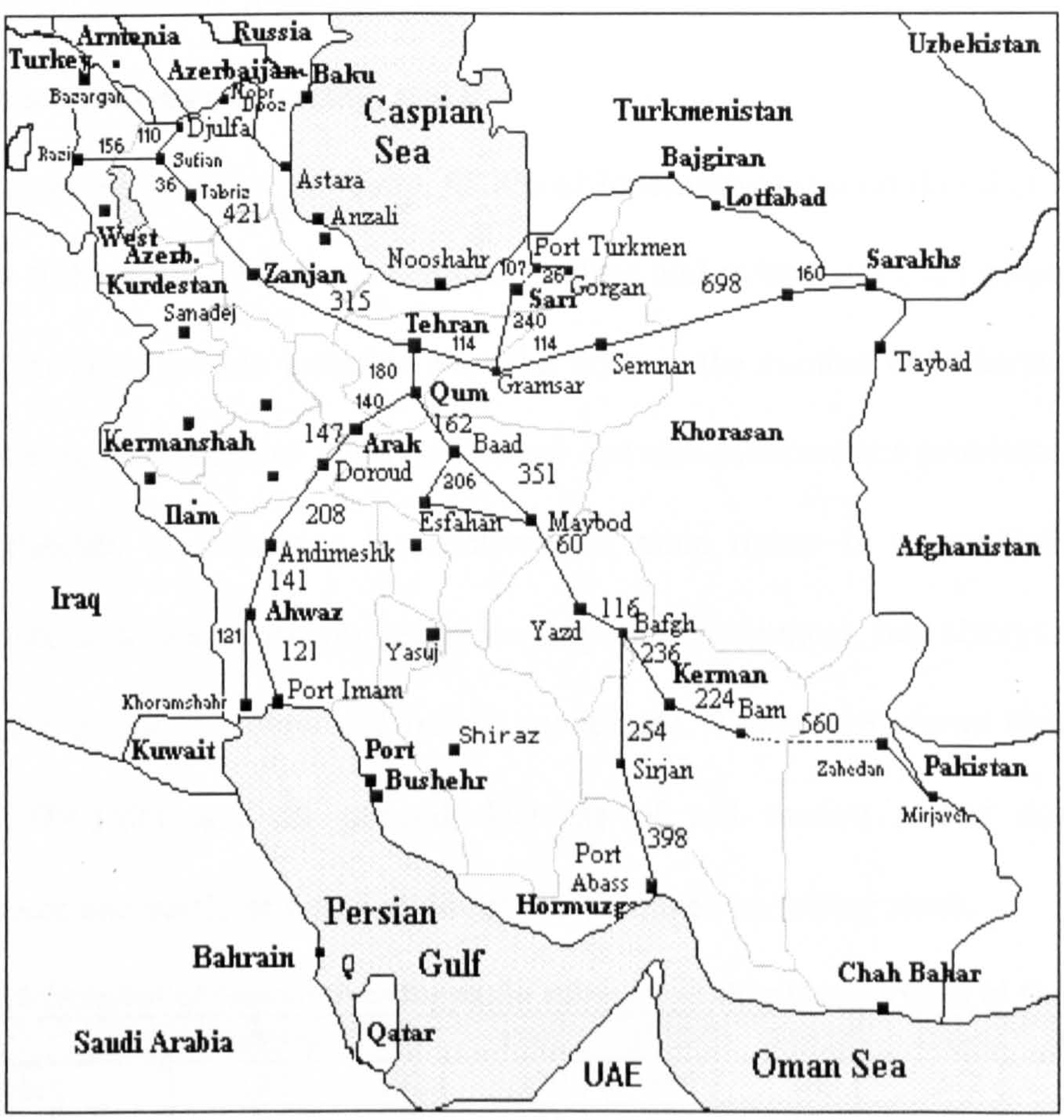
2.3.3.1 Organisation and development

The Islamic Republic of Iran Railway Company (IRIRC) consists of rail line operations and maintenance of passenger and freight services along domestic and international networks consisting of 5,020 km standard gauge track in 1993, excluding the small narrow gauge isolated from the main network and connected to the Pakistan railway. The railway is owned and run by the government. The rail network is mainly single track and non-electrified although there are extensive approved development plans in both aspects. The IRIRC was restructured in 1987 (IRIRC 1986-90) from a purely public entity into a public company to enable it to perform more efficiently. Operations are under company control, while construction and development are directly run by the MRT.

2. 3.3.2 Network characteristics

Tehran functions as a hub for the mainly single line network as shown in Figure 2.3 and therefore the network is poor in terms of speed. In terms of connectivity it directly crosses 14 of the 24 provinces and through about 54 main stations to the end destinations in the main geographical route directions. In terms of freight it is purpose-built to serve the southern ports of Imam and Khoramshahr to Tehran and then to the east coast of the

Figure 2.3 Islamic Republic of Iran railway network, major ports and border crossings in 1995.



Source: Map is based on CD ROM: World Atlas for Multimedia IBM PC and compatible versions 4, 1991-1993. Distances Based on Thomas Cook Overseas Timetable, March-April 1995, p.282.

Caspian Sea and main border crossing points of the country with the FSU (Djulfa) and with Turkey (Razi). The railways of Iran have are in a poor condition and unmodernised. The war with Iraq and over-utilisation has worsened the network and reduced the speed of trains. From 1986 and particularly during the 1989-1993 First Economic Development Programme after the Islamic revolution, a planned programme forrenewal and rehabilitation of tracks was adopted and executed (IRIRC 1984-1993). It can be seen in Table 2.14, that during this period IRIRC made substantial progress (Sanat-e-Haml-o-Naghl 1993b).

Table 2.14 Improvement and development of rail tracks in Iran during the. First Economic Development Programme (km).

	1989	1990	1991	1992	1993
Rehabilitation	95	130	120	150	150
Renewal	20	70	75	130	150
New lines	-	260	82	145	392

Source :IRIRC (1984-1993), performance report of the Islamic Republic Iranian Railway Company for 1984-1993, p. 21.

2.3.3.3 Locomotives and rolling stock

As an oil producing country, 97.8% of locomotives run on diesel (1.5% electrified, and 0.7% turbotrain). The number of locomotives and rolling stock are given in Table 2.15 showing the considerable variation over the years in the number of in-service locomotives and indicating the shortages in driving power and also maintenance problems.

The availability of in-service locomotives for main routes in a mountainous and vast country like Iran, which mainly relays on imported equipment, has always been a critical issue and a reason for slow rail freight movement. Table 2.15 shows these fluctuations during 1979-1993 and the general decrease of rail motive power due to age and maintenance and partly as result of direct war damages on rolling stock.

Table 2.15 Number of locomotives for main routes and shunting services of the IRIRC (unit).

	1979	1980	1981	1982	1983	1984	1985	1986
Main routes	128	102	120	166	169	242	247	239
Shunting	22	62	105	161	151	76	73	74
Total in service	150	164	225	237	320	318	320	313
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	
Main routes	227	148	169	176	150	163	156	
Shunting	77	58	67	65	63	53	52	
Total in service	304	206	236	241	213	216	208	

Sources: PBO (1989-1993), the preliminary results of the first social, cultural and economic development plan of the Islamic Republic of Iran, transport sector, unpublished, p. 1-11; IRIRC (1984-1993), p. 17.

The capacities of all types of in-service rail freight cars in 1990 was about 623,453 tonnes. The development of rail of wagons is shown in Table 2.16. They consist of eight types, of which the proportions are shown in Table 2.17.

Table 2.16 The development of freight railcars in Iran.

Year	1979	1980	1981	1982	1983	1984	1985	1986
Freight railcars	12422	12247	11750	12265	12150	12422	11750	12205
Year	1987	1988	1989	1990	1991	1992	1993	
Freight railcars	13074	13074	12439	12224	12629	13000	14400	

Sources: IRIRC (1984-1993), p. 18; PBO (1989-1993), p. 1-11.

The age of the rolling stock of IRIRC is rather high (14.9 and 18 years for locomotives and railcars respectively in 1993). The rate of renewal and replacement of locomotives and freight wagons during the First Economic Development Programme 1989-1993, was rather slow (Sanat-e-Haml-o-Naghl 1993b) achieving only 63 locomotives and 1771 wagons, which was 65.6% and 44.3% respectively of the programme targets. The composition and number of the above-mentioned manufactured rolling stock is shown in Table 2.18.

Table 2.17 Composition of eight major types of freight railcars of IRIRC in 1990.

Railcars type	Covered	Low sided	Wided flat	High sided	Flat	Tank	Ballast	Ore high sided
Number	2900	1995	180	3170	420	2543	750	892
%	23	16	1	24	3	20	6	7

Source: IRIRC (1986-1990), English Version. p. 46

Table 2.18 Composition and number of the eight major types of domestic manufactured freight railcars of IRIRC during 1984-1993.

Wagon production	Covered	Flat	Ballast	Tank	Ore	Coach	Diesel locomotives	Bulk cement
Number	380	261	190	1718	1677	86	3	80

Source: IRIRC (1984-1993), p. 22.

2.3.3.4 Operations of the IRIRC

The comparison of the annual freight performance of IRIRC during 1979-1993 indicates that there has been a 223% increase in volume (see Table 2.19), while in terms of commodities generally, mineral flows constitute more than 50% of the total services. The amount of freight carried by the railway during 1993 was 19.83 million tonnes, 13% of which was trade from seaports and across borders, and international cargoes via Turkey.

Along with the general task of providing relatively cheap passenger and freight services during the war with Iraq, IRIRC has greatly supported the war logistics both in cargo and forces. Because a considerable proportion of rail operations are in the south west and very close to the war zone, the transport of crude oil and its products was greatly restricted during the war period. During the period of 1984 -1993 the average length of haul in rail freight in Iran was relatively low (varying between 732 km and 912 km for 1986 and 1993 respectively). The increase is due to the end of the war and more rail freight operations in south west provinces (see Table 2.19).

The composition of the seven categories of commodities and products carried by IRIRC indicates that, except for 1986 and 1987 as peak war times, the carriage of minerals, crude oil and its products, and imports through ports, border crossings and also through Turkey have always been the three major areas of business for rail freight in Iran.

Table 2.19 Volume and tonne/km freight carried by IRIRC.

	1979	1980	1981	1982	1983	1984	1985	1986
Freight (thousand tonnes)	6138	5712	6782	7931	9973	10874	11614	12704
Freight (million tonnes/ km)	3124	3428	3811	N/A	9700	7570	8890	7320
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	
Freight (thousand tonnes)	14788	12957	12334	14881	16979	17649	19830	
Freight (million tonnes/km)	8830	8050	7960	7630	7700	8000	9120	

Source: IRIRC (1984-1993), p. 25; PBO (1989-1993), p. 1-11, SCI (1982), Iran Statistical Yearbook for 1981, pp. 585-586. SCI (1994) Iran Statistical Yearbook for 1993, p. 313. Sanate-Haml-o-Naghl (1982), January, p. 45; Sanate-Haml-o-Naghl (1983), August, p. 105.

Table 2.20 shows the volume and seven categories of freight carried by rail in Iran with the shares of the three border crossings for the four years 1990-1993 indicated as part of the total "others and international". The contribution of rail from the only rail-connected port (port Imam) is shown at the bottom of the table as the difference between the sum of the rail trade from the three border crossings and the "total others and international".

The above-mentioned seven types of rail trade statistics for the period 1986-1991 can also be described as 22 type of goods commodities, the 1991 shares of which are shown in Table 2.21.

Table 2.20 Volume and composition of domestic and foreign trade of Iran by rail (000 tonnes).

	1979	1980	1981	1982	1983	1984	1985	1986
Oil	1899	1416	1201	1786	1939	2028	2289	2343
Minerals	1761	1416	1948	2173	3281	3978	4383	3771
Agricultural	607	503	721	851	884	990	577	864
Foodstuffs	322	232	384	350	445	387	464	390
Industrial	352	182	379	750	1005	855	496	331
Administration cargoes	401	214	396	537	398	569	484	424
Others* & international of which :	796	1519	1712	1561	1975	2030	2884	4548
International (Razi)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Djulfa	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mirjaveh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Port Imam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	6138	5482	6741	8008	9927	10837	11577	12671

	1987	1988	1989	1990	1991	1992	1993
Oil	2036	2210	2427	2483	2661	3089	3470
Minerals	3487	3990	4092	5475	6576	8293	8854
Agricultural	2180	1648	1535	1794	1346	1129	951
Foodstuffs	569	530	529	540	402	452	408
Industrial	718	714	1450	1732	2847	2143	3534
Administration cargoes	343	448	37	25	28	297	32
Others* & international of which:	5423	3378	1832	1929	2512	2245	2581
International (Razi)	N/A	N/A	N/A	522.23	157.25	108.37	5.48
Djulfa	N/A	N/A	N/A	993.71	1013.97	74.49	1.37
Mirjaveh	N/A	N/A	N/A	14.37	28.11	32.85	4.25
Port Imam	N/A	N/A	N/A	398.7	1313.64	2029.30	2569.91
Total	14756	12918	11902	13978	16372	17648	19830

Source: Same as table 2.19. * : Means trade through ports and border crossings.

Table 2.21 Composition and volume of the major types of IRIRC freight in 1991 (000 tonnes).

Imports goods	**Passenger parcels**		**Transit goods**	**Army goods**	**Animals**	**Vehicles**	**Wood**
2073	28		158	130	89	44	16
Other industrial	**Metals**	**Other agricultural**	**Sugar**	**Fruit/ vegetable**	**Grain**	**Cereals**	**Other mineral**
2107	740	145	239	18	331	1015	5061
Salt	**Coal**	**Other oil products**	**Kerosene**	**Gas oil**	**Crude oil**	**Administration goods**	
34	1481	460	162	227	1813	609	

Source: Ministry of Finance and Economic (1992), unpublished report, p. 9.

The analysis of the available data during 1986-1990 as shown in Table 2.22, indicates that among twelve rail districts in Iran, the three regions of South East Iran, South West Iran, and Tehran with 66.1% of the total rail freight are major sources of freight movements. South East Iranian railway as a source of iron ore to Esfahan has average of 26.4%; the

South West is a main point for the carriage of crude oil and its products into the other parts of the country, and also as the most important rail outlet for foreign trade. The South West with 22.9%, and Tehran with 16.8% of the total freight have generated most traffic during 1986-1990.

Table 2.22 Volume of freight handled in 12 rail districts of Iran (000 tonnes).

Rail districts	1986	1987	1988	1989	1990
Tehran	1988	2192	2124	2362	2671
Lorestan	347	508	229	179	272
Arak	159	76	193	230	268
South West	3401	4040	2371	2411	3327
North	279	269	3336	304	308
North East	259	253	331	334	390
North West	165	189	229	303	525
Azerbaijan	1149	1884	2027	1583	1574
Khorasan	158	134	123	178	152
South East	33637	4083	3528	2987	3939
Zahedan	287	33	41	61	22
Esfahan	1376	1126	1428	1401	1432
Total	12674	14788	12957	12334	14881

Source: IRIRC (1986-1990), Facts & Figures, English Version., p. 29.

2.3.3.5 Rail productivity

On the basis of permanent and contracted temporary employees of the IRIRC during 1986-1993, the most important operational productivity indicators of the IRIRC have been computed and are shown in Table 2.23 (column 6) which generally reveal the decrease in the number of employees and the increase in the volume of the traffic units, resulting in increased rail productivity.

Table 2.23 Operational productivity of the IRIRC for passenger and freight (units: millions otherwise specified).

	Indicators	1986	1987	1988	1989	1990	1991	1992	1993
1	Passenger-km	4640	3670	4660	4750	4570	4590	5300	6420
2	Freight-tonne-km	7320	8630	8050	7960	7630	7700	8000	9120
3	Traffic unit (1+2)	11960	12300	12710	12710	12200	12290	13300	15540
4	Rail length, km	4567	4568	4568	4569	4847	4850	5020	5020
5	IRIRC employees, number	41290	40790	38960	38480	37170	36940	35780	34450
6	Employee/km of line (5/4), number	9	8.90	8.50	8.40	7.70	7.60	7.10	6.90
7	Traffic units/km line (3 / 4)	2.60	2.70	2.80	2.80	2.50	2.50	2.70	3.10
8	Traffic units/ employee (3/5), 000	289.70	301.50	326.20	330.30	328.20	332.70	371.70	451.10
9	Passenger	6.34	5.27	6.80	6.67	7.81	8.14	8.22	9.17
10	Freight-tonne	12.70	14.79	12.96	12.33	14.88	16.98	17.65	19.83

Source: IRIRC (1986-1990) various pages; IRIRC (1984-1993) various pages.

2.3.3.7 Rail traffic and frequency

While the maximum speed for a passenger and a freight train is 80 km/h and 55 km/h respectively (Jane's World Railways 1990) the average speed of a freight train in Iran in 1992 was only 4.1 km/h for a 4500 tonne train (PBO 1993). The South West railway district is the busiest route for both freight and passenger trains as shown in Table 2.24.

Table 2.24 Daily movements of trains along five major IRIRC networks in 1992.

Train type	North East	North	South West	South East	North West	Total
Freight	24	32	33	27	19	135
Passenger	30	5.5	31	6.5	19	92

Source: Ministry of Finance and Economics (1992), annex 5, p. 6.

Train services and frequencies vary during different seasons. An analysis of the five year seasonal passenger and freight operation of IRIRC during 1986-1990 (Table 2.25) shows that rail freight peak time is during April, October and November, while for passenger movements the traffic is high during August and March. The operation of IRIRC passenger and freight is subject to regular and long delays as a result of the single track layout and also because of technical deficiencies, poor programming, and lack of human skills (see Table 2.26).

Table 2.25 Seasonal train traffic in Iran (million tonnes).

	January	February	March	April	May	June
1986	1197	1325	852	1090	1044	848
1987	1222	1209	1441	1411	1083	1102
1988	878	820	1216	1342	1255	1209
1989	998	1092	855	1095	1008	879
1990	1365	1237	1084	1266	1251	1168
	July	**August**	**September**	**October**	**November**	**December**
1986	928	1049	1180	1054	1061	1197
1987	1111	1130	1188	1300	1358	1233
1988	1112	1010	962	1097	1039	1016
1989	973	903	1166	1225	1122	1066
1990	1104	1142	1242	1310	1339	1372

Source : IRIRC (1986-1990). pp. 62-86.

Table 2.26 Causes and properties of train delays in Iran in 1992.

Causes	Human factors	Technical	Poor programming	Emergency
Delays %	36	44	17.5	2.5

Source: Sanate-Hamlo-Naghl (1993c), Issue of train delays in Iranian Railways: assessment of causes and some suggestions, No. 127, P. 35.

2.3.3.8 Costs and revenues of IRIRC

Table 2.27 reflects the revenues and costs of the IRIRC during 1984-1993 and the gradual trend toward an equilibrium as a break-even organisation.

Table 2.27 Composition of costs and revenues of IRIRC, million Iranian Rials.

	1984	1985	1986	1987	1988	1989	1990	1991
Costs	37660	42330	40610	46000	50590	51930	76870	99420
Revenues	25410	24060	24060	31100	31750	34220	49180	81240
Subsidies	14000	11840	10420	8040	6590	5580	4430	2500

Source : IRIRC (1986-1990). p. 27

According to IRIRC (1984-1993, p.27), since 1984 the IRIRC subsidies have declined and it is claimed that in 1992 the company did not receive government aid. Revenue for passenger and luggage, freight, transport sub-revenues (warehousing and railcar hire revenues), international transport and miscellaneous revenues are indicated in Table 2.28.

Table 2.28 Revenues composition in IRIRC, million Iranian Rials.

	1986	1987	1988	1989	1990
Passenger revenues	5091	5729	7112	7512	8367
Freight revenues	16749	20946	19204	20105	31121
Luggage	132	119	135	373	476
Transport subsidies	1848	2539	3516	3357	4961
International transport revenues	442	906	715	982	1238
Other revenues	676	864	1069	1889	3018
Total	24938	31103	31751	34218	49181

Source: IRIRC (1986-1990), pp. 61-87 . Note: The inconsistency between values in Tables 2.27 and 2.28 is due to source.

2.3.4 Port transport

2.3.4.1. Administration of ports

Iran has a coast line of about 3000 km and is connected with the sea for foreign trade from both south and north. All seaports are under a central port authority called the Ports and Shipping Organisation (PSO) which is the owner of all seaports and is responsible for the maritime administration of Iran. It is not only responsible for both the management and operation of seaports, but also for the construction and maintenance of all superstructure and the infrastructure of seaports, ship registration, the examination and issue of a certificate of competence for the establishment of stevedoring companies, shipping agencies and port state control, the safety of navigation and maritime pollution, communications and conventions, and enforcement of the national maritime law, etc.

PSO is affiliated as a vice-ministerial organisation to the Ministry of Roads and Transport (MRT) of the Islamic Republic of Iran. It has four main divisions: Financial and Administration, Technical and Engineering, Planning and Programming, and Ports and Marine Operation.

2.3.4.2 The port authority directorates in coastal provinces

The Maritime Administration of Iran (PSO) has 13 internationally recognised and active ports which are categorised into eight major and five minor commercial ports in Iran. There are also two inland lake ports in the north west of the country on both sides of Lake Uroomiyeh. Each directorate administers, protects and supplies one or a series of other minor ports in all port-related matters. Appendix 1 gives the provincial directorates of the Ports and Shipping Organisation of the Islamic Republic of Iran by coastal region.

2.3.4.3 Infrastructure

The major present infrastructure and superstructure (including cargo handling equipment and storage areas) of Iran's seaports vary among different ports, but the ports of Imam and Abass have superior cargo handling facilities. On the basis of analysis in this chapter they are selected as the landbridge ports for this study. The deep berths and anchorage are in these two main major southern ports. Other major ports are equipped with facilities according to the nature and volume their operation. All major and minor seaports combined have 17,256 metres of berths with a maximum depth of 12m for containers and general cargoes and 15m for iron ores (the ports of Khoramshahr and Abadan and the lake port of Uroomiyeh are excluded as major ports since their infrastructure was damaged during the war). These ports have a total number of 100 seagoing and barging berths and the entire port operation is conducted through different terminals composed of one or more berths and other superstructure facilities.

About 77% of the total length of berths (see Table 2.29) is suitable for ocean-going ships of more than 6m draught and the rest function with a lower working depth. Among all ports, only the two main ports of Imam and Abass can serve ships of 12 m draughts. The other south coast ports allow to 6-8 metres only, while Caspian ports only accept ships of less than 6 metres draft. Table 2.29 shows the general composition and characteristics of infrastructure of the seaports of Iran in 1993.

The ports of Abass and Imam, as the two most important and largest commercial sea ports of Iran (with 68 berths) in terms of length and depth of berths and channel entrance, hold most

Table 2.29 The infrastructure of six major Iranian seaports.

	Type of berth	No. of berths	Capacities*	Depth (meters)	Length (metres)
1	**Ocean going:**	77	26.65	9-15	14592
	of which				
	General	61	19.45	12	11101
	Container	10	4	12	2051
	Iron ore	2	3.2	10-15	440
	Grain	2	N/A	12	560
	Liquid bulk	2	N/A	12	440
2	**Barge harbours**	23		1-6	2664
3	**Total**	100	30.15	1-15	17256

Source: Based on PSO (1993), annual performance of the Ports and Shipping Organisation for 1993, and PSO (1992) various pages. Operational Report of the PSO for 1992, various pages. * : million tonnes, PSO estimates.

(79% of total 86 berths) of the above-mentioned infrastructure (excluding the war-damaged ports of Khoramshahr and Abadan). In terms of berths the ports of Abass and Imam have a variety of different types (see Table 2.30).

As well as the ports of Imam and Abass in the Persian Gulf, the port of Anzali on the Caspian Sea, due to its infrastructure and facilities compared with Nooshahr, can also function to serve the CAC countries for the second sea leg of the landbridge. Therefore, it is important to study their present infrastructure and potential. A feature of port Imam is that it has two huge petro-chemical complexes and also the Mahshahr oil product terminal adjacent to the port.

Table 2.30 Facilities of different seaports of Iran in different berths in 1993.

	Port/berths	Imam	Anzali	Bushehr	Chah Bahar	Abass	Nooshahr
1	Terminal container	5	0	0	0	5	0
2	Multipurpose	0	0	0	0	2	0
3	Heavy cargo berths	0	0	0	0	4	0
4	General cargoes	24	5	4	4	17	2
5	Liquid cargoes	0	0	0	0	2	0
6	Iron ore	1	0	0	0	1	0
7	Silo (Grain)	2	0	0	0	0	0
8	Ro/Ro	0	0	0	0	1	0
9	Aluminium terminal	1	0	0	0	0	0
10	Live-sheep terminal	1	0	0	0	0	0
11	Oil products	0	0	1	1	2	1
12	Total	34	5	5	5	34	3

Source: Based on PSO (1993), annual performance of the Ports and Shipping Organisation for 1993 ,various pages. Inconsistency with Table 2.29 is due to sources.

2.3.4.4 Port storage facilities in Iran

Other important factors of capacity in Iran's major seaports are the large reserved areas, the number and type of storage facilities and ports equipment. After the two congestion crises of 1974 and 1980 and the closure of the main seaport of Khoramshahr, a great attempt was directed towards the construction and completion of transit sheds and warehouses in all ports, but mainly in the port of Imam to establish a more reasonable link between imported goods and goods transferred inland, as infrastructure developments were disrupted by the revolution and the war with Iraq. In 1993 all six major ports had 45 covered warehouses and transit sheds and 9 under construction in the port of Imam. Tables 2.31 and 2.32 show total existing storage facilities and those under construction at national and individual port levels.

Table 2.31 Storage capacity and types in seaports of Iran in 1993 (sq. metres).

Facilities	Open storage	Covered storage	Total	Under construction
Area & volume	13932490	442172	14374662	192000

Source: PSO (1993), annual performance of the Ports and Shipping Organisation for 1993. various pages.

As shown in Table 2.32 the ports of Imam and Abass have the highest proportion of both open and covered storage areas equal to 29% (Imam) and 47.5% (Abass) of the open storage and 38.7% (Imam) and 43.2% (Abass) for all storage areas in Iranian ports.

Table 2.32 Share and types of storage areas of major seaports of Iran in 1993 (sq./metres).

	Imam	Anzali	Bushehr	Chah Bahar	Abass	Nooshahr	Total
Open storage	1228000	154175	443000	350000	2008000	46600	4229775
Covered storage	171000	22351	23000	18000	191000	15000	440351
Total	1399000	176526	466000	368000	2199000	61600	4670126

Source: PSO (1993), annual performance of the Ports and Shipping Organisation for 1993, various pages; PSO (undated probably 1991a), An investigation in the performance of the Iranian Ports for 1941-1990), p. 64.

2.3.4.5. Port equipment

In terms of the superstructure of ports, basically all port operations rely on the port authority's mobile and fixed equipment. The lack of quay cranes is obvious in Iran's major southern ports; the only quay cranes which were acquired and have become operational in recent years serve the container terminals of Imam and Abass ports. For the first eight years of the revolution and the war with Iraq the port equipment was used extensively with little repair due to lack of spare parts, currency problems and little domestic production. There is also a low level of containerisation. The fixed and mobile heavy and light equipment and installations for all six major port authorities are shown in Table 2.33, indicating the great reliance of port operations on ships' gear and cranes, and also on general cargo practices for ship to berth and the transfer of cargo into storage.

Table 2.33 Main mobile and fixed port authority equipment in Iran in 1993.

Type of equipment	Units	Remarks
Crane	160	
Lift truck	169	
Tractors	196	
Transtainer	12	Only in ports of Abass (10) and Imam (2)
Top lift	14	
Towing head	39	
Trailers	654	
Gantry cranes	4	Only in ports of Abass (2) and Imam (2)
Electrical rail mounted installation	6	Only mounted in Northern ports
Pneumatic conveying installation	13	
Pneumatic ship unloader	4	Only in ports of Abass (2) and Imam (2)
Grain terminal silos & installation	2	
Iron ore installation	2	

Source: PSO (1993), annual performance of the Ports and Shipping Organisation for 1993. various pages.

While all main gantry cranes, transtainers, grain towers, and quay cranes etc. are as specified in Table 2.33 the share of all six major ports presented in Table 2.34 indicates that more than half of the mobile cargo handling equipment is located in the two major ports of Imam and Abass.

Table 2.34 Share of different ports in main cargo handling equipment in 1993.

	Crane	Lift truck	Tractor	Top lift	Pneumatic unloader
Port Imam	50	54	75	5	2
Port Abass	38	48	25	6	2
Bushehr	17	25	29	0	0
Chah Bahar	11	11	20	0	6
Anzali	26	18	30	2	1
Nooshahr	18	13	17	1	2

Source: PSO (1993), annual performance of the Ports and Shipping Organisation for 1993. various pages.

2.3.4.6. Imbalance of international seatrade in ports

Iranian maritime imports are substantially greater than non-oil product exports. In 1993 imported non-oil product commodities and goods through ports totalled 16,375,000 tonnes but exports only 4,647,000 tonnes (a ratio of 4:1). Since the end of the war and up to 1993 the sea trade as shown in Table 2.35 (column 6) has approximately doubled in volume for both imports and exports.

Table 2.35 Iranian non crude oil sea borne and total foreign trade (000 tonnes).

	Foreign trade	1988	1989	1990	1991	1992	1993
1	Sea imports with oil products	12447	15019	17379	19378	21748	22651
2	Sea imports non-oil	8225	12764	15034	16378	16734	15728
3	Sea non-oil exports	1178	1204	1134	2117	3082	4498
4	Seatrade non-oil (2+3)	9403	13968	16168	18495	19816	20226
5	Sea exports with oil products	1248	1317	1338	2378	3399	4924
6	Total sea trade (1+5)	13695	16341	18717	21756	25147	27575
7	Total Iran non-oil imports	10742	19241	21045	21501	19091	18861
8	Total Iran non oil exports	1224	1455	1308	2395	3351	5037
9	Total Iran exports with oil products	1294	1568	1510	2657	3668	5433
10	Total Iran non-oil trade (7+8)	11966	20696	22353	23896	22443	23898
11	Total Iran imports with oil products	14964	21496	23390	24501	24105	25784
12	Total Iran non-crude oil trade (9+11)	16258	23064	24900	27158	27773	31217

Source: PSO (1993), annual performance of the Ports and Shipping Organisation for 1993, p.36. SCI (1993), Iran Statistical Yearbook for 1993, pp. 452-456.

The cargo traffic in most major Iranian ports consists of some considerable loading and/or unloading of oil products by ship and shore pumping systems through pipelines (columns 1 and 5). The volume of oil product imports during the war and also during 1988-1993 through ports, compared with total trade during the war, was considerable (see Table 2.36). The total volume of foreign trade through seaports during the twelve years 1967-1978 was about 98,007,000 tonnes and varied between 2,761,000 tonnes and 15,462,000 tonnes for 1967 and 1978 respectively; an increase of about 460% (PSO, 1991a). During the twelve years after the Islamic revolution from 1979-1990, the total trade carried through major seaports was announced as 168,819,000 tonnes indicating an increase of only 114.5% whereas the population had doubled since the revolution in 1979. The lower figure for trade of 9,623,000 tonnes was in 1979 and the highest was 20,645,000 tonnes during 1990.

In terms of the foreign trade in general cargo and oil products, the four southern Persian Gulf ports contributed on average a share of 92.7% of the total cargo trade of the seaports during the six years 1988-1993 (Table 2.37) while the northern ports in the Caspian Sea contributed the rest (7.3%).

At the regional level the two ports of Imam and Abass accounted for almost 84.5% of the total cargo handled (119,183 tonnes) by the southern ports, equal to 78.3% of the total (128,569 tonnes) for the ports of Iran during 1988-1993. The composition of sea trade includes sixteen categories of cargoes (metals, fertiliser, barley, maize, coal, sugar, rice, dairy products, fish, general cargo, chemicals, oil products, wheat, meat, soya, and vegetable oil) for imports and 21 for exports which are the basis for annual reports. By classifying all into these nine broader groups as indicated in Table 2.36, it is possible to show the throughput of all six major ports of Iran during 1988-1993 and for later stages (PSO 1993). Table 2.36 indicates the low proportion of containerised goods (1% to 3 % of the total during the six years) and the high volume of general cargo and dry bulk (grain, barley and maize), and bagged cargo (mainly sugar and fertiliser). Using the survey of 1993 as a base year (a relatively stable year after the war) it can be seen that oil products (mainly imports) still

Table 2.36 Volume and composition of Iranian imports and exports (000 tonnes).

		1988		1989		1990		1991		1992		1993	
		Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
1	General cargo	1485	958	2967	275	3784	336	4492	2034	4826	1745	5037	2520
2	Dry bulk	3648	000	5607	000	4729	000	4150	000	4265	000	3767	000
3	Vegetable oil	317	000	479	000	449	000	494	000	510	000	613	000
4	Oil products	4204	70	3006	113	3478	204	4292	261	5014	266	6923	426
5	Bagged	1927	000	2910	217	2300	122	2022	000	3324	80	2253	000
6	Reefer	84	000	183	000	151	4	167	000	155	6	171	210
7	Metals	624	000	845	244	3861	193	5026	000	3067	823	3057	1530
8	Minerals	140	291	280	478	551	483	618	345	587	162	830	238
9	Total import/ exports	12429	1268	16277	1327	19303	1342	21261	2640	21748	3082	22651	4924
10	Total sea trade	13697		17604		20645		23901		24830		27575	
11	Containers of total sea trade	152		296		649		672		632		657	
	%	1.1		1.7		3.1		2.8		2.5		2.4	
12	Total general cargo trade (10-4)	9423		14485		16963		19348		19550		20226	

Source: Based on PSO 1988, 1989, 1990, 1991, 1992, and 1993 annual performances of the Ports and Shipping Organisation various pages.

* : Oil exports whose exporting port s are not mentioned in the source.

Table 2.37 Iranian sea and total import/export trade of non crude oil foreign trade (000 tonnes).

	1988		1989		1990		1991		1992		1993	
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
Imam	1688	127	5161	470	5866	427	7931	1052	7368	1556	7259	2788
Total port	1815		5631		6293		8983		8924		10047	
Abass	6605	1071	7231	780	8523	783	8634	1101	9698	1310	11740	1484
Total port	7677		8011		9306		9735		11008		13224	
Bushehr	2149	47	1729	70	1966	128	1796	221	1774	193	1412	174
Total port	2196		1799		1969		2017		1967		1586	
Chah Bahar	631	1	898	2	1024	000	1017	4	1260	2	816	2
Total port	632		900		1024		1021		1262		818	
Total regional import /export	11073	1246	15019	1322	17379	1338	19378	2378	20100	3061	21227	4448
Total South	12320		16341		19930		21756		23161		25675	
Anzali	333	1	801	2	1225	1	1192	1	1055	13	1036	42
Total port	334		803		1226		1193		1068		1078	
Nooshahr	1023	2	457	3	699	3	691	000	593	8	388	8
Total port	1025		460		702		691		601		396	
Total regional import /export	1356	3	1258	5	1924	4	1883	1	1648	21	1424	50
Total North	1359		1263		1928		1884		1669		1474	
Total import / export sea trade	12429	1249	16277	1327	19303	1342	21261	2379	21748	3082	22651	4498
Missing oil exports*	70		113		204		261		000		000	
Total Iran sea trade	13697		17717		20849		23901		24830		27575	

Source: Same as table 2.36.

Table 2.38 Composition of tonnage and share of the sea trade through major Iranian ports (imports & exports) for 1993 (000 tonnes).

Sea trade	General	Dry bulk	Vegetable oil	Oil products	Bag	Reefer	Metals	Minerals
Tonnage	7557	3767	613	7349	2253	381	4587	1068
%	27.4	13.7	2.2	26.6	8.2	1.4	16.6	3.9

Source: Based on PSO (1993), pp. 37-38.

constitute the highest proportion of trade (see Table 2.38). The flow is handled directly by pipelines to other areas and also to storage tanks outside the port and Customs areas. In non-oil product trade, traditional dry bulk cargoes (grain, etc.) and then general cargoes are the main flows through sea ports.

2.3.4.7 Performance of ports

As mentioned earlier, most cargoes go through the two largest ports of Imam and Abass, followed by Bushehr and Chah Bahar. After the cease-fire in 1988 the port of Imam has steadily increased its contributions to such an extent that in 1993 it had 36.4% of the total seaport foreign trade of Iran. The average share of the port during 1988-1993 was 31% of the total sea trade and was mainly composed of metals, followed by general cargoes and dry bulk in 1993. This situation is shown in Table 2.39.

Table 2.39 Composition of throughput for the port of Imam for 1993 (000 tonnes).

Trade	General	Dry bulk	Minerals	Bagged	Reefer	Metals	Total
Imports	1493	2017	-	959	116	2674	7259
Exports	1660	-	123	-	-	1005	2788
Total	3153	2017	123	959	116	3679	10047
%	31.4	20.1	1.2	9.5	1.2	36.6	100

Source: Based on PSO 1988, 1989, 1990, 1991, 1992, and 1993 annual performances of the Ports and Shipping Organisation various pages.

The port of Abass is the other large port suggested by the analysis as a suitable landbridge port, and handled about 63.7% of the total sea imports of the country during the war period 1981-1988 (PSO, 1991a). The port of Abass (both Shaheed Rajayee and Bahonar) accounted for between 40% and 56% of the total ports' national trade during 1988-1993, equivalent to between about 44% and 62% of the total southern ports' performance.

Table 2.40 Composition of throughput for the port of Abass for 1993 (000 tonnes).

Trade	General	Dry bulk	Reefer	Bagged	Oil products	Metals
Imports	2996	1441	55	958	4795	55
Exports	715	000	158	000	0000	525
Total	3711	1441	213	958	4795	580
%	28.1	10.9	1.6	7.2	36.3	4.4
Trade	**Mineral**	**Vegetable oil**	**Total**			
Imports	830	610	11740			
Exports	86	000	1484			
Total	916	610	13224			
%	6.9	4.6	100			

Source: Based on PSO 1988, 1989, 1990, 1991, 1992, and 1993 annual performances of the Ports and Shipping Organisation various pages.

The third ranking southern port is that of Bushehr with 9.7% of the total southern port trade and 9.1% of Iran's non-oil port trade in the period 1988-1993. Bushehr, with a total trade of 1,586,000 tonnes (63% oil products) is mainly engaged in general cargo and bagged cargoes like rice and sugar imports, and also is an important port for the regional trade of small vessels with Arab States in the Southern Persian Gulf.

The fourth most important southern port, particularly for Central Asian trade, is the port of Chah Bahar on the Indian Ocean with a 4.8% share in the operation of the southern ports during 1988-1993. It contributed only between 2.6% and 5.5% of the total annual performance within southern ports (or between 3% and 5% of all national cargo throughput for ports) during 1988-1993. This port is not operative for about three months of the year during the monsoon period. Trade varies but it is mainly concerned with grain and general cargoes as shown in Table 2.41.

Table 2.41 Composition of imports and exports in ports of Bushehr, Chah Bahar Anzali, Nooshahr for 1993 (000 tonnes).

Ports & trade	General	Dry bulk	Minerals	Bag	Oil products	Vegetable oil	Reefer	Metals	Total
Import	207	53	00	150	999	3	00	000	1412
Export	93	00	29	000	000	0	52	000	174
Bushehr	352	53	29	150	999	3	52	000	1783
%	16.8	3	1.6	8.4	67.1	0.17	2.9	000	100
Import	84	256	00	156	320	0	00	000	816
Export	2	000	00	000	000	0	00	000	2
Chah Bahar	86	256	0	156	320	0	00	0	818
%	11	31	0	19	39	0	00	00	100
Import	183	00	0	10	577	0	00	266	1036
Export	42	00	0	00	000	0	00	000	42
Anzali	225	00	0	10	577	0	00	266	1078
%	21	00	0	1	53	0	00	25	100
Import	74	00	0	20	232	0	00	62	388
Export	8	00	0	0	0	0	0	0	8
Nooshahr	82	00	0	20	232	0	0	62	396
%	21	00	0	5	58	0	0	16	100

Source: PSO (1993), annual performance of the Ports and Shipping Organisation for 1372. various pages.

In the north, Iran has only the two ports of Anzali and Nooshahr which are limited to coastal trade with states around the Caspian Sea (including Russia), in winter, and in summer through the Volga and the Don to the Black and the Baltic Seas. They both had about 7.3% of Iranian sea trade during 1988-1993 and 5.2% in 1993. Anzali handled 59.5% of the total northern ports' trade during 1988-1993 but nationally accounted for only 4.4% of Iran's total sea trade. Nooshahr, the second port in the north, covered 40.5% of Iran's Caspian sea trade (equal to 3% of national port cargo throughput) during the six years to 1993. The trade of Nooshahr port mainly includes general cargoes and metal products while imports of oil products from Turkmenistan and Azerbaijan during the war with Iraq and later accounted for more than half of the port operations as shown in Table 2.41.

2.3.4.8 Productivity and service of ports in Iran

According to Honeycutt (1989, p. 24):

> "In the development of human resources, three factors come into play: the employee ...; the work ...; the climate. ... It is the interaction of these three elements that determine overall productivity, employee satisfaction and commitment to the organisation".

The assessment of Iran's seaport productivity, where there is centralised government control over cargo operations, equipment and land and sea traffic, and management within ports, is a difficult task. Port productivity in Iran can be criticised for both internal inefficiency and also for the poor quality of the road/rail transport fleet and rolling stock. There is evidence of both quantitative and qualitative shortages in skilled labour and personnel, port equipment and procedures, etc. which impairs the ports productivity. The general port productivity of Iranian seaports was calculated and is shown in Table 2.42. It is based on the following equation:

Productivity = Annual seaports' trade/Total berths' length/ Annual working day.

The labour productivity of ports must covers all organisations directly involved such as port authorities, stevedoring, shipping, forwarders, shippers and customs administration in the port trade. But such data is only available for the period 1991-1993. Cargo handling in all three stages of port operations - ship, quay, and storage - is directly under the practical control of both the ports authorities and the stevedoring companies while only the stevedoring companies are involved in the ship (hold) operation in the southern ports where port authorities play a key role in the quay and storage operations and can be considered an important factor in the entire port cargo handling operations. Therefore, productivity in terms of tonnes/employee, as shown in Table 2.42 (columns 8 and 10), is based and calculated on available information about the PSO personnel who receive training programmes (PSO 1993) and the maritime transport sector (Atrchian 1996). The productivity related to the PSO indicates a general improvement during 1988-1993, which is partly due to the courses given and partly to the increase in the volume of ports trade simultaneous with a decrease in the total number of PSO employees. The productivity measure concerned with total maritime transport shows a decline due to the increased employment in the sector over the period of study.

Table 2.42 General port productivity of Iran's six major seaports (000 tonnes except where otherwise specified).

	Year	1988	1989	1990	1991	1992	1993
1	Total non-oil seatrade	9403	13968	16168	18495	19816	20226
2	Berths length (metres)	14592	14592	14592	14592	14592	14592
3	Working days	341	341	341	341	341	341
4	Productivity: Per day/ annum / tonnes/berths metres (1: 2: 3)	1.9	2.9	3.4	3.9	3.9	4.1
5	Total seaports trade	13697	17717	20849	23901	24830	27575
6	Productivity: Per day/ annum / tonne / berths metres (5: 2 :3)	2.8	3.6	4.2	4.8	5	5.5
7	PSO total personnel	6457	6598	6837	6757	6145	5956
8	Productivity: tonnes non-oil sea trade per PSO employee (1/7)	1456.3	2117	2364.8	2737.2	3224.7	3395.9
9	Total marine transport employees	N/A	N/A	N/A	38543	40817	43225
10	Productivity: tonnes non-oil sea trade per total maritime transport employee (1/9)	N/A	N/A	N/A	502	479	467.9

Source: Same as Table 2.36. PSO (undated probably 1991a), An investigation into the performance of Iranian ports for 1941-1990, various pages; PSO (1993), p. 51 for PSO personnel; Atrchain (1996), for marine transportation employees. pp. 24-25. Note: assumes minimum working days per annum of 341 based on official holidays during a Iranian year.

The composition of maritime sector includes four other sub-groups concerning all those organisations and companies with direct influence on maritime transport (PSO, NITC, IRISL, private shipping companies and agents), supporting services (insurance, surveying agents, Customs services, etc.), industries (ship and boat repair and construction), and construction (development and improvement of ports).

The quality of port performances can be shown by using two classes of indicators - ship and the cargo, and personnel indicators using different units of measurement; time, tonnage handled, and cost for ship, quay, and storage operations. The analysis of the past and current port efficiency is based on data for 1992 published by the PSO, which is the only available source.

The five ship indicators most commonly used to show both maritime and cargo traffic over ports are port or turnaround time, waiting time, service time, operation time, and idle time. These indicators are computed and shown in summary in Table 2.43. Total port, or turnaround time, is defined as the total time taken for arrival and readiness for berthing and for the clearing of goods from or into hatches. For each ship in each of the six major ports it varies between 1 and 30 + days in 1992. The annual average port turnaround time of a ship as shown in Table 2.43 is the sum of the staying days for every ship divided by the numbers of ships calling to each port during that year. Port turnaround time also includes the waiting time and service time of ships during their stay in port.

Table 2.43 Average port turnaround time of ships visiting seven major Iranian ports in 1992 (days).

		Major Iranian ports							
			Abass ports						
		1	2		3	4	5	6	7
	Ship Indicators	Imam	Rajayee	Bahonar	Bushehr	Chah Bahar	Anzali	Nooshahr	Total
1	Port days	11.15	11.36	15.80	8.90	14.01	2.98	2.98	9.60
2	Operation days	9.22	8.36	7.15	6.72	10.54	2.29	2.40	6.67
3	Service days	9.44	8.83	7.93	7.08	11.49	2.58	2.69	7.15
4	Waiting days	1.71	2.53	7.87	1.82	2.52	0.4	0.29	2.45
5	Idle days	0.22	0.47	0.78	0.36	0.95	0.29	0.29	0.48

Source: Based on PSO (1992), Operational report of the PSO for 1992, various pages.

According to UNCTAD (1973, p. 27) the two principal indicators - service and waiting times - are defined as follows:

Service time is the total time spent at a berth, including idle time. A ship berthed alongside for discharging or loading is liable to some interruption. Therefore, service time includes both operation and the idle time which a ship may face during its berthing. Operation time, as a proportion of the service time, refers to the time which a ship is alongside a berth to deliver or receive cargo without any interruption caused by ship, quay equipment, gang failure or weather conditions. Idle time is the difference between service and operation times, and indicates the total pause and down time if the cargo operation of a ship is for any reason interrupted. Waiting time is the average time a ship spends between arriving at the port and arriving at the berth where cargo-handling is to take place. It is therefore, the difference between port and service times and the time for ships waiting in anchorage to come to a berth for loading and unloading. In the analysis of the ships' port indicators in 1992 as a sample of port services, it must be taken into account that 21.3% of the total port trades in Iranian seaports involves the easy and speedy transfer of oil products. This results in the ship indicators being lower than otherwise would be the case. The comparison of the two consecutive years of 1991 (calculated by the PSO) and 1992 for three ship indicators at major ports suggests that there were improvements in port turnaround times.

Table 2.44 Comparisons of the ship indicators in Iran (days).

Ship indicators	1991	1992
Port days	9.76	9.60
Service days	7.20	7.15
Waiting days	2.55	2.45

Source: for 1991 is derived from PSO (1992).
For 1992 same as Table 2.43.

2.3.4.9 Waiting times and demurrage

The extensive waiting time of ships has twice severely damaged the economy of Iran; first early in the 1970s at the time of sudden oil price increases, and then during 1981-1982 because of the war with Iraq and the closure of the port of Khramshahr, resulting in the poor level of operation at the port of Imam as the other largest port and also other ports (Lane 1984). The economy has also suffered from general inefficiency including shortages of cranes and road/rail facilities. According to the statistics of the Central Bank of Iran (Nooshahr, 1982), during these two greatest periods of congestion, Iran's economy suffered annually by about US $ one billion. The reasons for demurrage (Nooshahr 1982) were:

* Congestion in destination ports
* Delays during discharging times
* Delays in the opening of trade credits.

The contribution of different imported commodities to demurrage is shown in Table 2.45.

Table 2.45 Share of different main basic imported commodities in demurrage during 1992.

Commodities	Wheat	Fertiliser	Fish meal	Rice	Sugar	Others
%	40	2.7	27	15	9.5	5.8

Source: MRT (1994), Complete Text of the Proceedings and Approvals of the Transportation Co-ordination Group of the High Council of the Islamic Republic of Iran. Vol. 2. various pages.

Table 2.46 indicates that during 1988-1992 about US $ million 237.9 was paid in demurrage. During a period of generally increasing imports, the extent of demurrage (US $ per tonne) has fallen.

Table 2.46 Imports and demurrage in Iran.

	1988	1989	1990	1991	1992
Demurrage (US $ million)	45.60	68.54	70.60	46.97	6.15
Seatrade imports (000 tonnes)	7.74	12.76	15.03	16.37	16.23
Demurrage tonne / US $	5.89	5.37	4.70	2.87	0.38
Ships' traffic	1078	1314	1644	1897	1939

Source: Based on MRT (1994), Proceedings and approvals of the Transport Co-ordination group of the High Council of the Islamic Republic of Iran. Vol. 2, various pages. Various PSO publications for 1993, 1992, 1990,1989, 1988. various pages.

These improvements were possible due to the interaction between the government bodies and port industries. The PSO was able to have a more open hand in purchasing and equipping ports with new container and general cargo technologies, and in conducting many more training courses. At the same time, after the war normal working procedures were gradually implemented and existing equipment was repaired and replaced (PSO 1993).

2.3.4.10 Maritime and land traffic in Iranian seaports

During 1979-1993, 21754 seagoing vessels visited Iranian ports, of which about 70% visited the Persian Gulf and Indian Oceans port in the South of Iran and 30% the two Caspian Sea ports (PSO 1991a, PSO 1992, and PSO 1993). The share of each port is shown in Table 2.47. Among the major southern ports, Abass and Imam accounted for 37.4% and 18.4% respectively. After the end of the war with Iraq the volume and direction of traffic was changed considerably as the port of Imam, which was not operational during the previous

Table 2.47 Maritime sea going traffic visiting Iranian major ports.

	Imam	Bushehr	Abass	Chah Bahar	Total South	Anzali	Noo-shahr	Total North	Total Iran
1979	607	71	213	00	891	219	50	269	1495
1980	425	74	316	00	815	304	76	380	1395
1981	273	114	486	00	873	221	100	321	1194
1982	124	165	495	00	784	310	232	542	1326
1983	237	185	630	00	1052	312	288	600	1652
1984	114	143	672	51	980	272	89	361	1291
1985	000	150	772	44	966	249	130	379	1345
1986	000	135	655	42	832	116	84	200	1032
1987	27	164	638	56	885	242	346	588	1231
1988	87	163	397	43	690	133	255	388	1078
1989	283	140	460	65	948	232	134	366	1314
1990	352	147	512	63	1074	386	184	570	1644
1991	544	152	609	60	1365	349	183	532	1897
1992	567	138	651	72	1428	345	166	511	1939
1993	584	160	639	43	1426	371	124	495	1921
Total	4224	2101	8145	539	15009	4061	2441	6502	21754*
%	18.4	9.7	37.4	2.5	69	18.7	11.2	29.9	100

Source: PSO (undated report probably 1991a), An investigation into the performance of Iranian ports for 1941-1990, part II. p. 9. Different PSO publications for 1993, 1992, 1991, and 1990, various pages.
*: the traffic of Kharamshahr and Abadan during 1979 and 1980 (1.1%) included in total.

three years to 1988, gradually re-established a major position in the maritime traffic of Iran by 1993. The daily rate of ships arrival into ports after the end of the war was increased during 1988-1993 by 78.2% with an average rate of 13.% annually. The sea traffic during this period through the southern ports (6931 ships) is about 2.4 times that of the northern region (2862). Table 2.48 shows the average daily rate of ship arrivals in each port on a 365 day basis.

Before the revolution Iranian ports had an active container and LASH (Lighter Aboard Ships) trade. Due to the war with Iraq container traffic declined. However, with the end of the war and the completion of the Abass container terminal and equipment, the trade has shown some recovery (see Table 2.49).

Table 2.48 Maritime traffic in major Iranian ports (ships/day).

Ports	1988	1989	1990	1991	1992	1993
Imam	0.24	0.79	0.96	1.50	1.60	1.60
Abass	1.10	1.30	1.40	1.70	1.80	1.80
Bushehr	0.45	0.38	0.43	0.42	0.38	0.44
Chah Bahar	0.12	0.18	0.17	0.60	0.20	0.12
Anzali	0.36	0.64	1.10	0.96	0.95	1.10
Nooshahr	0.70	0.37	0.54	0.50	0.46	0.34

Source: PSO (undated report probably 1991a), An investigation into the performance of Iranian ports for 1941-1990, part II. p. 9. Different PSO publications for 1993, 1992, 1991, and 1990, various pages.

Table 2.49 Container ship traffic in Iranian ports (ships/year).

	1978	1979	1980	1981	1982	1983	1984	1985	1986
Semi container	276	187	108	84	25	93	91	66	75
Full container	443	136	61	62	74	115	105	65	116
Container trade	N/A	N/A	N/A	N/A	N/A	258	238	195	184
	1987	1988	1989	1990	1991	1992	1993		
Semi container	62	48	106	229	209	662	708*		
Full container	135	108	146	216	57	47	-		
Container trade	231	153	296	696	673	704	797		

Source: PSO (undated report probably 1991a), An investigation into the performance of Iranian ports for 1941-1990, part II. p. 9. Different PSO publications for 1993, 1992, 1991, and 1990, various pages. *: Data is available only for total semi and full container.

The traffic by land vehicles into seaports always has been a critical issue as a result of the imbalance between the volume of trade and the number of heavy goods vehicles, the long distances between ports and destinations and origins of cargo, adverse weather conditions, lack of inland loading/ unloading facilities, etc.

Table 2.50 indicates that the ports of Imam and Abass have dominated the traffic for lorries with about 26.5% and 54.4% of the total in 1989, and 29.6% and 59.1% in 1993 respectively, while the port of Imam has had all the rail traffic of the ports.

Table 2.50 Number of heavy goods vehicles and wagon traffic into Iranian seaports.

	Port Imam		Other ports: heavy goods vehicles					HGVs
	Truck	Rail	Bushehr	Abass	Chah Bahar	Anzali	Nooshahr	Total ports
1989	175122	25041	52878	359899	41146	22269	10789	662103
1990	209490	27577	76250	424054	52210	34559	14583	811146
1991	263255	38743	71922	438373	49657	13749	15446	862879
1992	298201	23600	61230	481031	58320	18211	15998	932991
1993	264245	28900	28338	527716	29250	27516	16004	893069

Source: PSO (1992); PSO annual performance reports for 1993, 1992, 1991, 1990, and 1989 various pages; Wagon for 1992 and 1993 is based on Sanate-Haml-o-Naghl, (1995c), No. 144, p.44.

The distribution of road vehicles for port cargoes is organised through the Vehicle Distribution Co-ordination Centre as part of the MRT and functions in close co-operation with port authorities at ports and border crossing terminals on the basis of "first come/first served".

2.3.4.11 Port hinterland in Iran

There are very few up-to-date, and comprehensive published studies about the port hinterland in Iran. Due to the concentration of industry there, most of the port and border crossing imported foreign trade is destined for greater Tehran and its suburban areas. This is followed by Esfahan. Another important aspect of the port hinterland in Iran is that both cargo owners and transport authorities and operators are government-owned and do not consider specific modal costs as important. Therefore, destination ports for cargo delivery may change frequently.

2.3.5 Border crossing operations

Iran's Customs administration is responsible for the operations in different border-crossing terminals and inland Customs zones. The supervision of these border crossings is assigned to Customs, but cargo operations and warehousing are carried out by the Public Warehousing Company. Since most of the foreign trade of the country takes place with Europe and Japan, the two border crossings of Bazargan and Djulfa play significant roles. The former is mainly concerned with land transport with Europe and America by road freight only, while the latter is involved with the European and Far East trade mainly by rail through the Trans-Siberian Railway. The trade though border crossings was influenced after the collapse of the former Soviet Union and, as shown in Table 2.51, Djulfa's trade, due to the Azerbaijan and Armenian conflicts, declined and stopped, while trade through some other points (e.g. Astara) has increased significantly. The other border crossings with a pivotal role for Central Asian countries is Sarkhs which was connected to the rail network to Central in 1996 (Sanate-Hamlo-Naghl 1996c).

Table 2.51 Non-oil imports of Iran (000 tonnes).

Ports & border crossings	1987	1988	1989	1990	Total border crossings	Average % share
Djulfa	2326	2239	1803	2689	11535	43.1
Bazargan	979	843	834	1827	8947	33.4
Astara	91	87	124	118	1546	5.8
Razi	579	2745	445	498	4543	17
Mijaveh	31	23	52	14	186	0.7
Total annual border crossings	4006	5937	3258	5146	26757	100
Total non-oil ports	11161	8239	13271	15899	95892	78.1
Total Iran	15167	11816	16529	21045	122760	100
Ports & border crossings	**1991**	**1992**	**1993**			
Djulfa	2367	109	0.02			
Bazargan	1821	1826	817			
Astara	158	281	687			
Razi	153	108	14			
Mirjaveh	28	33	5			
Total annual border crossings	4528	2357	1524			
Total non-oil ports	16973	16734	13615			
Total Iran	21501	19091	17610			

Source: Based on MRT (1995), Letter: 24/2/1374.

2.3.6. Sea transport system

The sea transport system of Iran includes merchant ships and oil tankers which in their size, tonnage and number form a substantial fleet, particularly in the Middle East. Both fleets are summarised under the following headings:

2.3.6.1 Islamic Republic of Iran Shipping Line (IRISL)

Iran is nowadays ranked seventeenth in the world in dead weight tonnage (dwt) (UNCTAD Review 1993). The Islamic Republic of Iran Shipping Line (IRISL) to a significant extent covers both the imports and exports of national trade and recently has undertaken passenger movements along the Persian Gulf coast. The IRISL is at present a state owned enterprise that functions under the Ministry of Commerce. It was established initially in 1967-68 as Arya Shipping Line with 51% public and 49 % private shares with capital of

3175 million Iranian Rials (US $. 45 million). The company started its operation primarily as a conference line between the ports of the Persian Gulf and Europe with two small coasters of 25500 dwt, but now functions as ship owner, liner operator, ship's charterer and agent, and container owner. Table 2.52 shows the development of the national merchant shipping fleet since 1979.

Table 2.52 Growth and voyages of IRISL own and chartered ships.

	No. of owned ships & dwt (000)				No. of journeys	
	Ocean-going	Passenger ships	Total	dwt (own+passenger)	Chartered	Own
1979	42	-	42	525	29	91
1980	38	-	38	496	40	159
1981	40	-	40	678	85	146
1982	42	-	42	799	294	140
1983	59	-	59	1166	539	112
1984	69	-	69	147	387	174
1985	73	-	73	2006	259	199
1986	76	-	76	2090	213	228
1987	69	-	69	2093	283	N/A
1988	70	6	76	2115	134	226
1989	72	6	78	2132	274	221
1990	71	7	78	2115	324	217
1991	72	7	79	2119	220	249
1992	70	9	79	2115	138	301
1993	N/A	N/A	N/A	N/A	99	317

Source: Payam Darya (1994), No. 22; SCI (1991a), (1991b), (1992b), and (1994b), and SCI (1993).

Table 2.53 shows that bulk and general cargo carriers constitute most of the fleet both in terms of dwt and number of ships. The company is engaged in both liner and tramp shipping of which the former is of greater importance. The liner services of the IRISL are represented by conventional, multi-purpose and container ships with a carrying capacity of 1.3 million tonnes annually, in round trips between the Persian Gulf and north and central European countries, the U.K, the Mediterranean, South East Asia, the Far East, East Africa, and South America. IRISL tramp shipping runs more or less on the same routes as well as to Canadian, Black Sea, and West Africa ports.

Table 2.53 Composition and dwt of IRISL fleet in 1990.

	Bulk carriers	General cargo	Product carriers	Container	Reefer
No. of ships	43	22	3	2	1
000 dwt	1581	343	120	47	12

Source: IRISL (1990) English Report. p. 3.

The maritime transport of Iran as mentioned earlier is mainly composed of imported goods of which the IRISL covers a significant proportion. It has at least a 57% share in the carriage of the national foreign trade directly or through chartered ships as shown in Table 2.54. It also has about 70% of the trade through ports on average for the period 1988-1993 (IRISL 1990).

Table 2.54 Share of the IRISL and its chartered ships in the imports of Iran (000 tonnes).

	1988	1989	1990	1991	1992	1993
IRISL ships	4744	5638	6073	6468	7900	8200
Chartered ships	2082	7427	7398	4274	3351	2363
Total IRISL ships	6826	13065	13471	10742	11256	10563

Source: IRISL (1990) English Report. p. 5. and Payam Darya (1994), No. 22, pp. 53-54; SCI (1991a), (1991b), (1992b), and (1994b), and SCI (1993) various pages.

2.3.6.2 National Iranian Tanker Company (NITC)

The establishment of the National Iranian Tanker Company (NITC) dates back to the time of the nationalisation of oil in 1951. The company was formed as a joint venture with British Petroleum (BP.) to carry mainly crude oil. It was reformed in 1975. The company is affiliated to the Ministry of Oil of the Islamic Republic of Iran, with several independent subordinate companies for exploitation, production, and refining. With the beginning of the war with Iraq in 1980 and the air threats to the shipping routes and Iranian oil terminals, the nature of the functions and the tonnage of the NITC was changed to cope with the national requirement to sell Iran's oil in the world market or to transport it into the safe waters within the Persian Gulf. Consequently the dwt of the tankers was increased sharply. In 1995 there were 42 vessels of different sizes of which 29 were ocean-going tankers including ultra large crude carriers (ULCC) in 1995. NITC was the biggest tanker company in the Middle East with a fleet of 5.7 million dwt, mainly crude carriers.

2.4 Modal split

The pattern of freight modal split in Iran is strongly under the influence of the government as it owns most of the trade - in particular foreign trade - and also heavily controls the modes and interfaces. The modal split has two distinctive features in terms of domestic and foreign trade flow and also modal assignment. Rail transport is only available for 14 provinces with direct lines, contributing in 1993 to the distribution of 7% of foreign trade and 8.4% of domestic trade. Therefore, the road system is the most intensively operated land mode in the country, while most of the oil production of the country is transferred by pipelines from points of production to the populated areas of the country. Road carries, on average, more than 93% of the total freight of the country (estimate is based on the performance of rail for both domestic and foreign trade during 1979-1992).

2.4.1 Domestic trade

Iran, inhabited by about 55 million people in 1991, has greater Tehran as a significant pole for freight generation and consumption, as a hub of the single line railway, and one end of most motorways in the country. As shown in Table 2.55 the road mode contributed on average about 85% of domestic trade during 1979-1993, whereas rail, which mainly carries mineral and foreign trade, accounted for 4.6%. However, its share shows an increasing trend. The government, according to the second development programme, intends to decrease the role of road in the distribution of oil products with an increase in pipeline efficiency and new lines (PBO 1993). Therefore, pipeline mode contribution is based on a 59.8% share in carrying oil products in 1993 and it is assumed this has increased to this level by 0.36% every year from 1979. Domestic trade uses the full capacity of freight transport vehicles (LGVs, HGVs and vans) due to its varied nature and limited packaging. Therefore it is not restricted, unlike foreign trade, to HGVs of greater than 13 tonnes.

Table 2.55 Domestic production and modal contributions in Iran (000 tonnes).

	Total domestic production				Pipelines: Share of pipeline in oil products (based on 59.8% share in carrying oil products in 1993 with a 0.36 backward decreasing rate)		Domestic production excluding oil products carried by pipeline (1-3)
	1	2	3	4	5	6	7
	Total domestic production	Domestic production without oil products by pipelines (for rail & road) (1-5)	Real domestic production excluding exports	Exports with oil products	Tonnage carried by pipeline	% of total oil products in domestic production by pipeline	Tonnage
1979	159713.8	145401.7	144263.7	1138	14312.1	54.76	144659.5
1980	156737.6	142258.1	141679.1	579	14479.5	55.12	141606.7
1981	143906.0	130378.3	130224.3	154	13527.7	55.48	129861.4
1982	187046.2	171119.0	170957.0	162	15927.2	55.84	170616.9
1983	214483.4	196193.1	195969.1	224	18290.3	56.20	195737.5
1984	207417.8	187631.4	187367.4	264	19786.4	56.56	187267.6
1985	221041.1	200038.2	199384.2	654	21002.9	56.92	199787.3
1986	209298.6	190172.2	189039.2	1133	19126.4	57.28	190065.4
1987	192223.0	172910.7	171686.7	1224	19312.3	57.64	172924.1
1988	186831.0	167256.0	165731.0	1525	19575.0	58.00	167851.8
1989	185742.2	161757.4	160403.4	1354	23984.8	58.36	162069.7
1990	217938.5	193092.3	190023.3	3069	24846.2	58.72	193566.2
1991	252590.1	223909.7	221253.7	2656	28680.4	59.08	224628.2
1992	262396.7	234264.9	230596.9	3668	28131.8	59.44	235135.8
1993	277223.3	242931.6	237368.6	5563	34291.7	59.80	244193.2

Table 2.55 continued.

	Rail share (domestic and foreign trade)			Road mode share (3-4)		
	8	9	10	11	12	13
	Total rail tonnage	Tonnage domestic excluding general cargoes and oil products	% of total without oil products by pipelines and exports (% of 13)	Tonnage (2-9)	% of total domestic production (in 13)	Total domestic production without exports (5+9+11)
1979	6138	5342	3.4	138921.7	87.6	158575.8
1980	5482	3963	2.5	137716.1	88.2	156158.6
1981	6741	5029	3.5	125195.3	87.1	143752.0
1982	8008	6447	3.5	164510.0	88.0	186884.2
1983	9927	7952	3.7	188017.1	87.8	214259.4
1984	10837	8807	4.3	178560.4	86.2	207153.8
1985	11577	8693	3.9	190691.2	86.5	220387.1
1986	12671	8123	3.9	180916.2	86.9	208165.6
1987	14756	9333	4.9	162353.7	85.0	190999.0
1988	12918	9540	5.2	156191.0	84.3	185306.0
1989	11902	10070	5.5	150333.4	81.5	184388.2
1990	13978	12049	5.6	177974.3	82.8	214869.5
1991	16372	13860	5.6	207393.7	83.0	249934.1
1992	17648	15403	6.0	215193.9	83.2	258728.7
1993	19383	16802	6.2	220566.6	81.2	271660.3

Source: For volume of the domestic productions different SCI publications, UN (1985), (1992), (1993), (1993a), UN (1995) various pages; and UNCTAD (1993a), (1993b) various pages; for modal split different IRIRC and PSO publications.

2.4.2 Foreign trade

The modal split of foreign trade moving within Iran is based on the three modes of rail, road and pipelines. The major feature is the share of pipelines in the transport of oil products from ports. The only data about the modal share of pipelines transport for oil products is for 1993 when 59.8% of total foreign trade oil products went from ports by pipelines (PBO 1993). Assuming that it was the same for the entire period of the study, Table 2.56 estimates modal share and clearly shows the significance of the road mode in the foreign trade for general cargo and oil products. Transhipment moves are excluded from this analysis but have been dealt with in Table 2.37 as exports.

Table 2.56 Estimate of modal shares of the general cargo and oil products foreign trade in Iran (000 tonnes).

	1	2		3	4 (1-2)	5		6	
	Non-crude oil foreign trade	Pipeline *		Oil product trade through ports	Share of rail and road	Rail mode		Road mode (4-5)	
		Pipeline	% of total oil products			Volume	% of total (1)	Volume	% of total (1)
1988	16489	2478.92	58.00	4274	14010.08	3378	20.5	10632.08	64.5
1989	22850	1820.25	58.36	3119	21029.75	1832	8.0	19197.75	84.0
1990	24956	2162.10	58.72	3682	22793.90	1929	7.7	20864.90	83.6
1991	28700	2689.91	59.08	4553	26010.10	2512	8.8	23498.10	81.9
1992	27773	3138.43	59.44	5280	24634.57	2245	8.1	22389.57	80.6
1993	30555	4394.70	59.80	7349	26160.30	2581	8.5	23579.30	77.1
Total	151323	16275.90				14469	10.3	119026.90	78.6

Source: Different PSO, IRIRC, PBO and Iran Customs Administration reports for 1988-1993. *: 59.8 in 1993 with the assumption of the decreasing rate of 0.36 backward x column 3.

2.5 Conclusions

This chapter has studied the Iranian economy from the macroeconomic point of view and Iran's trade and transport system in depth. The aim was to provide sufficient data to support further stages of the study. The main revenue-making sectors of Iran were identified and their fluctuations were traced from 1979-1993. It has become evident that Iran has passed through a turbulent period due to the Islamic revolution in 1979, the war between 1981 and 1988 and the later reconstruction process. Each mode and interface in terms of organisation, infrastructure, superstructure, layout and performance was studied in sufficient detail to provide an insight into the advantages and weaknesses of the transport system. The internal modal split for both domestic and foreign trade was investigated, and it was seen that Iran is heavily dependent on the road mode for both trades. The two southern ports of Abass and Imam are particularly important for foreign trade.

However it is evident that Iran may have a suitable transport infrastructure for use by the Central Asian and Caucasus countries. This topic will be pursued in subsequent chapters.

3. Central Asian and Caucasus countries

3.1 Political geography

The aim of this chapter is to examine the main trends in the economy, foreign trade and transport of the Central Asian and Caucasian countries (CAC) in the context of their foreign trade through Iran. Since the dissolution of the former Soviet Union (FSU) in 1991 the newly independent states have been faced with many changes, problems, conflicts and shortages. Apart from ethnic and territorial considerations, the economic systems of all the FSU republics have had to replace a centralised economic system with an international market system, but with little experience in international affairs.

The eight new CAC countries as shown in Figure 3.1 can be characterised as oil-producing countries (except for Armenia and Georgia). Like all other former Soviet republics after the collapse of the USSR, the CAC countries have had a hard transitional period of political conflicts, decline of demand and supply and consequently trade, currency exchange and payment problems. However, their economy and trade is under slow improvement with the establishment of new institutions to support and convert their former central planning into an open market system (Michalopoulos 1993 and Fischer, Sahay and Vegh 1996).

The CAC region, from the early years of the establishment of the USSR, was for about 70 years integrated closely into a very centralised planning policy dictated and controlled from Moscow. The development of the Economic Co-operation Organisation (ECO) by the treaty of Tehran 1985, originally a new format of the treaty of Izmir of 1964 but without military objectives, should bring into being a region with new international relations (Gharabaghi 1994, Raeece-Dana 1995). It may help to overcome any suspicion about the policy of Iran towards its neighbours.

Figure 3.1 Location of the Caucasus and Central Asian countries.

The borders on this Figure are for illustration purposes only.

Each of the two main geographical regions of the CAC countries (Caucasus and Central Asia) has its own political and economic features, which are discussed in the following sections.

3.1.1 Caucasus countries

The Caucasus region, much smaller in area compared with Central Asia, is also poorer in resources. It functions as a bridge between the oil-rich Middle East countries and Europe through the Caspian and Black Seas. All three Caucasus countries are unstable and living without peace due to serious internal and external conflicts and do not have the prosperity, security and common policy, therefore, to improve their fragile economic situation and independent status. The region, however, is a sensitive and unstable area primarily for Russia, and with other neighbouring countries it can play "a special role in world affairs" (Barylski 1994, Roberts 1996).

Azerbaijan is a semi-maritime country along the western shores of the Caspian Sea and is very rich in off-shore oil reserves. It has a population of about 7.2 million of which most (83%) are Muslims. Azerbaijan also contains the Nagorno Karabakh republic with an Armenian majority, resulting in disputes with Armenia. This has hindered its economic development and weakened the political system since 1991 (E.I.U 1992, Rutland 1994).

Armenia is a mountainous landlocked country in the south-west of the Caucasus region with a tiny border of about 40 km with Iran as shown in Figure 3.1. It has a population of about 3.5 million, of which about 68% are urbanised. Most (93.3%) of the people are Christians but with different ethnic minorities such as Russians and Kurds and therefore, unlike Azerbaijan and Georgia is free of internal ethnic problems (E.I.U 1992, Rutland 1994).

Georgia, at the interface between Asia and Europe, is the only maritime country among the CAC republics, as it is located on the west coast of the Black Sea as shown in Figure 3.1. According to the Europa World Year Book (1994a) based on a U.N census in the Demographic Yearbook, it has a population of about 5.5 million, of whom most are Orthodox

Christians but with Muslim and Jewish minorities, and ethnic minorities such as Russian, Armenian, Azerbaijani, Ossetain, Greek, etc. Its ports (e.g. Batumi) have an ideal location for the European trade of all the CAC republics and Iran (E.I.U 1993) but their proper utilisation will depend on the settlement of conflicts in western Georgia (Barylski, 1994).

3.1.2 Central Asian countries

The five Central Asian countries to the north east of Iran have a much larger area than the three small Caucasus republics, with mountainous and desert regions and a dispersed low population (Ogutcu 1995). They are strongly under the social, economic, cultural, religious, and political influences of neighbouring countries such as China, India, Pakistan, Iran and Afghanistan. They also have been involved in some ethnic unrest internally and in the border provinces of China and in the Afghanistan internal conflicts, and to some extent foreign investors may have doubts about their long term interests (Rashid 1994). China, on the one hand, may, following the collapse of the former Soviet Union, lose a potential threat to its northern borders. On the other hand, it may be disadvantaged from having growing free market economies of potentially ethnic and religious states in its vicinity (Harris 1993). Iran, the most populous country in the south of Central Asia, has cultural and historical links in the region, particularly in the areas where language is derived from Persian, such as in Tadjikistan and many parts of Uzbekistan (Akbarzadeh 1996).

Gyrkyzstan is a small and mainly agricultural mountainous country of 766,400 sq./km in the north-eastern part of Central Asia. The population (4.4 million) is composed of Muslims of mainly Gyrkyz origin, but with Tadjik and Uzbek minorities. It was the first country to leave the Rouble zone of the Commonwealth of Independent States and launched the Som as the national currency in May 1993 (E.I.U 1992).

Kazakhstan is the second largest republic of the former Soviet Union, and the largest within the CAC republics (about 2.7 million sq. km). It is much bigger than Iran with a long coast line of about 2320 km on the Caspian sea as shown in Figure 3.1. It has a population of 16.7 million with a density of six persons/sq. km. The population is comprised 39% Kazakhs, 37% Russians and 5% Germans most of whom follow predominantly the Muslim religion (E.I.U 1992).

Tadjikistan is larger than Gyrkyzstan and located in the South East of Central Asia on the Pamir Mountains. The population (5 million) is composed mainly of Muslims of Tadjik origin, but there are also Uzbek, Russian and Tatar minorities (E.I.U 1992).

Turkmenistan has a relatively small population, mainly living in the southern strip close to Iran in the capital city of Ashkhabad and other cities including Mary, Chardzhov, and the port Krasnovodsk on the eastern Caspian Sea coast. 90% of Turkmenistan is desert. Its inland waterway is along the Amu Darya river (E.I.U 1992). Through the unique location of Turkmenistan the Central Asian countries, are linked in the north-east to Iran (Barylski 1994).

Uzbekistan is the third largest country of the CAC republics, after Kazakhstan and Turkmenistan in area, and after the former in population. It is a completely landlocked state. Its only waterway access is by river (1100 km length) through Turkmenistan to the Aral sea at the border with Kazakhstan. The population is mainly Muslim. Other than Uzbeks, it consists of 8.4% Russians, 4.7% Tadjiks, and 4.1% Kazakhs, with smaller minorities of Tatars and Crimeans (E.I.U 1992).

3.2 Economies of the CAC countries

The FSU republics and Eastern bloc after independence in 1991 have left communism and moved towards a new system. Each country is faced with some serious economic problems (Murrell 1996). The economies of the CAC countries have developed within a larger integrated and centralised FSU and Eastern bloc, a region within which there are still dependent ties, but where major steps have been taken towards a market economy. (UNCTAD/UN 1994, Murrell 1996). The collection of economic data for this region is difficult.

> "The official Russian statistics do not provide indices of export and import volume changes ... Statistics on Russian foreign trade only start with the emergence of Russia as an independent state, as Soviet Union foreign trade statistics were compiled only for the USSR as a whole, without breakdown by republics. Hence, all data on Russian trade for the years before 1992 are estimates derived from USSR statistics, the accuracy of which diminishes as one moves backwards from 1992" (UNCTAD/UN 1994, p.69).

3.2.1 Caucasus countries

The general tendency of the Caucasus countries is to move towards a free market economy and away from the traditionally strong economic and industrial ties with Russia and other FSU republics.

Table 3.1 shows that the three republics of the Caucasus had reasonable growth up to 1989 when the disintegration of the USSR started. The diversity of their economic structure, as well as the existence of internal and inter-republic conflicts, have had great effects on the output of these countries. For instance, the industrial production of small countries like Armenia and Georgia is largely dependent on the importation of raw materials and intermediary goods from other republics, and in particular Russia, and energy (oil) from Azerbaijan and Russia.

The GDP of 1993 was half that of 1985 (Table 3.1) due to the general consequences of the dissolution of the USSR, transport disruption and limitations, hostilities with Azerbaijan over Nagorno Karabakh, and conflicts between Russia and Georgia. Both Armenia's and Georgia's rail connections were disconnected due to these incidents and this worsened the economic situation. At the same time, Azerbaijan, which is rich in gas and oil resources, has been affected to a lesser extent from the disagreement with Armenia.

Table 3.1 Caucasus countries GDP before and after independence ($ m).

Caucasus	1985	1986	1987	1988	1989	1990	1991	1992	1993
Armenia	21395	22412	23248	23835	26912	26060	24718	12102	11198
Azerbaijan	30413	31828	34296	36871	36119	33279	34368	22860	21152
Georgia	41276	37558	38532	42305	45378	42095	34761	21515	19908

Source: E.I.U (1994a) based on I.M.F: World Bank, Statistical Handbook of the FSU, United Nations Economic Commission for Europe, Bulletin for Europe, Vol. 44 1992; EIU calculation. various pages.

The structure of the economies in the three Caucasus countries to some extent differ. Azerbaijan is substantially rich in oil and gas and highly attractive for foreign investors. The economy of Georgia is based on non-oil minerals, agricultural products, and heavy industries. Armenia does not have significant mineral deposits, but has well-developed industries suffering from energy shortage and heavily dependent on Russian imports of intermediary goods. The share of different sectors is shown in Table 3.2.

Table 3.2 Comparison of sectoral shares (%) in the economy of the Caucasus countries in 1991.

Sectors	Armenia	Azerbaijan	Georgia
Industry	48.3	54.2	35
Agricultural	25.7	26.1	37
Construction	14.6	10.6	11
Transport & communication	2.2	2.9	5
Trade & catering	5.6	2.2	6
Others	3.6	4.0	7

Source: E.I.U (1992), various pages for Georgia, Armenia, Azerbaijan, Central Asian Republics.

3.2.2 Central Asian countries

The five Central Asian countries are vast in geographical scale and rich in oil, gas, minerals, and agriculture that is still unexploited while suffering from a water shortage (Rashid 1994). Table 3.3 presents a comparison of the Central Asian countries' GDP indicating a continuous growth before 1990 and a decline during and after the collapse of the FSU.

Table 3.3 Central Asian countries GDP before and after independence ($ million) (Purchasing power parities*).

	1985	1986	1987	1988	1989	1990	1991	1992	1993
Kazakhstan	56333	54954	62874	68698	71821	74269	65731	57821	53502
Gyrkyzstan	9223	9794	10159	11924	12939	13938	13974	10757	9622
Tadjikistan	12946	13761	14004	16291	16538	16981	16124	10757	9954
Turkmenistan	8177	8775	9420	10811	10512	11166	11067	10757	11060
Uzbekistan	30465	31725	32417	36803	39668	46070	47769	44374	41059

Source: E.I.U (1994a), various pages for Central Asia, based on I.M.F: World Bank, Statistical Handbook of the FSU, United Nations Economic Commission for Europe, Bulletin for Europe, Vol. 44 1992; E.I.U calculation.

* : Showing the GDP and or GDP per head for all 15 former Soviet republics. It gives an indication of living standards and domestic purchasing power, free from the distortions caused by the exchange rates (E.I.U 1994a).

Kazakhstan, with potential economic output in the three major categories of industrial, agricultural and mineral production, has a strong economic structure and within the CAC countries the highest GDP as shown in Tables 3.1 and 3.3. The structure of the economies in the five Central Asian countries is largely similar with oil and gas resources, agricultural and industrial manufacturing. They are also very rich in gold and have potential for cotton growing. Table 3.4 shows the importance of the industrial and agricultural sectors in general for the Central Asian countries.

Table 3.4 Comparison of sectoral shares (%) in the economy of the Central Asian countries in 1991 (current prices).

	Kazakhstan	Gyrkyzstan	Tadjikestan	Turkmenistan	Uzbekistan
Industry	41.4	45.3	30.6	19.6	33.2
Agricultural	35.8	36.4	43.9	46.4	43.2
Construction	9.6	7.7	12.8	22.7	10.7
Transport & communication	3.9	2.8	2.6	4.2	4.2
Trade & catering	5.5	0.0	0.0	0.0	0.0
Others	3.8	7.7	10.1	7.1	8.7
Total	100	100	100	100	100

Source: E.I.U(1992), various pages for Central Asia, based on World Bank, Statistical Handbook: States of FSU.

Turkmenistan and Uzbekistan with rich hydrocarbon resources, and without any external or domestic conflicts or problems, and Gyrkyzstan as an agricultural based economy, have experienced smallest economic downturn. Uzbekistan is also very rich in gold with potential for cotton growing. Tadjikstan economy is based mainly on agricultural products, silk and in particular cotton (Akbarzadeh 1996).

3.3 Foreign trade of the CAC countries

The main feature of trade, when the CAC countries formed an integral part of the USSR, was that the inter-republic trade and trade with the Eastern bloc dominated the "foreign" trade of these countries. Generally this type of trade declined after independence as a result of the imposition of import and export controls and the availability of hard currency in new markets. After independence, trade with FSU republics created payment problems resulting from the new currencies and differences in the monetary systems. For many countries it is has been economic to trade with these new republics while their exports are moving toward international prices, since they offer cheaper goods. But as most of the CAC countries are rich in raw minerals (hydrocarbons and others) it seems that in future there will be a considerable shift in the structure of trade of many materials and products. Moving toward international prices to acquire foreign currency for imports is critical for all CIS countries but rather difficult for those such as Armenia and Georgia, which do not have raw materials and have low quality manufactures compared with western countries.

3.3.1 Caucasus countries

3.3.1.1 Azerbaijan

In recent years Azerbaijan's trade with countries other than the CIS has been in deficit (Table 3.5). It has a sizeable trade surplus with the other states of the FSU, mainly on the basis of gas and oil (Table 3.6). The close geographical proximity and common features of Azerbaijan and Iran have led to a considerable expansion of bilateral trade and joint utilisation of infrastructure after independence (E.I.U 1992).

Food and light industrial products constitute the bulk of the Azerbaijan exports as shown in Table 3.6. There is a significant contribution from exports in oil and gas, ferrous metals, light industries, and food products to trade surpluses with other republics during 1990-1991.

Table 3.5 Values of inter-republic and international trade of Azerbaijan (Rb: million).

Trade	1989		1990		1991		1992	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Total	7122.9	5189.8	6429	5752	12204	11022	207756	131580
Total inter-republic	6674.9	3794.3	6104	4248	11456	8837	102175	85026
Balance	+2880.6		+1856		+ 2619		+17149	
Total foreign	448	1395.5	325	1504	748	2174	105581	46554
Balance	-948		-1179		-1426		59027	

Source: Europa World Yearbooks (1994a) p. 444 and (1995a), p. 1547.. Inconsistency is due to sources.

Table 3.6 Composition of the Azerbaijan inter-republic import/export (Rb: million).

Composition of trade	1988		1990		1992*	
	Exports	Imports	Exports	Imports	Exports	Imports
Petroleum & gas	886.1	292.4	747.3	428	1450	6702
Ferrous metallurgy	88.5	206	71.2	218.5	270	24166
Non-ferrous metals	102.2	91.3	80	100.8	384	2334
Chemicals	601	407.1	518	488	1161	15964
Machines and metalworking	1012.3	1104.5	936.3	1119.4	2115	29884
Wood and paper products	0	99.2	0	117.1	0	3656
Products of light industry	1479.1	620	1365.8	707.9	2270	7461
Food	1828.5	642.3	1748.6	500.9	3892	30905
Agricultural products	312.6	51.8	134.1	145.8	280	7379
Other commodities	140.5	13.9	124.8	117.1	0	0
Total inter-republic trade incl. other commodities	6450.8	3528.5	5726.1	3943.5	11822[1]	128451[1]

Source: The Europa World Yearbooks (1994a) and 1995a, various pages related to Azerbaijan based on IMF, Economic Review: Azerbaijan. International Financial Statistics: Supplement on Countries of FSU, World Bank, Azerbajan: The Transition to a Market Economy and Statistical Handbook: States of the FSU. *: Includes both inter-republic and international trade data. 1: Includes other commodities. Inconsistency is due to sources.

According to E.I.U (1994a) the inter-republic trade of Azerbaijan decreased sharply after independence by 64.6% (imports) and 49.2% (exports) in 1992. For exports and imports with countries other than FSU republics, light industrial products and machinery were important, while imports of food products were important as shown in Table 3.7. European and Asian countries had the highest trade levels with Azerbaijan (see Table 3.8).

Table 3.7 Composition of the Azerbaijan international import/export trade (Rb: million).

Composition of trade	1989		1990	
	Exports	Imports	Exports	Imports
Petroleum & gas	102.7	1.5	101.6	1.9
Ferrous metals	0.0	82.2	0.0	49.1
Chemicals and chemical products	0.0	94.4	0.0	87.5
Products of machine-building industry	105.9	167	112.4	348.8
Products of light industry (textiles)	172.5	362.9	61.2	403.2
Products of food industry	0.0	409.8	0.0	431
Agricultural processed products	0.0	228.4	0.0	131.1
Total international trade incl. other commodities	448	1395.5	325.1	1504.9

Source: Same as table 3.6.. Inconsistency is due to sources.

Table 3.8 The share (%) of main foreign trade partners of Azerbaijan in 1990.

	Germany	Bulgaria	Czechs & Slovakia	Hungary	Poland	Cuba	Europe	Asia	America
Exports	10.7	9	7.2	5.9	5.7	5.7	62.7	15.9	5.7
Imports	13.4	7.2	8.5	4.7	10.9	5.2	65.3	20.5	5.2
Total	24.1	16.2	15.7	10.6	16.6	10.9	128	36.4	10.9

Source: E.I.U. 1992, Georgia, Armenia, Azerbaijan, Central Asian Republics, Country Profile- Annual Survey of Political and Economic Background: Based on: World Bank, Statistical Handbook: States of the FSU.

3.3.1.2 Armenia

Armenia was an industrial republic of the FSU and was very active in foreign trade, having sometimes a surplus of trade before independence (see Table 3.9).

Table 3.9 Value of foreign trade of Armenia (Rb: million, current prices).

	1985	1986	1987	1988	1989	1990
Exports	4997	5554	4115	3767	3691	3523
Imports	4979	5181	4249	4877	4898	4662

Source: E.I.U (1992), based on World Bank, Statistical Handbook: States of the FSU.

According to IMF sources (E.I.U 1992) for the second half of the 1980s, imports/exports were assessed as more than 50% of the total GDP. Industrial goods formed the main components of both exports and imports for Armenia (see Table 3.10).

Table 3.10 Composition of the import/export trade in Armenia (Rb: million, current prices).

Trade	1985		1986		1987	
	Import	Export	Import	Export	Import	Export
Light industry	1054	1276	981	1301	1066	1550
Machine building & metal	1568	2022	1731	2295	929	1027
Food industry	524	502	650	505	546	572
Energy	481	-	510	-	374	-
Chemical products	388	394	443	445	363	421
Agricultural goods	141	42	169	49	146	15
	1988		1989		1990	
	Import	Export	Import	Export	Import	Export
Light industry	1117	1501	1107	1427	1166	1501
Machine building & metal	1002	845	1005	861	975	828
Food industry	843	584	946	641	754	412
Energy	456	-	435	-	304	-
Chemical products	362	376	385	338	370	213
Agricultural goods	212	15	200	10	290	12

Source: E.I.U (1992), based on World Bank, Statistical Handbook: States of the FSU.

According to World Bank statistics (E.I.U 1992) the principal trading partners of Armenia in external trade are the European countries of which Bulgaria (exports) and Germany (imports) have had the highest shares in 1990. Asian and American countries are also prominent (see Table 3.11).

Table 3.11 Share of European countries, Asia and American continent in the foreign trade of Armenia in 1990 (% of total in foreign trade Roubles).

	Bulgaria	Germany	Czech & Slovakia	Poland	Hungary	Romania	Asia	America
Exports	11.7	10.7	8.7	6.8	5.8	3.9	10.5	7.7
Imports	7.6	15.7	9.1	9.6	5.6	0	16.9	16.2
Total	19.3	26.4	17.8	16.4	11.4	3.9	27.4	23.9

Source: E.I.U (1992), p.41, based on World Bank, Statistical Handbook: States of the FSU.

3.3.1.3 Georgia

Georgia, as an industrial republic in the FSU, used to be very active in trade having sometimes a surplus within the USSR, but an imbalance with other countries leading to a considerable deficit as shown in Table 3.12.

Table 3.12 Value of foreign trade of Georgia (Rb: million).

	1988	1989	1990	1991
Exports	5901	6084	5983	6112
Imports	6493	6469	6839	7266
Deficit	592	385	857	112

Source: E.I.U (1992), p.27, based on IMF Economic Review, Georgia.

Heavy and light industrial goods, minerals, construction materials, chemicals, agricultural goods, forestry products and food are the main components of both imports and exports as shown in Table 3.13.

Table 3.13 Composition of Georgia's foreign trade (Rb: million).

	1988		1989		1990	
Trade	Imports	Exports	Imports	Exports	Imports	Exports
Oil and gas	413	100	360	68	285	68
Ferrous metals	489	375	443	376	430	318
Non-ferrous metals	102	-	106	-	97	-
Chemical fuel	541	316	544	343	576	339
Machine building & metal	1533	848	1522	869	1580	804
Timber, wood, paper	248	-	244	-	279	-
Building materials	155	-	148	-	117	-
Light industry	1221	1275	1287	1285	1372	1260
Food industry	1204	2438	1142	2573	1174	2387
Agricultural goods	348	280	358	190	498	404
Others	27	11	103	105	140	93
Total	6493	5901	6469	6084	6839	5983

Source: The Europa World Yearbooks (1994a) and (1995b), various pages for Georgia, based on IMF, Economic Review: Georgia. International Financial Statistics: Supplement on Countries of the FSU, World Bank, Armenia : The Transition to a Market Economy and Statistical Handbook: States of the FSU.

The principal trading partners of Georgia, according to World Bank statistics (E.I.U 1992), in external trade are the European countries with about 71% of the total, of which Germany and Bulgaria (exports) and Germany and Poland (imports) had the highest shares in 1990, followed by Asian and American countries as shown in Table 3.14.

Table 3.14 Share of the major European, Asian and American countries in the foreign trade of Georgia in 1990 (% of total foreign trade in Roubles).

	Bulgaria	Germany	Czech & Slovakia	Poland	Hungary
Exports	10.7	10.7	7.7	8.4	6.0
Imports	8.5	17.7	9.6	10.8	6.1
Total	19.2	28.4	17.3	19.2	12.1
	Romania	**Italy**	**Netherlands**	**U.K**	**Finland**
Exports	3.4	4.4	2.7	3	0.0
Imports	0.0	0.0	0.0	0	3.2
Total	3.4	4.4	2.7	3	3.2
	Japan	**Syria**	**Other Asia**	**Cuba**	**Other America**
Exports	4	0.0	11.2	5.4	1.9
Imports	4.9	3.2	7.8	4.8	3.3
Total	8.9	3.2	19	10.2	5.2

Source: E.I.U (1992), p.28, based on World Bank, Statistical Handbook: States of the FSU.

3.3.2 Central Asian countries

3.3.2.1 Gyrkyzstan

The economy of Gyrkyzstan is mainly agricultural based (E.I.U 1992). The country is very rich in minerals but has insignificant hydrocarbon resources and is heavily dependent on imports from other republics (Europa World Yearbook 1994a). It was heavily dependent (about 98% of trade) on foreign transactions with other republics, an imbalance which still continued in the 1990's (see Table 3.15) but there has been attempts to restructure the agricultural sector toward a market economy (Delehanty and Rasmussen, 1995).

Table 3.15 The Gyrkyzstan inter-republic import/export trade (Rb: million).

	1987		1988		1989	
	Import	Export	Import	Export	Import	Export
Total inter-republic	2150	2691	2424	2900	2433	3183
Balance	+541		+476		+750	
Total foreign $ million	774	54	806	74	883	65
Balance	-720		-732		-818	
	1990		**1991**		**1992**	
	Import	**Export**	**Export**	**Import**	**Import**	**Export**
Total inter-republic	3179	2446	6506	5409	67407	46301
Balance	-733		+1097		-21106	
Total foreign $ million	1063	53	1374	41	3165	6461
Balance	-1010		+1333		+3296	

Source: E.I.U (1992), p. 81 and Europa World Year Book, (1994a), various pages for Gyrkyzstan, based on IMF, Economic Review: Gyrkyzsstan, and international Financial Statistics: Supplement on Countries of the FSU; World Bank, Gyrkyzsstan: The Transition to a Market Economy and Statistical Handbook: States of the FSU.

As indicated in Table 3.16, exports and imports at inter-republic levels are dominated by the light and machine building industries and food products, although after independence exports of electric power coal, ferrous and non-ferrous metals with countries outside the former USSR republics were significantly increased (Table 3.17).

Table 3.16 Composition of the Gyrkyzstan inter-republic import/ export trade (Rb: million).

Trade	1990		1991		1992	
	Exports	Imports	Exports	Imports	Exports	Imports
Petroleum gas	0	269	0	578	0	19654
Electric power	67	0	188	0	3047	0
Coal industry	22	38	14	85	1013	2137
Ferrous metals	1	167	0	292	340	4280
Non-ferrous metals	164	96	500	277	5662	2506
Chemicals and chemical products	23	324	218	566	667	7489
Products of machine-building industry	893	985	2018	1272	21506	17023
Wood and paper products	0	114	7	183	185	2221
Construction materials	13	69	67	81	1445	736
Products of light industry	649	1017	1901	1882	12609	5171
Products of food industry	516	663	1317	1080	3721	4247
Agricultural unprocessed products	87	247	182	323	792	4185
Total inter-republic include others	2446	3179	6506	5409	46301	67407
Total incl. external trade	2499	4242	6547	6783	52762	70572

Source: Europa World Year Book (1994a), various pages for Gyrkyzstan, based on IMF, Economic Review: Gyrkyzstan, and International Financial Statistics.

Table 3.17 Composition of the Gyrkyzstan external import/export trade (Rb: million).

Trade	1990		1991		1992	
	Exports	Imports	Exports	Imports	Exports	Imports
Ferrous metals	1	0	0	0	340	0
Non-ferrous metals	19	0	8	0	3454	0
Chemicals and chemical products	1	51	0	44	273	531
Machine-building and metal working	11	106	8	88	559	212
Wood and paper products	0	0	7	0	185	0
Products of light industry	9	364	3	275	1414	670
Products of food industry	8	415	0	644	146	1200
Agricultural unprocessed products	0	80	0	242	0	477
Total (including others)	53	1063	41	1374	6461	3165

Source: Same as table 3.16.

The main trading partners of Gykyzstan in 1990 at the continental level cover Europe and then Asia. In Europe, as shown in Table 3.18, Italy, Germany and Bulgaria have dominated exports, and Germany and Czechoslovakia (now the Czech Republic and Slovakia) imports. In Asia, North Korea and Japan were important for exports and imports respectively, while Cuba was important for both trades in the Americas.

Gyrkyzstan was among three former USSR republics with an overall trade surplus with the CIS, while in deficit with Russia during 1994 (UNCTAD/UN 1994). In Europe in the same year the UK (15.1%) and France (8.9%) and, in Asia, China (36.6%) have achieved the highest ranks for exports. The USA (32.8%) and China (23.1%) were the most important importing countries in 1992.

Table 3.18 Major shares of the international import/export of Gyrkyzstan in 1990 (% of the total in foreign trade Roubles).

	Germany	Italy	Bulgaria	Chzech & Slovakia	Poland	Hungary	Yugoslavia
Exports	9.0	11.90	9.0	6.0	4.5	4.5	3.0
Imports	18	2.30	7.6	9.3	6.2	6.2	2.9
	Others in Europe	North Korea	Japan	Others in Asia	Cuba	Others in America	
Exports	13.6	11.90	1.5	22.0	4.5	0.9	
Imports	12.5	1.00	4.8	10.9	3.0	2.7	

Source : EIU (1993c), Gyrkyzstan, p. 81.

3.3.2.2 Kazakhstan

The foreign trade of Kazakhstan is dominated by other former republics as a result of the high level of industrialisation. Since January 1992 the liberalisation process has led to individuals and enterprises becoming engaged in foreign trade without government permission being required, except for goods of national interest (fuel, minerals, mineral fertilisers, grain, cotton, wool, caviar and pharmaceutical products). These may be exported only by state organisations. Kazakhstan after 1988 has had a considerable deficit in inter-republic and international foreign trade (see Table 3.19) . It plays a significant role within the CIS and at the beginning of 1995 had implemented two significant improvements by establishing a free trade zone with Uzbekistan and Kyrghyzstan, and a Customs agreement with Russia and Ukraine (Griffin 1996).

Table 3.19 Value of inter-republic and international trade of Kazakhstan inter-republic in million Roubles, market prices and international in $ million).

	1988		1989	
	Inter-republic	International ($ m)	Inter-republic	International
Exports	8337	1600	8201	1700
Imports	12455	2664	13259	2550
Balance	-4118	-1064	-5058	-850
	1990		1991	
	Inter-republic	International	Inter-republic	International
Exports	8443	1800	13208	1254
Imports	13026	2015	17363	1356
Balance	-4583	-215	-4155	-102

Source: E.I.U (1992), p. 68. based on IMF, Economic Review: Kazakhstan.

For exports to former USSR republics (see Table 3.20), oil and gas, and machinery are important, while ferrous and non-ferrous metals are important in international trade. In the case of imports, machinery and oil and gas are important in the inter-republic trade, and machinery and food in international markets.

The main continental trade partner of Kazakhstan is Europe with 64.7% of exports and 72% imports, followed by Asia and America. At the country level (as shown in Table 3.21) Germany, Japan, and Cuba had the highest share in the foreign trade of Kazakhstan.

Table 3.20 Composition of Kazakhstan's import/ export trade (Rb: million, world market prices).

	1989		1990	
	Exports	Imports	Exports	Imports
Petroleum gas	875	1447	795	1181
Electric energy	224	371	233	420
Coal	312	000	306	000
Iron and steel	1077	1040	1036	986
Non-ferrous metals	791	272	777	275
Chemicals and chemical products	1121	1703	1082	1727
Products of machine-building industry	836	5359	786	5510
Wood and paper products	000	988	000	832
Construction materials	000	313	000	331
Products of light industry	1625	3113	1536	3374
Products of food industry	617	1871	612	1880
Agricultural unprocessed products	1146	457	1764	392
Total trade (includes others products)	9094	17569	9350	17830
Total inter-republic trade	8201	14571	8443	14314
Total foreign trade	893	2998	906	3516

Source: Europa World Year Book, 1994b, various pages for Kazakhstan, based on IMF, Economic Review: Kazakhstan, and International Financial Statistics: Supplement on Countries of the FUS; World Bank, Kazakhstan: The Transition to a Market Economy and Statistical Handbook: States of the FSU.

Table 3.21 Share of major European, Asian, and American countries in the foreign trade of Kazakhstan in 1990 (% of total in foreign trade Roubles).

	Germany	Bulgaria	Czech & Slovakia	Poland	Hungary
Export	11.0	9.0	7.5	6.30	5.0
Import	17.9	8.3	9.0	10.7	6.2
	Romania	Italy	U.K	Yugoslavia	Finland
Export	3.6	3.4	3.1	3.0	0.0
Import	2.4	3.3	0.0	2.7	3.4
	Other Europe	Japan	India	Vietnam	China
Export	12.8	3.4	2.2	1.8	0.0
Import	8.10	2.8	0.0	0.0	2.7
	North Korea	Other Asia	Cuba	USA	Others America
Export	0.0	10.4	5.1	0.9	0.4
Import	2.6	9.70	4.8	2.6	1.0

Source: E.I.U (1992), p. 70, based on World Bank, Statistical Handbook: States of the FSU.

3.3.2.3 Tadjikstan

Tadjikstan's foreign trade is dominated by the former republics with which (except for 1991) it had a deficit of about five times during 1992 and 1993 (Sinclair 1995). The total foreign trade had a slow growth during 1987-1991, while the increase in 1992 (as shown in Table 3.22), as in other former republics, is due to independence and the devaluation of the Rouble rather than to an increase in real values.

Table 3.22 Composition of Tadjikstan exports/imports trade (Rb: million).

	1987		1988		1989	
	Exports	Imports	Exports	Imports	Exports	Imports
Total	2264	3261	2359	3300	2385	3460
Total inter-republic	1970	2908	2025	2856	2040	2891
Balance	-938		-831		-851	
Total foreign	294	353	334	444	345	569
Balance	-59		-110		-224	
	1990		1991		1992	
	Exports	Imports	Exports	Imports	Exports	Imports
Total	1980	3816	3701	3668	36646	30886
Total inter-republic	1672	2212	3201	3067	16433	23839
Balance	-540		+134		-7406	
Total foreign	308	725	500	601	20213	7047
Balance	-417		-101		+13166	

Sources: EIU (1992), pp. 91-92, based on IMF, Economic Review: Tadjikstan; The Europa World Year Book, (1994b), various pages for Tadjikstan, based on IMF, Economic Review: Tadjikstan, and international Financial Statistics: Supplement on Countries of the FSU; World Bank, Tadjikstan: The Transition to a Market Economy and Statistical Handbook : States of the FSU.

Tadjikstan's trade is mainly based on agriculture, one of the most important being cotton, which accounted for 11% of the total former USSR production (E.I.U 1992). Inter-republic transactions accounted for about 81.8% of exports and 90% of imports in 1990. To a great extent the commodity structure in Tadjikstan, as shown in Table 3.23, is similar to other Central Asian countries. The other principal exports are aluminium, raw cotton, textiles, fruit and vegetables, silk and marble, while its major imports are fuel, manufactured goods, and food products (Europe Yearbook 1994b). Primary and manufactured goods dominate its exports while intermediate goods, including capital goods and energy, are important and mainly supplied by CIS republics. After independence in 1992, petroleum and gas constituted 25.6% of the total inter-republic import value, followed by chemical products, and iron and steel. At the same time exports to former republics mainly consist of non-ferrous metals (29.1%), machinery (28.4%), and raw materials (25.8%).

Exports from Tadjikistan to outside the CIS after independence showed greater expansion than imports, which to some extent is due to the devaluation of the Rouble (UNCTAD/UN 1994). However, the same report stresses the difficulty of obtaining accurate statistics. Non-

Table 3.23 Structure of Tadjikstan inter-republic export/import trade (Rb: million).

	1990		1991		1992	
	Exports	Imports	Exports	Imports	Exports	Imports
Petroleum & gas	000	272	000	364	000	6093
Electric power	63	71	000	000	000	000
Iron and steel	000	110	000	191	000	2952
Non-ferrous metals	298	193	955	79	4782	524
Chemicals and chemical products	119	322	72.0	258	787	4761
Machinery and metal working	228	796	486	475	4661	2926
Wood and paper products	000	124	000	197	000	820
Construction materials	29.0	-	181	000	225	000
Products of light industry	1061	558	954	574	4233	2777
Food and beverages	405	424	491	707	1091	1455
Agricultural unprocessed products	92.0	182	000	107	000	697
Other commodities	59.0	142	000	000	000	000
Total inter-republic trade	2378	3359	3201	3067	16433	23839

Source: Europa World Year Book (1995b), p. 2952. based on IMF, Economic Review: Tadjikistan, and international Financial Statistics: Supplement on Countries of the FSU; World Bank, Tadjikistan: The Transition to a Market Economy and Statistical Handbook : States of the FSU.

ferrous metals made up almost 99.5% of exports, while agricultural products formed about 96.4% of the total imports in 1992 (see table 3.24).

Table 3.24 Composition of Tadjikstan international import/export trade (Rb: million).

	1990		1991		1992	
Trade	Exports	Imports	Exports	Imports	Exports	Imports
Non-ferrous metals	168	39	488	000	20107	00
Chemicals and chemical products	000	57	000	1.00	00	10
Machinery and metal working	000	113	000	2.00	00	13
Products of light industry	126	298	2.00	198	76	124
Food and beverages	000	151	000	272	95	000
Agricultural unprocessed products	4.00	81.0	000	126	00	6790
Other commodities	4.00	29.0	000	2.00	00	110
Total	308	768	500	601	20213	7047

Source: Same as table 2.23.

Among the former USSR republics, Russia, Turkmenistan and Kazakhstan greatly expanded their imports in 1992 by 46.7%, 14.6%, and 12.2% respectively. At the same time Russia, Kazakhstan, and Ukraine took 47.5%, 14.7%, and 11.7% respectively of the exports of Tadjikistan (Europa World Yearbook 1995b).

At the international level, European countries have dominated Tadjikstan foreign trade with 61.1% and 67.6% of exports and imports respectively, while Asia accounted for 18.5% and 17% respectively. At the country level, Germany and Bulgaria had most exports and imports with Tadjikstan (see table 3.25). Cuba and Japan, were prominent among American and Asian countries.

After independence international trade took a much higher share and accounted for 55.2% (exports) and 32.8% (imports) of the total trade of Tadjikstan (EIU 1994a).

Table 3.25 Share of major European, Asian, and American countries in the foreign trade of Tadjikstan in 1990 (% of total in foreign trade Roubles).

	Germany	Bulgaria	Chzech & Slovakia	Poland			Hungary
Export	1.10	9.0	7.7	5.1			3.1
Import	15.7	7.3	00	8.1			5.2
	France	Italy	U.K	Austria			Finland
Export	2.7	3.6	3.1	0.0			2.7
Import	0.0	4.7	0.0	4.1			3.7
	Other Europe	Japan	China	Other Asia	Cuba	USA	Other America
Export	12.8	3.4	0.0	15.1	5.6	0.0	1.4
Import	18.8	2.5	2.7	11.8	5.2	3.7	1.8

Source: E.I.U (1992), p. 93, based on World Bank, Statistical Handbook: States of the FSU.

3.3.2.4 Turkmenistan

Before 1990 Turkmenistan had a trade deficit with the former USSR republics and also with other countries equivalent to 13.2% of GDP as shown in Table 3.26 (E.I.U 1992).

Table 3.26 Composition of Turkmenistan export/import trade (Rb: million).

	1989		1990		1991	
	Exports	Imports	Exports	Imports	Exports	Imports
Total	2660	3334	2641	3606	7906	5497
Total inter republic	2418	2744	2469	2923	6785	4608
Balance	-326		-454		+2179	
Total Foreign	242	590	172	685	1121	889
Balance	-348		-513		+232	

Source: EIU (1992), p. 115, based on IMF, Economic Review: Turkmenistan; Europe World Year Book, (1994b), p. 3072. based on IMF, Economic Review: Turkmenistan, and International Financial Statistics: Supplement on Countries of the FSU; World Bank, Turkmenistan: The Transition to a Market Economy and Statistical Handbook : States of the FSU.

But from 1991, as a rich hydrocarbon producing country, the situation was changed mainly due to the export of oil and gas to former Soviet states, with which there has been a considerable surplus. The value of both inter-republic and international trades increased significantly by about two times (exports) and four times (imports) during 1989-1991.

The composition of exports in terms of value with both ex-USSR republics and internationally is presented in Tables 3.27 and 3.28 for 1989-1991. The most important item is energy (oil and gas) followed by industrial products.

Table 3.27 Structure of Turkmenistan inter-republic export/import trade (Rb: million).

	1990		1991		1992	
	Exports	Imports	Exports	Imports	Exports	Imports
Petroleum gas	743	100	696	79	2563	125
Electric power	70	-	67	-	152	-
Iron and steel	-	84	-	106	-	167
Chemicals	152	209	147	203	400	320
Machinery and metal working	-	949	-	959	-	1509
Wood and paper products	-	125	-	97	-	152
Products of light industry	1076	453	1083	551	2767	867
Food and beverages	85	478	206	445	300	700
Agricultural unprocessed products	128	34	124	132	370	208
Other commodities	93	99	74	98	80	154
Total inter-republic trade	2418	2744	2469	2923	6785	4608

Source: Europe World Year Book (1995b), p. 3072 based on IMF, Economic Review: Turkmenistan and international Financial Statistics: Supplement on Countries of the FSU; World Bank, Turkmenistan: The Transition to a Market Economy and Statistical Handbook: States of the FSU.

Table 3.28 Structure of Turkmenistan international export/import trade (Rb: million).

	1990		1991		1992	
Trade composition	Exports	Imports	Exports	Imports	Exports	Imports
Petroleum & gas	2	-	9	-	445	-
Iron and steel	-	19	-	7	9	-
Chemicals and petroleum products	1	-	7	-	35	-
Machinery and metal working	-	93	-	120	-	155
Wood and paper products	-	12	-	9	-	12
Products of light industry	223	243	139	255	576	330
Food and beverages	2	144	7	185	17	240
Agricultural unprocessed products	5	51	4	60	42	78
Other commodities	8	-	5	-	-	-
Total international trade	242	590	172	685	1121	889

Source: Europa World Year Book (1995b), p. 3072. based on IMF, Economic Review: Turkmenistan and international Financial Statistics: Supplement on Countries of the FSU; World Bank, Turkmenistan: The Transition to a Market Economy and Statistical Handbook: States of the FSU.

In terms of individual inter-republic trade, the share of countries is shown in Table 3.29 where within the CIS exports to Russia and Ukraine are the most prominent.

Table 3.29 The share of the main inter-republic foreign trade of Turkmenistan in 1990.

	Belarus	Kazakhstan	Russia	Ukraine	Uzbekistan	Others
Exports	2.06	2.59	49.81	7.41	27.78	10.78
Imports	3.59	3.99	41.74	15.60	5.67	31.40

Source: Europa World Year Book, (1994b), p. 2974.

Europe dominates for other trade with 71% of the total imports and 63.6% of exports, followed by Asia with 20% of exports and 22.1% of imports (see table 3.30).

Table 3.30 Major shares of international foreign trade of Turkmenstan in 1990.

	Germany	Bulgaria	Chzechs & Slovakia	Hungary	Poland	China
Export	11.4	9.3	7.1	5.7	5	0.0
Import	25.4	7.2	8.1	0.0	9	2.7
	Romania	**Finland**	**Former Yugoslavia**	**India**	**Japan**	
Export	4.3	0.0	0.0	2.9	0	
Import	0.0	3.2	3.2	5.7	3	
	Cuba	**USA**	**Europe**	**Asia**	**America**	
Export	5.7	0.0	63.6	22.1	6.7	
Import	2.8	3.0	71.0	20.0	7.2	

Source: E.I.U, (1992), various pages for Turkmenistan, based on World Bank, Statistical Handbook: States of the FSU.

Imports from foreign countries other than the former Soviet Union were only about 11% of the total. Trading partners within the former USSR were mainly Central Asian countries. As indicated in Table 3.31 the highest value for inter-republic imports is for capital goods followed by intermediate products, while foodstuffs are the most important imports from other countries.

Table 3.31 Composition of the foreign trade of Turkmenistan in 1990 (Rb: million; foreign trade prices).

Major commodity group	Inter-republic	Others	Total
Capital goods	37	2	39
Energy	1760	23	1783
Food	116	3	119
Intermediate manufactures	711	2	793
Intermediate primary goods	50	0	50
Other consumer goods	99	4	103
Total	2773	114	2887

Source: E.I.U (1992), p. 116 based on World Bank, Statistical Handbook: States of FSU.

3.3.2.5 Uzbekistan

The economy of Uzbekistan during the Soviet era was mainly based on cotton and Karakul skins both for domestic industries and foreign trade, although its land has a high potential for other agriculture using artificial irrigation (E.I.U 1994a and Lerman, Garcia-

Garcia and Wichelns, 1996). The foreign trade of Uzbekistan, like all other former republics, heavily depends on Russia, accounting for 65% of imports in 1993 (Griffin 1996). This resulted in considerable deficits. Table 3.32 shows the inter-republic and foreign trade and trade balance of Uzbekistan. Trade outside the CIS is not significant (see table 3.32).

Table 3.32 Composition of Uzbekistan export/import trade (Rb: million).

	1989		1990		1991		1992	
	Export	Import	Import	Export	Export	Import	Import	Exports
Total	10169	14158	14158	9351	19535	21475	191885	150518
Total inter-republic	8542	12046	12046	8169	17339	17766	162246	123136
Balance	-3504.4		-3694.7		-427		-39110	
Total foreign trade	1628	2112	2798	1182	2196	3709	29639	27382
Balance	-486		-1613		-1513		-2257	

Source: EIU (1992), p. 103, based on IMF, Economic Review: Uzbekistan; Europa World Year Book (1994b), p. 3267. based on IMF, Economic Review: Uzbekistan , and International Financial Statistics: Supplement on Countries of the FSU; World Bank, Uzbekistan: The Transition to a Market Economy and Statistical Handbook : States of the FSU.

As shown in Tables 3.33 and 3.34 in terms of the composition of foreign trade, Uzbekistan produces a surplus in oil and gas, non-ferrous metals, and light industries including cotton and its products while it has considerable deficits in food and ferrous metals.

The main trading partners of Uzbekistan during 1992 for both exports and imports were Russia and Ukraine with 53% and 13% of exports, and 14% and 53% of imports respectively (Europa World Yearbook 1995b). At the intra-CIS level, during 1994 it had a surplus of about US $246 million, particularly with Russia. At the non-CIS level Uzbekistan is very active in the cotton markets of the world. For example, it constitutes 94% of trade with the UK (UNCTAD/UN 1994).

Table 3.33 Export/import structure of Uzbekistan at the commodity group level in 1992(Rb: million, domestic prices).

Type and composition of trade	Exports	Imports
Oil & Gas	16956	886
Machinery & metals	22614	3292
Light industries (incl. cotton)	72143	1938
Non-ferrous metals	15355	000
Food industry	000	26762
Ferrous metals	000	26255
Total	127068	59134

Source: E.I.U (1993c), Uzbekistan, p. 19.

Table 3.34 Composition of Uzbekistan export/import trade (Rb: million).

Composition of trade	1989		1990	
	Exports	Imports	Exports	Imports
Petroleum & gas	646	1032	598	888
Electric energy	214	000	207	000
Iron and steel	000	676	000	661
Non-ferrous metals	468	424	447	409
Chemicals and chemical products	894	1111	853	1147
Products of machine-building industry	1190	3553	1231	3625
Wood and paper products	000	725	000	560
Construction materials	000	228	000	205
Products of light industry	4659	2761	4242	2963
Products of food industry	795	2156	824	1983
Agricultural unprocessed products	757	661	447	1309
Total trade including other products	10169	14158	9351	14662
Total inter-republic trade	8542	12046	8169	11864
Total foreign trade	1628	2112	1182	2798

Source: Europa World Year Book (1994b), p. 3267. based on IMF, Economic Review: Uzbekistan ,and International Financial Statistics: Supplement on Countries of the FSU; World Bank, Uzbekistan: The Transition to a Market Economy and Statistical Handbook: States of the FSU.

The latest comprehensive aggregate data for its non-CIS trade partners is shown in table 3.35, indicating the important roles in 1992 of the former CMEA and UK for the exports of Uzbekistan, and Switzerland for its imports.

Chart 3.35 Main international import/export trade of Uzbekistan in 1992.

	UK	Belgium	Germany	Switzerland	Other EU
Imports	00.0	00.0	3.00	21.2	6.6
Exports	13.5	12.9	10.8	00.0	9.2
	Turkey	Former CMEA	Others	China	
Imports	3.8	4.8	46.7	7.3	
Exports	8.9	14.2	32.7	0.0	

Source : EIU (1994a), Uzbekistan, p. 19.

3.4 Transport of the CAC countries

All CAC countries are connected to each other and other neighbouring countries with a non-standard rail network. Armenia, Gyrkyzstan, and Tadjikstan have no access to the sea, while Georgia is the only full maritime country of the bloc. Azerbaijan with Kazakhstan and Turkmenstan have direct access to Russian and Iranian ports through the Caspian Sea and through the Volga Don Canal to the Black and Baltic Seas.

According to Mc Donell (1995, p. 14):

> Since the independence, the traffic on the Black Sea has been almost totally disrupted and most of the previous fleet is in disrepair or has been dispersed. The formerly thriving roll-on/roll-off shuttle service between Turkmenbashi (port of Krosnovosk) and Baku has been virtually discontinued. Even so, some new trades are developing. Several Iranian ports, notably Nooshahr and Bandar Turkmen, are exchanging cargoes with other Caspian littoral countries and, ..."

Kazakhstan is the Far East gateway of the Central Asian railway connecting China to Iran and other Middle East and Western countries while Georgia is the gateway for Europe.

Demand for transport in the CAC countries was severely affected by the consequences of independence both internally and externally. This resulted from existing significant inter-republic economic dependence and new border crossing barriers, although a fundamental movement towards co-operation has taken place since the end of 1991. While the previous central planning designed the road system only to act as a feeder service to rail in the CAC countries, the new situation inevitably forced these countries toward the expansion of roads and a road freight system capable of taking vehicles with higher capacities of about 20 tonnes (Jenkins, 1994).

As stated, road transport in the CAC countries is characterised by feeder services for rail. The eight republics have 42.9% and 17% of the total former USSR 903,000 km of roads and 147,360 km of rail network. Road freight traffic is mainly composed of light and short distance traffic on narrow roads. (Jenkins 1994). Since the break up of the former USSR there is no reliable data about the inventory of rolling stock and road freight vehicles of each of the CAC countries .

3.4.1 Transport in Caucasus countries

The Caucasus countries, although smaller, have more integrated transport networks than the Central Asian republics. They have 7.5% of the rail and 3% of the total roads of former USSR. The hard surface road and rail networks of the Caucasus region (Table 3.36) are about one-fifth (1/5) that of the Central Asian republics.

Table 3. 36 Transport infrastructure and superstructure in the Caucasus countries.

Road vehicles	Armenia (1992)	Azerbaijan (1992)	Georgia (1989)	Total Caucasus
Rail networks, km	825	2040	1570	4435
Road networks, km	7700	28600	31200	67500

Europa World Year Book (1994a), various pages for Caucasus countries.

3.4.1.1 Azerbaijan

Azerbaijan, a semi-maritime country on the Caspian Sea, has partial access to the Baltic and Black Seas in Summer through the Volga-Don waterway in Russia. The regular coastal cargo/passenger crossings operate between the port of Baku and all other ports of the Caspian Sea and are designed to take passengers, rail wagons, trailers, and refrigerated goods (Agazadeh, 1994).

In terms of rail connections, Azerbaijan is linked through the broad gauge eastern system with Tbilisi (Georgia), to the Russian Autonomous Republic of Daghestan in Makhchkala, and Yerevan (Armenia) through Nakhichvan. The total length of the link is 2040 km of which 806 km is electrified and about 1270 km. is double track. According to an agreement with Iran in 1992, Azerbaijan will be connected with the Autonomous Republic of Nakhichevan through Iran, bypassing the Armenian territory. The rail network in Azerbaijan is claimed to handle 40 million tonnes of freight and 20 million passengers annually. Azerbaijan has a road network of 30,400 km of which 28,600 km (see Table 3.36) were hard-surfaced in December 1989.

More than sixty per cent of the truck capacity of the former USSR was devoted to vehicles of eight tonnes or lower, emphasising the poor long distance trucking system and the importance of the road mode as a feeder service to rail (Holt 1993).

3.4.1.2 Armenia

Armenia as a landlocked country is connected with road, rail and air modes to neighbouring countries. In 1990 it had a total rail track of 820 km and 100 diesel-electric and 80 diesel locomotives. In terms of international connections there are rail links to Turkey, Iran, Georgia and the Autonomous Republic of Nakhjavan. The motor roads in Armenia mainly have hard surface. As a part of the former USSR it suffers from the lack of an independent rail gateway with Iran (all trade was carried out through the Autonomous Republic of Nakhjavan of Azerbaijan) and it was disrupted when the conflicts concerning Nagorno Garabakh started. A major positive development for Armenian foreign trade was the completion of a bridge over the Araks river along the Iranian border in 1996 in the Noor Dooz (Megri) providing normal flows of trade to the Persian Gulf and Europe respectively for Armenia and Iran (Sanate-Hamlo-Naghl 1996a).

3.4.1.3 Georgia

In terms of international connections there are rail links to Turkey, Azerbaijan, and the Russian Federation. Georgia, as the only maritime country of the republics being considered, is connected with road and rail modes to neighbouring countries and others through the Black Sea ports of Batumi and Sukhumi. Georgian railways in 1990 had a total length of 1570 km. The road network in 1989 comprised 35,100 km of which 31,200 km were hard surface.

3.4.2 Transport in Central Asia

The Central Asian transport system covers vast areas. All five countries in this region are connected with rail and road at different levels as shown in Table 3.37. They have 35.4% (903000 km) of the total public roads of the former USSR and 14% of the rail network (Holt 1993). Rail forms the most important mode for the transport of freight and passengers for long distances. In Central Asia, two countries have access to the Caspian Sea, although, unlike Georgia, none have access to the open seas. Another feature of Central Asia is the existence of the Aral Sea and the two navigable rivers of Amu Draya and Syr Darya, which constitute important intra-Central Asian freight communications for different shipping companies.

Table 3.37 Transport infrastructure and super structure in the Central Asian countries (km).

Transport infrastructure	Kazakhstan (1991)	Turkmenistan (1989)	Gyrkyzstan (1990)	Uzbekistan (1990)	Tadjikstan (1990)	Total
Rail networks	14148	2120	370	3460	480	20578
Road networks	166864	22600	28400	73100	28500	319464

Sources: Europa World Year Book (1994a) and (1995b) various pages.

3.4.2.1 Gyrkyzstan

Gyrkyzstan is a mountainous country and has the smallest rail and road network among the Central Asian countries. The limited rail network as shown in Table 3.37 connects the capital of the country to the Kazakhstan network only, but it is linked by road to Tadjikstan and Kazakhstan. It has only 600 km of inland waterway.

3.4.2.2 Kazakhstan

It has a poor quality road system except in the north-western part of the Uralsk (Hanter 1995). The available performance of the broad gauge railway as given in Table 3.39 indicates a decline in freight and passengers. Most of the freight of the country is transported by rail (E.I.U 1992). The north-eastward rail line of Kazakhstan is joined to the Trans-Siberian Railway (TSR) while its eastward line is connected to the Trans-China Railway (TCR). Kazakhstan is an important rail and road link between Russia and the other four countries of Central Asia. The road network in December 1991 was shown in Table 3.37, of which 114,636 km have a hard surface. It is mainly road-connected with Russia (46 border crossings) and with Uzbekistan and Gyrkyzstan each with 7 links, and China through 6 border crossings. Inland waterways are operated by different companies and in 1989 3,857 million tonnes-km of freight were carried by this mode (Europa World Yearbook 1995a). This includes navigation through the Syr Darya river to the Aral Sea and also domestic trade along Lake Balkhash. Kazakhstan has two main ports along the northern coastline of the Caspian Sea, both of which are active in coastal shipping trade with other states along the Caspian sea and also with European countries during Summer.

Table 3.38 Kazakhstan railway performance.

	1989	1990	1991
Passenger-km (million)	18,921	19,734	19365
Freight net ton-km (million)	409, 573	406,963	374,230

Source: The Europa World Yearbook (1995b), Based on UN Statistical Yearbook. p. 1738.

3.4.2.3 Tadjikstan

Tadjikstan has a shipping waterway of about 200 km on the Amu-Darya between Termz, Sarava, and Jilikulan and also through Syr Darya both of which, after passing Turkmenistan and Uzbekstan to the west and Uzbekstan and Kazakhstan to the north, end in the Aral Sea. It has 28,500 km of roads with a total railway of about 480 km in 1990 connecting the national capital to the other rail networks of the Central Asian countries.

3.4.2.4 Turkmenistan

Turkmenistan has fewer transport problems than other landlocked CAC countries as a result of having a long border with Iran (Akiner 1995). The Caspian Sea, with a controlled access to the Black and Baltic Seas in Summer, is the only sea outlet of Turkmenistan. Another waterway is the Amu Draya river of about 1300 km, which provides domestic and regional trade routes from Turkmenistan to Uzbekestan and Kazakhstan ending at the Aral Sea. Turkmenistan has a broad gauge Eastern system railway network of 2,120 km. The rail fleet consists of 1280 freight cars with speeds of up to 80 to 90 km/hours and 400 coaches having a speed range from 95 to 100 km/hour. The road networks of about 23,200 km (of which 18,400 were hard-surfaced in November 1991) are mainly narrow band. Turkmenistan will play an essential role for other Central Asian foreign trade through Iran, in particular when the bilateral rail project of Sarakhs-Tajan is completed at the end of 1996. It should accommodate an annual freight load of eight million tonnes when provided with appropriate technology (Tehrani, 1996). It will give access to the Persian Gulf and the Indian Ocean, to Pakistan and the Indian sub-continent, and also to Europe via Turkey (Shemshad Ahamad, 1995).

3.4.2.5 Uzbekestan

Uzbekestan is connected by road, rail and river to all its neighbours. It has the second largest rail and road network of the CAC countries after Kazakhstan (see table 3.38) and acts as a junction for the rail connections of the eastern and western parts of Central Asia. It has extensive navigable waterways through the Amu-Darya and Syr-Darya rivers and the Aral Sea coast.

3.5 Trade with Iran

Iran, as a potential and close market to most of these countries, established imports and exports with the CAC republics soon after the collapse of the former USSR. Iran also has extensive trade with the European and American continents via Turkish and Georgian ports. Therefore, another advantage for Iran and the Central Asian countries is that the transit route to the Black Sea port of Trobzan in Turkey is about 800 km longer than routes within Armenia to Batumi in Georgia (Sanate-Hamlo-Naghl 1995b).

Iran's trade with the CAC countries expanded rapidly after the break-up of the former USSR in 1992. They had 38.8% and 62.7% of Iran's total exports to and imports from the CIS with a value of about US \$ 401 million (Ministry of Economics and Finance, 1993). Table 3.39 shows the foreign trade of Iran with all the CAC countries for the first two years of independence of those countries. In only two years there was a growth of about 107% in total trade, with a net imbalance in the volume of trade with the CAC countries involved. Exports to the CAC countries in 1993 accounted for about 12% by weight (15% by value) of the total Iranian general cargo exports. The equivalent percentages for imports were 7% and 4% respectively (Sanate-Hamlo-Naghl 1994b).

Table 3.39 Volume of the foreign trade of Iran with CAC countries (000 tonnes).

		1992			1993		
	CAC countries	**Imports**	**Exports**	**Total**	**Imports**	**Exports**	**Total**
1	**Armenia**	1.73	0.80	2.52	44.61	12.88	57.49
2	**Azerbaijan & Nakhjavan**	733.76	26.79	760.54	1278.94	117.91	1396.85
3	**Georgia**	0.0009	0.07	0.07	0.92	0.54	1.46
4	**Gyrkyzstan**	0.035	0.00	0.035	0.00	0.3	0.30
5	**Kazakhstan**	9.44	0.15	9.59	44.17	8.07	52.22
6	**Tadjikstan**	0.13	0.45	0.58	13.53	0.34	13.87
7	**Turkmenistan**	2.96	10.19	13.15	52.98	4.85	101.43
8	**Uzbekistan**	000	0.09	0.09	0.09	0.59	1.49
9	**Total**	748.05	38.52	786.57	1,436.02	189.08	1,625.10

Source: For 1992 Customs' Administration of Iran (1992) annual reports for imports and exports. For year 1993 based on Sanate-Hamlo-Naghl, (1994b), No. 135, pp. 15-16 based Iran's Customs imports/exports detailed reports for 1992; Ministry of Economic and Finance (1993), Assessment of the Economic Co-operation of the of Iran with CIS in 1992, various pages.

During 1991, the three Caucasus countries, according to the Ministry of Economics and Finance (1993), had 29% of the total export value of Iran to the CIS and 59% of imports to Iran. The Central Asian countries had 9.8% and 2.2% of total CIS exports and imports with Iran.

The performance of freight transit for the CAC countries during the first eight months of the Iranian solar year in 1995 (starting from 22nd March) accounted for about 872 thousand tonnes. This trade was composed of rice, sugar, tea, oil products, chemical products, metals, machinery, household furniture, fertiliser, fibres and synthetic fibres (Sanate-Hamlo-Naghl 1995d).

3.6 Economic Co-operation Organisation (ECO)

It will take a long time for the CAC republics, neighbouring countries, and the world to understand and assess the future interests and objectives of the CIS and in particular Russia after the USSR. The CAC republics are looking for support for economic development and even defence against Russia (Baba 1994). All these countries will inevitably be dependent on the Russian economic and industrial system for a long time, but they also seek and welcome other alternatives both internationally and regionally to secure their present and future situation.

ECO is a new but non-military version of the Regional Co-operation for Development (RCD) and the Izmir treaty. ECO was originally set up in 1985 between Iran, Turkey and Pakistan with a permanent centre in Tehran to facilitate economic, technical, and cultural developments and co-operation. Its formal structure is composed of the Council of Foreign Ministers as the main decision makers, and meetings take place by rotation at least once a year. According to Shemshad Ahmad (1995) ECO is now, based on population, after the European Union (EU), the second largest regional organisation in the world. It has committees which follow three major specialised branches of co-operation assigned to each of the following founder members:

* The ECO banking system is based in Turkey.
* Insurance issues are discharged to Pakistan, and
* Transport issues to Iran (Sanate-Hamlo-Naghl 1995d).

ECO gained seven new members in 1993 (six CAC countries and Afghanistan) covering a region with 7 million square km. and about 300 million population (Haghi 1995). Armenia is an observer member of the treaty and frequently attends ECO sessions in Tehran while Romania is also seeking admission. ECO has therefore strengthened its position as a regional co-operation centre, developing its relations with other regional, Islamic and international agencies greatly (Gharabaghi 1994, Yearbook of International Organisations 1995).

ECO aims to eliminate Customs tariffs among member states (initially with a 10% reductions of tariffs), to establish an investment and developmental bank, to expand tourism, and to facilitate transport and communications (Baba 1994).

The ECO shipping organisation in 1995 had five members; Iran, Pakistan, Afghanistan, Turkmenstan, and Kazakhstan. Its operation now not only covers the Caspian Sea but also other international waters. The first ship of the ECO shipping organisation was provided by Iran and is now operating in the Indian sub-continent, the Far East, and the South of Europe (Tarjoman 1995).

3.7 Conclusions

This study has dealt with the CAC countries from the macroeconomic point of view and has a twofold research aim: first to investigate potential areas affecting the demand for international trade to provide an insight and support for other parts of the research; second, to indicate the existing transport situation of a region which requires the use of a new outlet for foreign trade. Therefore, it has attempted to investigate these countries in terms of political, economic, foreign trade, and transport levels and also the composition and role of the ECO as a regional co-operation organisation for the CAC republics and other members. The insight gained from the review, despite the lack of fully comprehensive statistics, can be used as support for further investigations relating to the Iran Sea-landbridge study (ISLB). It becomes evident that the CAC countries are passing through a transitional period and, due to sharp economic, political and trade changes, will also need developments in infrastructure provision. They have many common problems, but each country has its own potential and weaknesses and it is impossible to represent a complete and single future perspective for all countries combined.

However it would appear feasible to develop a general model based on aggregate international foreign trade values as a base for the long term evaluation of the potential ISLB flows from the CAC countries.

4. Landbridges: concept and practice

4.1 Introduction

The purpose of this chapter is to examine the concept of a landbridge, and to identify a suitable form to investigate the specific landbridge applicable to Iran and the CAC countries which will be described in the next chapter.

This chapter adopts an approach based on three main stages:

* The concept of a landbridge
* Influences (controls) on landbridge development
* Examples of landbridges

Different authors spell the term as "land bridge", "land-bridge" and "landbridge". This work will use the last mentioned spelling except when giving a direct quotation where another form of spelling may be used.

4.2 The concept of a landbridge

The landbridge phenomenon is not a new concept (Hayuth, 1987) and dates back to ancient times. e.g. the silk way caravans travelled between East and West for centuries and before the invention of modern transport systems was a well organised system employing mainly land, river and short sea modes. The landbridge concept suffers from a lack of detailed academic study and, therefore, the limited number of cited writings have been traced as far back as 1969.

4.2.1 Definition of a landbridge

A landbridge according to Hayuth (1987, p. 86) is:

> "The utilisation of the land transport for a part of what would normally be entirely an ocean voyage".

Miller (1977, p. 64) more specifically defines it as:

> "A service provided between two or more modes to transport goods originating from a foreign point, transiting domestic points, and finding its destination at another point".

The sequence of activities for the general concept of a landbridge is shown in Figure 4.1. It is as an integrated international transport service between origin and destination countries, using the infrastructure of any number of intermediary countries to connect the two sea passages at each end under a contract of carriage. In this sequence intermediary and destination country might be the same or differ. This is sometimes evidenced by a single bill of lading (B/L) between shipper and carrier, although the use of another single document such as a waybill is more relevant to the origin-destination nature of landbridge practices. The B/L has a precise legal function which is not directly relevant to this work. Therefore, the more general and less specific term "waybill" will be used, following a brief discussion.

Figure 4.1 General concept of a landbridge.

Consignment in country A (origin)	1st Sea mode	Consignment in transit countries 1st port	Consignment by rail / road	Consignment in transit countries 2nd port	2nd Sea mode	Consignment in country B (destination)
→			Single waybill	→		

The B/L, as a traditional and commonly used document of carriage of goods by sea, has three characteristics and functions (Wilson 1993, pp. 126-162); as evidence of the contract of carriage, as a receipt for goods shipped, and finally as a document of title. According to Wilson (1993, p. 163):

> "The waybill differs from the bill of lading in that, while it acts as a receipt and provides evidence of the contract of carriage, it lacks the third characteristic (as mentioned above) in that it does not constitute a negotiable document of title".

Some characteristics of the bill of lading are that anyone holding the document can receive the shipment, since it is a negotiable document. The shipper must despatch the bill of lading directly to the consignee by post or deliver it to a bank. A bill of lading needs to be sent to the consignee much faster than the shipment otherwise problems arise. A bill of lading is called a 'shipped bill' if a shipment is received on ships, otherwise it is 'received for shipment' and issued at any inland point where shipment is received (Day 1980, Todd 1990).

According to Todd (1990, p. 252):

> "The International Maritime Committee has taken the view that in the great majority of cases of general cargo a bill of lading is not necessary at all. Negotiability is not of the essence for most liner shipments, and shipments of manufactured goods, which are not re-sold during transit".

A waybill is a non-negotiable contractual document which acts as evidence of the carriage of goods, a receipt for the goods by the carrier and the carrier is obliged to deliver the shipments to a named receiver or cargo owner. It was developed first for use in land and air transport modes where there was no or limited time for negotiations; but later was adopted in sea modes in the 1960s when there was a considerable reduction in the journey time of shipments by sea because of faster ships and cargo handling operations in ports through containerisation, etc. This resulted in shipments arriving ahead of the legal cargo delivery documents and the waybill was introduced to avoid the wait. It is designed to cover a simple freight and to overcome the transit problems under traditional bill of ladings (for example communication problems which may delay documents in transit). Unlike bills of lading, the consignee at the destination cannot present a waybill to take delivery of the shipments unless there is proof of identity of the named consignee or his authorised agent at the port of discharge (Hopkins 1982, Todd 1990, Wilson 1993).

According to Wilson (1993, p. 163):

> "The modern waybill follows the pattern of the short form bill of lading in that it is a short form document with a blank back but with a specific clause incorporating the carrier's standard terms and conditions. As with the bill, the waybill is available either in a proprietary or common form".

However, the important concept in different landbridge operations is that a shipment should move under a single document along the entire routes from origin to destination

Negotiation over shipments is not required during the transit period but the carrier is obliged to deliver goods to a named consignee. Therefore, a waybill is an appropriate term to be used in this chapter; although it should be understood that a B/L could be relevant.

Despite the fact that all bridge operations (even short ones) use some kind of road or rail mode, landbridges may be classified under a number of headings, which are:

* Minibridge
* Microbridge
* Sea-air bridge
* Air-road-air bridge, and
* Sea-river bridge

These will be considered in sequence.

4.2.1.1 Definition of a minibridge

According to Hayuth (1987, p. 88) a minibridge is:

> "The movement of containers under a single bill of lading from one country via a vessel to a port in another country, thence by rail minibridge to a second port city, terminating at the rail carrier's terminal."

According to Norris (1972, p. 41) a minibridge is:

> "Two or more modes working in tandem - fully co-ordinated and producing a planned through service usually on a through pricing basis".

The minibridge is an integrated transport operation. It involves transport between two countries (or more) with only one sea transit during the entire journey. The journey ends at the second port in the destination country after an inland transit (Hayuth 1987) but nowadays is continued from the first port to other countries by road or rail modes. The stages of a minibridge are shown in figure 4.2. According to the traditional definitions minibridge services are less likely to cross more than two continents compared with landbridges. They appear to have been first offered in 1971, when transatlantic cargo destined for a US Gulf port was off-loaded at an East Coast port (Hayuth 1987, p. 88).

Miller (1977) and Hayuth (1987) restrict their discussion of the minibridge mainly to journeys starting or ending in the United States.

Figure 4.2 General concept of a minibridge.

Consignment in country A (origin) at an inland point (IP)	Consignment by domestic mode (road / rail)	Consignment in the port in country of origin (A)	Sea mode	Consignment in 1st port in country B	Consignment by domestic mode (road / rail)	Consignment in 2nd port in country B (final stage of minibridge)
→ Single waybill →						

The development of minibridge traffic according to Hayuth (1987) has been mainly for three reasons:

* The standardisation of container units,
* The growth of intermodal transport, and
* The great improvements in rail transport services.

The difference between a landbridge and a minibridge is that landbridges are composed of sea-land-sea movements while the latter is restricted to sea-land movements. According to Hayuth (1987) the advantages of a minibridge can be observed from both users' (shippers') and carriers' (shipping lines') viewpoints. Shippers are in favour of minibridges because they provide them with better services and alternative transport modes, ports of call and ship schedules, while carriers have the choice of those ports most suited to demands. Norris (1972, p. 41) discusses the minibridge concept from the carriers' and shippers' points of view. For carriers:

> "It may expand the market of either, both, or all of the carrier or other transport-oriented participants which, of course, reflects the stimulus of carrier competition" (page 41).

On the other hand, for shippers:

> "The minibridge, like its kin, intermodalism, represents a new - an additional- transport option which, in the relatively few minibridge arrangements that exist to date has proved, according to claims, a very effective technique in meeting some of the demand in transportation" (page 41).

According to Miller (1977) the microbridge (see Figure 4.3), is more limited in geographical dimensions than the minibridge. The main difference between the mini- and the microbridge is that the latter is not involved in the double port container operations in the destination country. According to Hayuth (1987, p. 94) a microbridge is defined as a:

> "Through container service to and from an interior point in the United States and involving at least two modes of transportation, generally ocean and rail."

Figure 4.3 General concept of a microbridge.

Consignment in country A (origin) at an inland point	Consignment by domestic mode (road / rail)	Consignment in the port in country of origin (A)	Sea mode	Consignment in the port in destination country (B)
→		Single waybill		→

4.2.1.3 Definition of a sea-air bridge

A sea-air bridge (Figure 4.4) is a pattern of transport between two countries where the consignment uses the sea mode to leave the country of origin and to reach a particular seaport which is also near an international airport in an intermediary country. Then, the consignment is air freighted to the destination country.

Figure 4.4 General concept of a sea-air bridge.

Consignment in country A (Origin) at a port	Sea mode	Consignment in the port of a transit country (C)	Shuttle modes between port & airport in country (C)	Consignment in the airport of transit country (C)	Air mode	Consignment in the airport in country B (destination)
→			Single waybill			→

The sea-air bridge concept started as a combined mode in the 1960s but did not particularly interest shippers until the mid 1980s (Eller 1987). According to Eller (1987) Air Canada and KLM were the first air carriers to develop the sea air bridge concept correctly. According to Raguraman and Chan (1994, pp. 380-381) :

> "The sea-air concept involves the movement of goods usually by sea on the first consolidated sector, and air on the latter, with the transfer between modes taking place at a hub".

They point out that the great advantage of sea-air transport over other combination modes is that it is less influenced by physical or geographical barriers. Another advantage of sea-air, is that it is cheaper than air freight alone and much quicker than sea freight on its own.

Co-ordination at points of transhipment is essential for the efficiency of sea-air bridges, and there is a need for official agreements between sea, air and customs authorities (Raguramann and Chan 1994). These agreements concern preferences in loading and unloading ships, facilitated warehouse cargo clearance, and minimal paper work.

4.2.1.4 Definition of air-road-air bridge

The combined air-road-air pattern was introduced to bridge a through flow between Asia, and South and Central America via the USA road networks (UNCTAD, 1993). Miami Airport played a central role in receiving road traffic from such West Coast ports as San Francisco and Los Angeles. There are four main reasons for the viability of such a system:

* Industrial development of Latin America
* Reduction in tariffs
* Development of North American Free Trade Agreement (NAFTA), and
* Elimination of trade barriers

4.2.1.5 Definition of sea-river bridge

This is an old established form of transport especially in Europe using navigable rivers. For example, the Rhine-Danube project (TNT Press 1992) will provide another sea-river bridge with a long river transit of about 3500 km between the Black Sea and the North Sea with new bulk sea traffic. Another sea-river bridge connects the north east Baltic Coast from St. Petersburg with the Caspian Sea via the Volga-Don and also to Black Sea ports through Russian territories.

4.2.2 The benefits of landbridges

When a bridge system is employed its type depends on the geographical location of the origin country and origin port, the volume, size and shape of shipments, and the difference between the cost of transport by land, sea and air modes to the destination country.

The main objectives for landbridge systems, according to Hayuth (1987), are to save both the transit time of unit loads and also total transport cost with fewer ports of call. This means, however that shippers' options over choice of ports will be reduced. Therefore, shippers will need to have confidence in the landbridge system used. Miller (1977, p. 65) indicates that:

> "The objective of a land bridge is to provide the foreign shippers, and the foreign consumers (in the long term), the most efficient and economical means of carrying goods".

Rijn (1981) indicates that transport by water is cheaper than by rail, but the advantage can be compensated if an overland route introduces a significant reduction in distance and in the freight rate. The capability and profitability of different modes, either singly or in combination, are obviously influenced by the distance travelled. According to Benson and Whitehead (1985) in using landbridge services the three following points must be taken into account : freight rates, time and cargo need.

According to Talley (1988, p. 150):

> "With the advent of deregulation, price and service competition among ocean carriers have intensified. In order to compete in this environment, ocean carriers have entered into joint arrangements with other modes (in particular, railroad) in order to gain central control on cargoes moving within an intermodal system consisting of ocean and inland carriers. Specifically, the competition of land-bridge with all water services have intensified".

According to Mahoney (1985) shippers prefer landbridges because of the rates and service they have obtained in the wake of deregulation. Mahoney also discusses the advantages of the bridge concept being under a single bill of lading compared with the traditional method of transport with the issue of several bill of lading or transit documents for each stage from origin to destination. In short, the development of a landbridge results from the following reasons:

* response to the world trading requirements for faster operation delivery
* the general rise in sea transport freight rates as a result of oil prices and wage levels
* reduction in damage of goods compared with all-water journeys
* growth of containerisation resulting in faster loading and unloading of products at origins and destinations, and intermediate points.
* increase in the supply of and demand for high value and sensitive goods.
* developments and improvements in overland networks and vehicles
* improvement of regional and international relations.
* integration of ownership and/or management of intermodal and sea/land carriers.
* improvement and unification of the legal aspects of the long distance carriage of goods such as the single bill of lading and waybill.

Miller (1977) identifies three advantages for both shippers and operators of landbridges with "efficient through service", and "decreased pilferage" for the former, and "ease of cargo handling" as the main advantage for the latter. Miller also suggests the two following advantages for the U.S as a landbridge host country:

* Moneys accrue to US companies, both domestic and international.
* Diplomatic and national prestige for US carriers as those who can provide efficient and economic channels of trade.

The development of the landbridge concept internationally has encouraged other developments. According to Mayer (1973, p. 154) in Canada and the United States (two important landbridge countries):

> "The combination of transatlantic, transpacific, and through landbridge traffic has stimulated the long-haul rail-roads of the high-speed services, including unit trains and run through trains specialising in rail-ocean container and piggyback services. In many instances through bills-of-lading are available between inland and coastal points and overseas origins and destinations".

4.3 Influences on landbridge developments

The development of the landbridge concept has taken advantage of two important technological developments of the second half of the twentieth century; international standard containerisation and swapbodies in Europe, which have allowed the development of intermodalism. However, successful application of the landbridge concept needs to take into account a wider range of important influences which can be placed under four main headings:

* Geographical
* Political
* Technical
* Organisational

Although these classes of influence will be considered separately, they are often interconnected.

4.3.1 Geographical influences

The geographical nature of the overland part of a landbridge to a great extent determines the efficiency of the services provided. e.g. The fact that Holland as a flat country is an important factor in the success of the port of Rotterdam as a landbridge port for neighbouring countries. Such physical barriers as mountains have implications both for rail and road in terms of lower speeds and frequency of services, the need for more powerful trucks and locomotives, and an increase in freight and other costs. Harsh climatic conditions may restrict a service such as the Trans-Siberian Railway (TSR) particularly during the frozen Winter and melting Spring periods.

The successful location of a landbridge requires reasonable market conditions between two origin and destination points. For example, the former Soviet Union lies between the Far

East and Western Europe with extensive interactive trade flows. Although the Trans-Siberian Railway was opened in 1907 (Hayuth 1987) it only become a successful landbridge route in 1971 after bilateral formal agreements between former Soviet agencies (e.g. Souyuzvneshtrans) and Japanese and European freight forwarders (Miller 1978).

4.3.2 Political influences

The political acceptability of the host country is another important factor in the growth of landbridges. Poor political and ideological relations with surrounding countries cause instability and lack of credibility. The flexibility of the geopolitical conditions of the landbridge host country is another factor, which in practice causes the growth and success of a landbridge.

Liberalisation in the use and operation of transport infrastructure and the ownership of ports and terminals (e.g. privatisation of services) have had a significant impact on the quality and quantity of services provided, when comparing the North American and Trans-Siberian landbridges (Hicks 1994).

The TSR landbridge of 13200 km can deliver a service within 24 days from Yokohama to Hamburg. This should be compared with the North American landbridge through the New York-San Francisco rail link with a transit time of 25 days for 21,222 km between Yokohama and Hamburg (Damas 1992a, Bonney 1991). The harsh weather and the special geopolitical conditions of the TSR create many shortages in rolling stock, and the management and information systems are less reliable compared with the USA or Canadian landbridges for similar origins or destinations.

4.3.3 Technical influences

Inadequate infrastructure also affects greatly the existence or operation of landbridges. As mentioned in section 4.3.2 the lack of credibility of the TSR results from a lack of railcars and rolling stock, signalling and information technology, etc. (Davies 1991, Damas 1992a).

4.3.4 Organisational influences

A landbridge is likely to be a more complex organisational structure than other types of transport system. An efficient landbridge system will largely depend on flexible co-ordination linking a road fleet, port ownership, rail operation and ownership of rolling stock, and on the number and operational capability of the operators involved. Therefore, national and international organisations can play significant roles in their viability and operations. In the Canadian landbridge both Canadian Pacific (CP) and Canadian National (CN) had a successful approach to the intermodal concept (Hayuth 1987). Both of these companies are not only involved in Trans-Canadian Railway ownership and operation but also in other modes and interfaces like seaports, trucking, and airlines which make decision making and options over shipments much easier (Hicks 1994). In the same context, TSR in a different organisational environment and as a government controlled organisation has suffered from insufficiencies as described earlier .

4.4 Examples of major landbridges

Different landbridges exist at inter-and intra-continental levels with geographical, political, technical, and organisational differences. Important landbridges operate within the three following areas:

* Europe/Asia
* Trans-Siberia
* North America

Figure 4.5 shows the most important ports and inland points used for landbridge purposes in this study.

Figure 4.5 Most important landbridge countries and ports in the world.

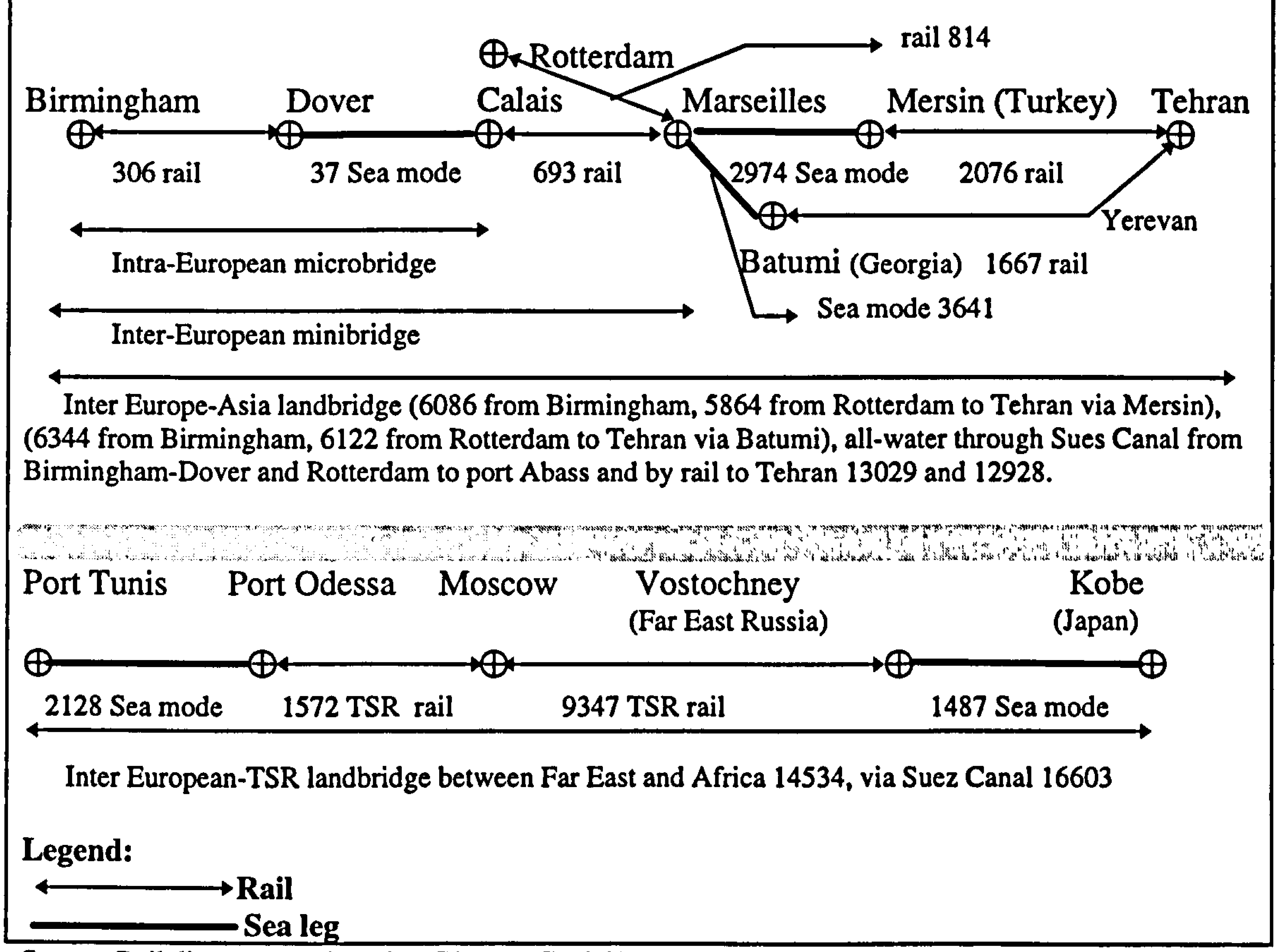
The borders on this Figure are for illustration purposes only.

4.4.1 Europe-Asia landbridges

4.4.4.1 Geographical characteristics

The specific feature of Europe is the variety of countries and economies, its maritime geography and its closeness to two other continents, which has made it suitable for all types of land, sea, and air integrated bridges (TNT Express 1992). Europe is surrounded by eight seas, causing the continent to be a source for all the current major landbridges in the world, and many intra-European landbridges (see Figure 4.5a for an example).

Figure 4.5a Intra-European landbridge, minibridge and microbridges, TSR landbridge with sea leg between port Tunis, Odessa and Vostochney (unit: km).



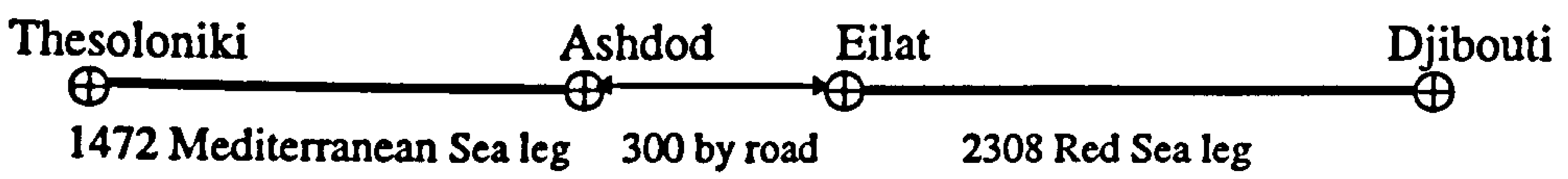
Source: Rail distances are based on Thomas Cook European and Overseas (1995), Timetables, vol. I & II, various pages. Sea distance are based on Caney and Reynolds (1981), Reed's Marine Distance Tables, various pages. Gavan (1987), The Ships Atlas 1987, (ed.). p. 4.

Minibridge services, restricted to one sea leg, exist between North and South Europe and also to and from Asia and Africa with short sea legs from and to the Mediterranean and the North Sea ports. Longer distance minibridges are also operative from these areas to the

Asian coast of the Black Sea and Mediterranean Sea via Turkey, Israel and Georgia (Eller 1987). These services compete with short sea trades operating between Scandinavian countries as well as the U.K and mainland Europe using road/rail networks to connect with second ports (Containerisation International 1995).

The Caucasus area and Eastern Turkish coastlines have long and short distance rail/road landbridges with the Baltic and North Sea or between the Black Sea, Mediterranean Sea, and Azof Sea as shown in Figures 4.5a and 4.6. The Caucasus, in its location along the west coast of the Caspian Sea provides a landbridge sea leg to Central Asia for Europe and America via Turkey or Georgia (Figures 3.1 and 4.5a).

Figure 4.6 The Euro-Israeli landbridge (unit: km).



The Euro-Israeli landbridge, 4080 from Thesoloniki to Djibouti, via Suez Canal 3978.

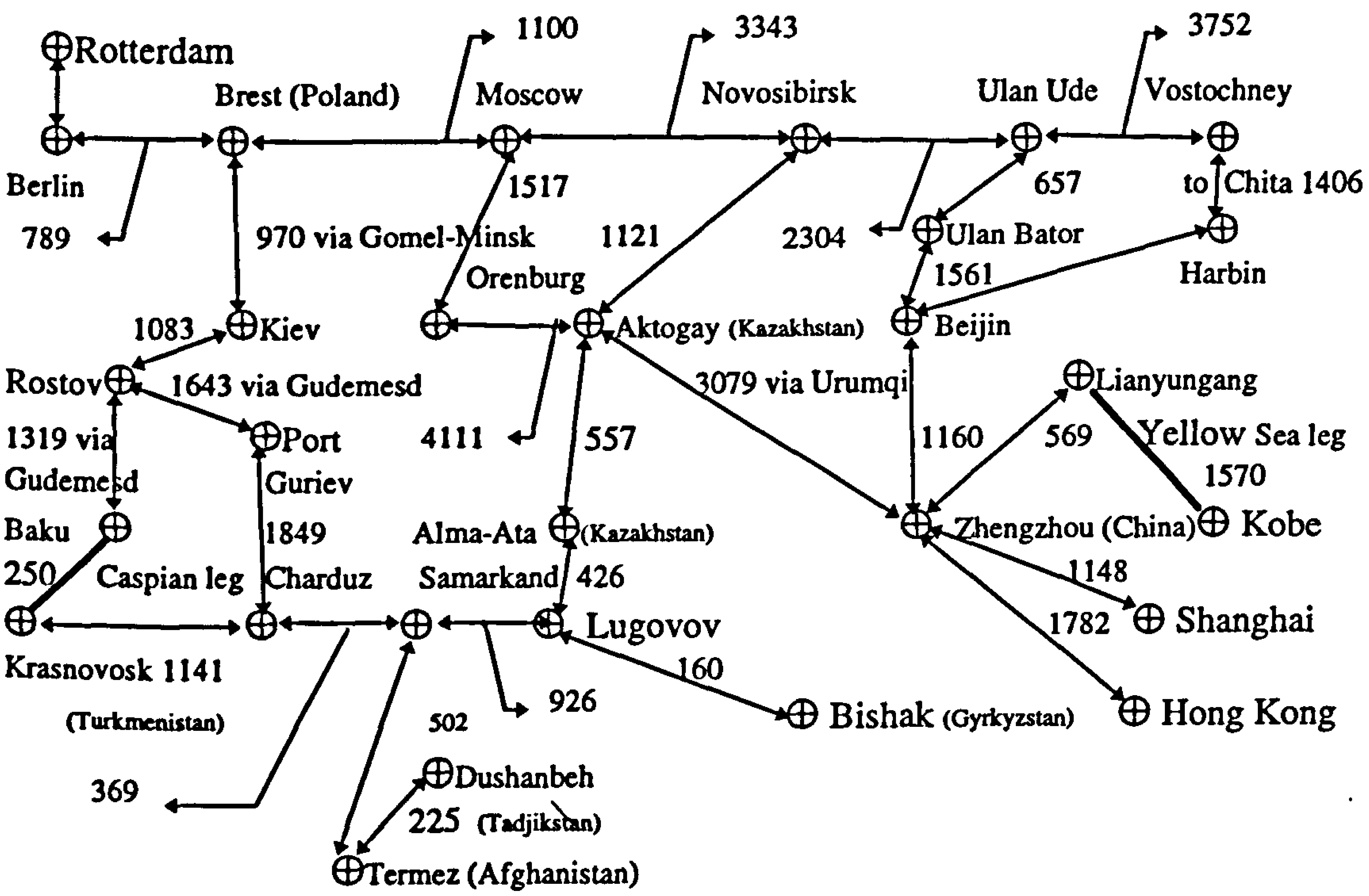
Source: Sea distances are based on Caney and Reynolds (1981), Reed's Marine Distance Tables, p. 71. Gavan (1987), The Ships Atlas 1987, (ed.). p. 13.

Turkey as the important interface between Europe and the Asian Middle East is a large maritime country surrounded on three sides by four seas (Black, Marmara, Aegean, and Mediterranean Seas) and has 8,300 km of coastline. According to Eller (1987), this locational advantage has helped Turkey to function as a key landbridge country. Different Euro-Turkish landbridges are able to save a distance of about 6943 km (similar origin-destinations compared with the Suez Canal route to the port of Abass) for journeys between Birmingham-and Tehran using two sea modes for Dover-Calais and Marseilles-Mersin and two rail modes for Calais-Marseilles and Mersin-Tehran. Turkey also is an operational landbridge via Rotterdam-Marseilles-Mersin-Tehran (Figure 4.5a) and between North American ports-Mersin-Iran and Iraq (Figure 4.9).

The Euro-Israeli landbridge (see Figure 4.6) takes advantage of Israel's location on the Red Sea (port of Eilat), and the ports of Ashdod and Haifa on the Mediterranean Coasts with about 300 km road. The Israeli or Kedem landbridge (Hayuth 1987) does not offer distance advantage over the all-water Suez Canal transport between Europe and Asia, but technically it operates effectively as a landbridge with a highly co-ordinated port-rail-shipping system offering economic services.

Over longer distances, the main destination of the Trans-Chinese Railway landbridge (TCR) is Europort of Rotterdam (UNCTAD 1992) (see Figure 4.7).

Figure 4.7 Trans-China rail landbridge via Central Asia, Caspian sea and CIS to Europe (unit: km).



TCR landbridge from Kobe-Lianyugang to Rotterdam through: 1- Aketehay (Kazakhstan)-Novosibirsk-Moscow-Brest 12442. 2- Aktehay-Orenburg-Moscow-Brest-Berlin-Hannover-Koln 13606. 3- Aketehay-Alma-Ata-Charduz-Krosnovosk-Baku (Caspian Sea bridge)-Rostov-Kiev 13919. 4-Alma-Ata-Charduz (Turkmenistan)-Guriev-Rosrov-Kiev-Misk-Brest 14701.

Source: Rail distances are based on Thomas Cook European and Overseas (1995), Timetables, vol. I & II, various pages. Sea distance are based on Caney and Reynolds (1981), Reed's Marine Distance Tables, various pages. Gavan (1987), The Ships Atlas 1987, various pages.

The TCR which connects the port of Lianyugang on the Yellow Sea to Europe and South West Asia via the CIS and Central Asian railways tries to compete with the Trans-Siberian

Railway (TSR) in Russia by offering 3000 km shorter journeys, and is more suitable for trade to/from Hong Kong.

4.4.1.2 Political characteristics

Europe, with a population of about 500 million (excluding Turkey and the former Soviet Union) is composed of twenty-seven mainly industrialised countries and is a major focus of international trade flows, both in terms of volume and value, making use of various single and integrated modes of transport. The existence of the EU (European Union) has facilitated greatly the use of multi-country networks, the movement of vehicles and the easing of Customs restrictions through different conventions and co-operative arrangements (Eller 1992). The existence of international centres, particularly ports such as Rotterdam, Hamburg, etc., are key elements in the success of the European origin/destination landbridges.

The present unsettled political situation in the Caucasus region has made different landbridge and minibridge operations less reliable after the break-up of the former Soviet Union. For example, there are disputes between Georgia and Russia over the Sukhumi region, and between Azerbaijan and Armenia over Nagorno Karabakh, which led to the stoppage of rail services from Georgian and Russian ports to Iran via Armenia after 1992.

Turkey has a population of 56 million of which 7% are Kurds who have a long standing conflict with the central government. They live in the eastern regions close to Armenia, Iran, Iraq and Syria, and can influence almost all Turkish landbridge rail/road routes. The other major regional issue for Turkey as a landbridge country for the Middle East is the dispute over the Euphrates and Tigris waters with Jordan, Syria, and Iraq (Europe World Year Book 1994b).

Turkey, with Iran and Pakistan, is an important member of the ECO (Economic Co-Ordination Organisation) which, after the break-up of the USSR, gained the membership of six new CAC countries as well as Afghanistan. Turkey also is a member of the BSECOG (Black Sea Economic Co-operation Group) composed of eleven countries. Both of these organisations are likely to provide strong support for the operation of different Turkish landbridges.

As a result of Israeli-Arab conflicts the Kedem landbridge (through Israel) does not serve neighbouring countries and in order to compete with movements through the Suez Canal, is heavily supported by government subsidies and technical services.

4.4.1.3 Technical characteristics

European countries have an extensive network of high performance multiband roads and double track rail lines as potential landbridge levers (average 69 km/hour road freight speed and 37 km/hour rail). According to Hayuth (1992) one reason for the success of international and inter-European container traffic is the utilisation of swap body containers for inter-European traffic and ISO marine containers for international traffic.

European countries have 43.8% of total world shipping tonnage (dwt) and 39.4% of the ships, and are the second largest ISO container producers in the world (UNCTAD 1993).

The Caucasus landbridge, which owns only 3% of the total former Soviet Union rail network (Holt, 1993), not only suffers from regional conflicts but also from operational and maintenance problems. There are also delays in the return of inter-republic rolling stock. This results in poor transit time performance in the order of, for example, about 20-35 days from St. Petersburg to Iran (Hicks 1994).

The Trans-Chinese Railway (TCR) is 7865 km in length between the ports of Lianyungang and Rotterdam (Strauss 1993). According to Speece and Kawahara (1994, pp. 57-58):

> "Much rail capacity is antiquated, and many of the rail lines are old. Despite considerable progress at upgrading some lines in the past decade, less than one-quarter of routes were double tracks by 1990. Only about 13 per cent were electrified railways. Only about one third of rail routes were serviced by locomotives with internal combustion engines. Over 40 per cent of locomotives run by the Central Railway Department are steam engines, while two-thirds of those in use at the local level are steam engines."

One of the main problems of the TCR, like the TSR, is that it requires two changes of railcars in each journey, both at the Central Asia-Kazakhstan borders (from standard to broad gauge) and at the CIS or East European borders (reverse action) which causes delays and costs.

Turkey has 10413 km of rail track and 60,840 km of all-season roads. It offers a landbridge operation through the main ports of Istanbul, Mersin, Izmir, and Samsun (Turkish State Railway 1994). Turkey is able to offer some strength in the landbridge sea leg services as it held 1.4% of the total world ships and 1.2% of the total dwt in 1993 (UNCTAD 1993).

The road system of the Kedem landbridge gains from sophisticated and efficient port equipment and managerial skills, but the route suffers from a lack of rail lines (Containerisation International Year Book 1991).

4.4.1.4 Organisational characteristics

European transport modes both in operation and ownership have for a long time been encouraged through competition to develop integrated modes, with sea transport companies undertaking land transport and vice versa (Hayuth 1987). According to Eller (1992) four co-ordinating bodies are involved in rail/road container transport and terminal operation across Europe at both domestic and international levels. The most important one, Intercontainer was established in 1967 and functions as a traffic facilitating and co-ordination centre (Whittaker 1975) while each member state is responsible for its own traffic. The other is the International Union of Rail-Road (IRU) which works as a combined company and was established in 1990 with 10 member states to function as an association for operators/carriers of piggy-back trailers and swap bodies (Containerisation International 1995).

The organisation of rail terminals as major ground hubs for landbridge and other transit purposes is through two co-ordinating centres (Whittaker 1975). The Trans-Europe-

Express-Merchandises (TEEM) is responsible for local domestic European markets, while Trans-Europe-Container-Express (TECE) acts for the international flow of containers from/to Europe. Different bridge services are offered by shipping companies on a global scale and there are about 105 Europe-based Non-Vessel-Operating Multimodal Transportation Operators (NVO-MTOs) of which about 70% are located in the U.K (Containerisation International Yearbook 1991).

China, with its large population, and its closed socio-economic system, tends to deploy human rather than mechanical power or more advanced technology which causes transport problems (Speece and Kawahara 1994). Therefore, investment in an international landbridge may not bring the same returns as more labour-intensive domestic investment. Poor communication infrastructure and lack of expertise in English and other major trading languages leads to inefficiency, particularly in ports, which are key elements in a landbridge operation (Containerisation International, 1994). According to the Korean Maritime Institute (1992, p. 86):

> "TCR has lack of know how in management of facilities, cargo tracking, booking and other parts of transportation services".

There are about five thousand Chinese corporations involved in foreign trade of which sixty function as freight forwarders. The two official and largest state-owned forwarders are Sinotrans and (UNCTAD 1989) then China Shipping Company (COSCO) undertaking integrated multimodal joint ventures with Japanese companies. Services in different major ports of China have low quality and long delays with bribing. However, foreign expertise is now being allowed to work in different areas of the transport sector. e.g. container trucking, freight forwarding, etc. (Speece and Kawahara 1994).

The transport services in Turkey are mainly provided and supervised by the ministry of transport and communication, and also through a board within the council of ministers. The seven major ports which mainly handle landbridge services are operated by the Turkish

State Railway or TCDD (Turkeiye Comhuriyeti Devlet Demiryollari). They include the three ports of Izmir, Istanbul, and Mersin, which are equipped with gantry cranes and other container facilities (Higgs 1995). Other minor ports, which are less active in landbridge movements, include Trabzon and Giresun which are run by the Turkish Maritime Organisation (TDI). Turkish landbridges have a strong potential for offering services to surrounding countries, but have some problems with equipment, organisation, and port congestion (Higgs 1995). Sometimes, in the case of traffic to Iran, there has been a sudden increase in prices, preventing delivery of shipments to Iran (Sanat-e-Haml-o-Naghl 1989).

In Israel, the Kedem landbridge is affiliated to the Zim Navigation Company while ports are governed by the Ports and Railway Authority, which works in close co-operation with the Kedem landbridge. This tightly co-ordinated system has led to reduced tariffs and the effective return of empty containers by Zim Shipping, adding to the success of this landbridge (Hayuth 1987).

4.4.2 Trans-Siberian Railway

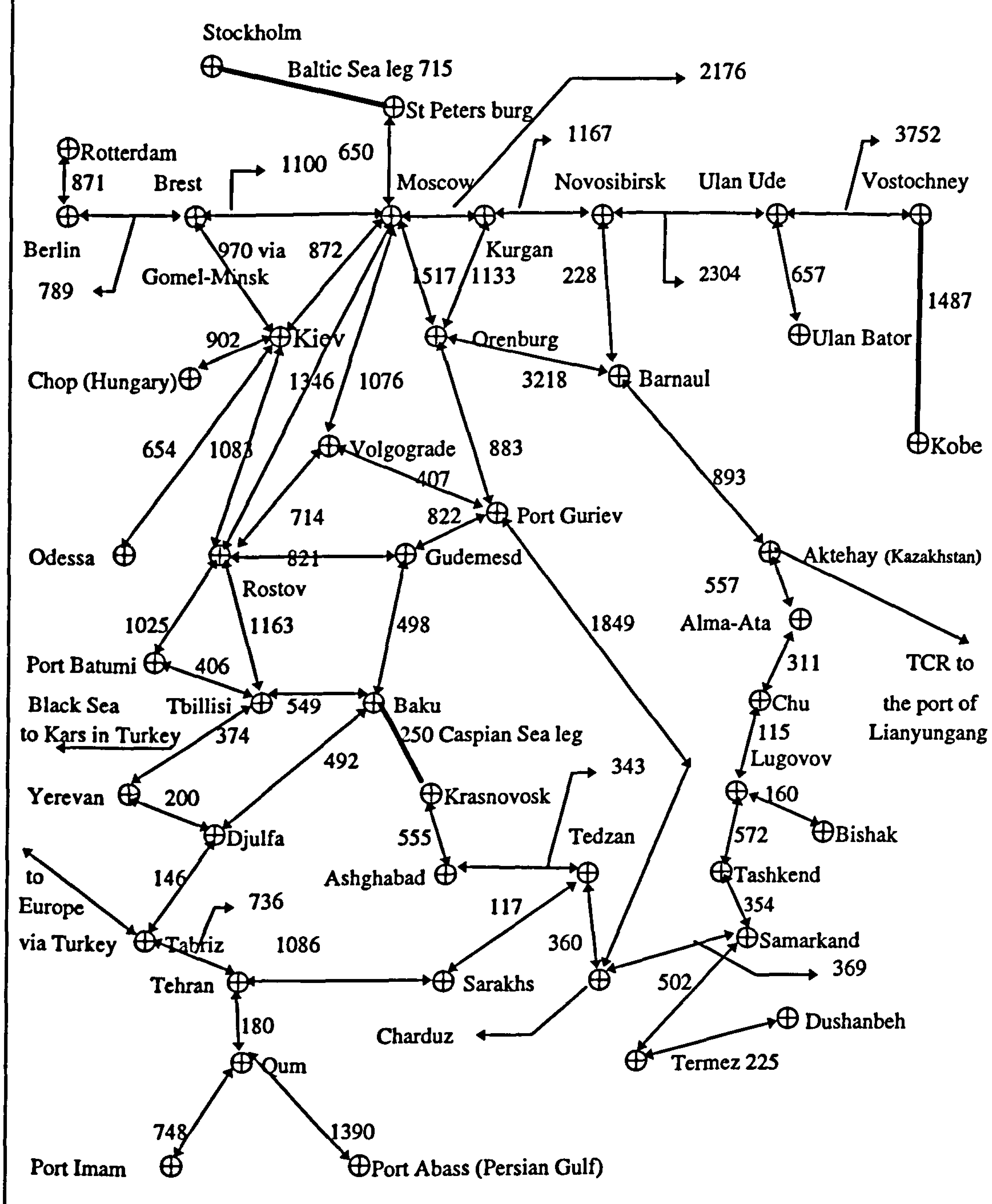
4.4.2.1 Geographical characteristics

The Trans-Siberian Railway (TSR), which originally was constructed during 1892 and 1916 (Strauss 1993), is the oldest and longest transit route in the world in terms of through services (Bonney 1991, Noble and King 1991). In April 1907 it started operating as a landbridge between Japan and Europe (Hayuth 1987) (see Figure 4.8).

It runs through a vast area with a harsh climate far from international waters. According to Damas (1992a) it saves 7000 km distance when compared with the all-sea Suez Canal route to Europe and provides an ideal route to Japan and other Far East countries.

The TSR main and sub-branches provide services which start at the ports of Vladivostok, Nakhoda and Vostochney on the Far East Coast of Russia, and end at the Azof, Black, Mediterranean, Baltic and Caspian Seas with more than seventeen port connections.

Figure 4.8 Trans-Siberian rail landbridge routes (unit: km).



1.TSR landbridge to: Kobe-Vostochney-Moscow-St. Petersburg-Stockholm 12251. 2. Kobe-Vostochney-Moscow-Brest-Berlin-Rotterdam 13646. 3. Kobe-Vostochney-Moscow-Kiev-Odessa 12412. 4. Kobe-Vostochney-Moscow-Minsk-Brest (Poland) 11986. 5. Kobe-Vostochney-Moscow-Kiev-Chop 12412. 6. Kobe-Vostochney-Moscow-VolgogradeRostov-port Batumi 13526. 7. Kobe-Vostochney-Moscow-Astarakhan-Baku-Djulfa 13853. 8. Kobe-Vostochney-Novosbirsk-Ala-Ata-Tashkand-Tedzan-Sarakhs (Iran) 11552.

Source: Rail distances are based on Thomas Cook European and Overseas (1995), Timetables, Vol. I & II, various pages. Sea distances are based on: Canet and Renolds (1981), Reed's Marine Distance Tables, pages 36 & 55.

4.4.2.2 Political characteristics

The TSR and the railways of the former USSR worked under a highly integrated political system with quasi-military control (Holt, 1993). The break-up of the USSR in 1991 led to the emergence of a number of new republics and a loss of the tight control of Russia over the operation of TSR branch lines. The number of TSR major ports was reduced from eighteen to seven with disruption caused by new borders. There was also an increase in the total transit times and in tariffs and greater inefficiency in railcar management etc. (Holt 1993). Trade in different parts of Europe and in CAC countries was lost. The reliability of TSR services was questioned as different republics wanted to focus more on their own freight and passenger requirements. After the break-up of the USSR, the resulting political conflicts affected TSR customers such as Iran, due to the closure of its important rail outlet in Djulfa following the dispute between Azerbaijan and Armenia. The TSR is used extensively as a vital part of domestic and strategic routes (carrying about 80% of domestic traffic in 1990) with some limited outlet for foreign countries (Holt 1993). Any new routes or increase in capacity would be a very long term project, particularly in the light of the current financial and political problems in the CIS, and especially in Russia.

4.4.2.3 Technical characteristics

The TSR stretch from Vostochney to Moscow is 9297 km of broad gauge requiring the time-consuming practice of lifting railcars at borders which transfer to another gauge. The TSR benefited greatly from subsidies from the former Soviet Union to enable it to earn hard currency and compete with all-water transport, by providing large size feeder shipping services in the Black Sea and the Baltic Sea (Containerisation International Yearbook 1991) and particularly for large market such as the Far East, South east Asia and Australia (Miller 1978 and Rijn 1981). After the collapse of the USSR in 1991, the fleet was divided between different independent countries, but still the CIS countries hold 12.1% of the total ships in the world and 3.2% of dwt (UNCTAD 1993). This provides considerable support for any landbridge service. According to Fraser (1994), Russia has more than seventeen ports in the Far East region but the TSR is linked only with the three ports of Vladivostok, Nakhoda, and Vostochney. The latter two are the more commercial and containerised ports and carry about 73% of the total trade, and usually there is congestion. Most of the foreign trade along the TSR is containerised, and the imbalance of trade between the Far East and West has resulted in a stock of containers in the West and the return of empty trains to the East (UNCTAD 1991, 1992 and 1993). To improve TSR services and overcome old and new problems, the Ministry of the Railways of the CIS, with the assistance of the other TSR operators, has made the following arrangements:

* The introduction of block trains, new flat cars, local and total transit time tables.
* The introduction of improved container control and recording systems particularly when trains approach borders.
* The improvement of the port of Vostochney in the Far East as an intermodal port (Damas 1992b, Holt 1993).

4.4.2.4 Organisational characteristics

The co-ordination of the operation of the TSR landbridge services before the break-up of the USSR was controlled by the Ministry of Foreign Affairs. But from 1991, the TSR has been run by the Ministry of Railways of the CIS, mainly through the two operators SOTRA (Souztransit) and SOYZ VENESH TRANSIT-SVT, (Damas 1992b, Hicks 1994, Containerisation Yearbook 1995). According to Transue and Little (1990), SOTRA in itself is composed of other different independent components which co-ordinate the services.

In the service organisation of all types of TSR bridges, foreign operators, mainly Japanese, German and American-based companies, are active (Bonney 1991). The organisational characteristics of the TSR are strongly under the influence of the former Soviet Union's centralised system of government. During the USSR period the service quality and reliability of the TSR did not have a good image and according to Bonney (1991) it suffered from delays. The post-Soviet structure in fact worsened the service problems by allowing more freedom of the railway regions in their control of the locomotives, and the effect, along TSR routes, was to cause delays and higher transit costs (Holt 1993). The new Ministry of Railways has very little control over the operation of trains in the given region in the CIS. According to Fraser (1993, p. 102) Russian officials stated that:

> "We note that the rail economy is becoming unfit for use, the locomotive pool is slipping owing to a shortage of repair capabilities and that there is a shortage of rolling stock."

According to Holt (1993, p. 76) in the CIS confederation the

> "Current organisational structure is not suited to providing the flexible, efficient, and reliable service required in a market economy".

According to Mc Donell (1995, p. 36):

> "Institutionally, the rail sector (in the FSU) has been fragmented. The Central Asian railway has been broken up into four national systems in which, *de facto,* many of the pre-existing operational agreements and conventions between republics remain in place; but the delay, costs and uncertainties resulting from the new arrangements are pervasive".

UNCTAD (1993) claims that the TSR output declined during 1993 and pointed out the four following reasons:

* An increase in the number of TSR operators
* A significant increase in tariffs
* Port congestion, and
* The intervention of state authorities.

4.4.3 North American landbridges

The distinctive industrial and geographical conditions together with a liberal trading environment, as well as the high quality road and rail networks and rolling stock, has led to well-developed landbridge operations, particularly the application of the minibridge concept, in the USA and Canada (Hayuth 1987). The introduction of the double stack train since the early 1980s has been particularly successful (Hayuth 1992). Further development by raising tunnel heights and reducing the tare weight of railcars, has created an extensive range of minibridge services with the Far East, Europe, Africa and South Asia.

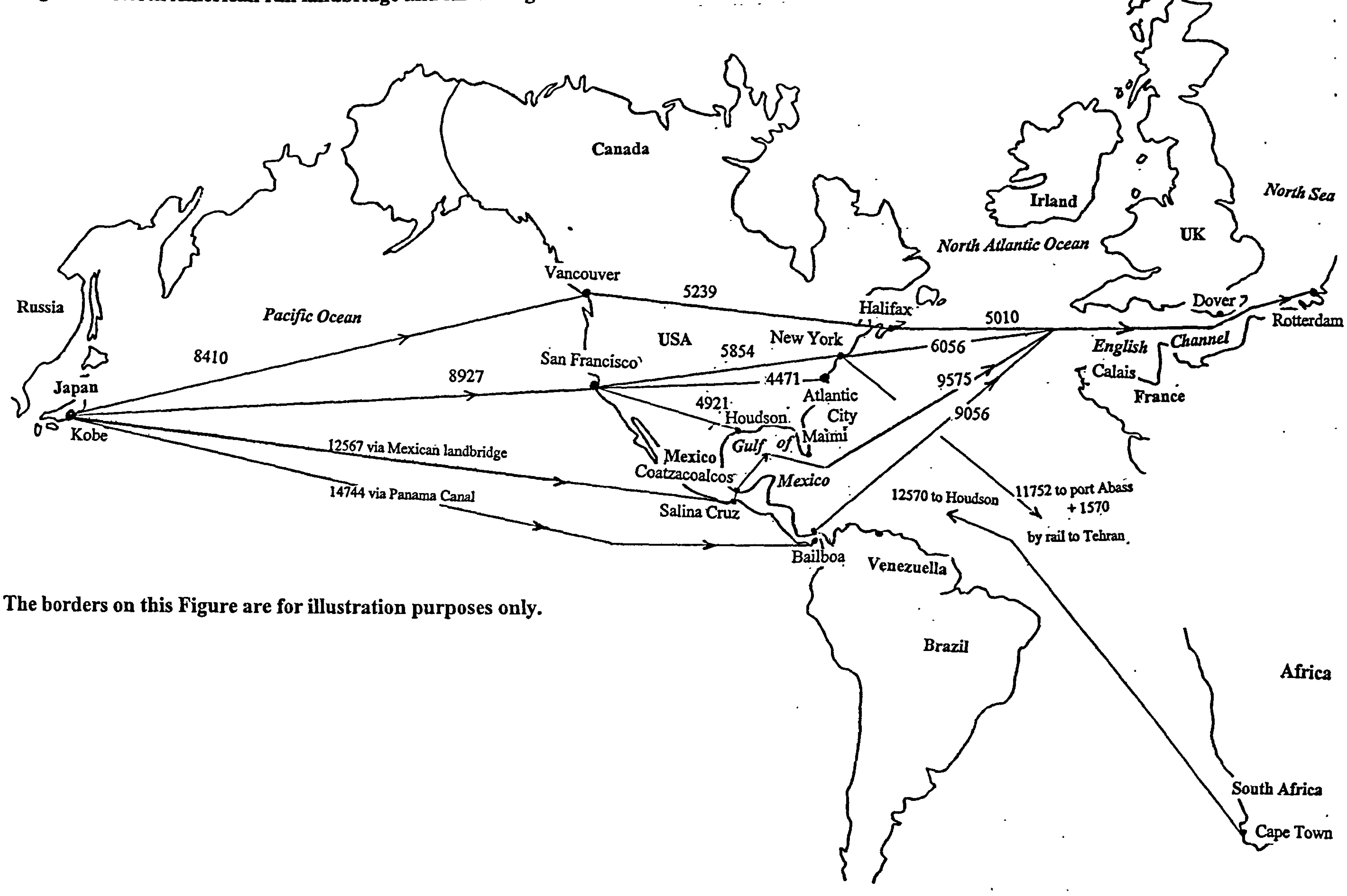
The continent of America makes a long north-south barrier between Europe and Asia, located between the Pacific and Atlantic Oceans, and is in an ideal situation with extensive co-ordinated rail and road networks to function as a landbridge between two major trading centres (Containerisation International 1991). The USA, Canada and Mexico are three American countries each with one active landbridge (Hayuth 1987) (see Figure 4.9 for two examples through New York-Houston). They compete with the all-water intercontinental passage through the Panama Canal and are about 2000 km shorter in distance than the Canal (Padelford and Gibbs 1975). They also function as competitors with the TSR landbridge, while at the same time competing with each other.

4.3.3.1 Geographical characteristics

Canada is about 5000 km in width, with a few rail bridges between the east and west coasts mainly through the three ports of Halifax, Montreal and Saint John (McCalla 1994), but also through Toronto in the east and Vancouver in the west. The deep penetration of the five lakes of Ontario, Erie, Huron, Michigan and Superior into the Canadian heartland (as well as the USA) has created an ideal location for more sea leg landbridge services from Europe through Canada by using the ports of Montreal, Quebec, etc. and shortening the overland rail bridge distance considerably.

The Canadian landbridge has a distance advantage over USA landbridges as the port of Halifax is the closest point with a distance of 2705 nautical miles to Europe (Rotterdam) (Figure 4.9). Also some major cities of the USA (e.g. Chicago and Detroit) are part of the hinterland of the ports of Halifax , Saint John or Montreal (Whittaker 1975).

Figure 4.9 North American rail landbridge and minibridges between Far East,



The borders on this Figure are for illustration purposes only.

The USA, with its location between Canada and Mexico, has significantly developed the landbridge concept in all aspects. The high industrialisation, population, production and consumption rates and trade with Europe and Far East regions, as well as the vast areas of domestic and maritime geography, are among the important reasons for the development of many complex types of landbridges functioning at national, regional and international levels. The shortest rail distance for a USA landbridge is 4471 km between Atlantic City on the east coast and San Francisco on the west (Figure 4.9 shows United States intercontinental landbridges). USA shippers and carriers use the Mexican landbridge for trade between the Gulf coast region and Mexico as it can offer shorter journey distances than the USA landbridge to locations such as Miami (Ashar 1995). The geographical feature of Mexico, with only 333 km between the Pacific and Atlantic Oceans, forms a unique rail and road bridge between the ports of Coatzacoalos and Salina Cruze (Mahoney 1985 and Hayuth 1987). It has about a 1405 km distance advantage over the Panama Canal which is 80 km in length (see Figure 4.9).

4.4.3.2 Political characteristics

Canada has a small population (about 26.5 million in 1990) for such a vast area, and is one of the seven most important industrial countries, able to provide a strong capital and technical base for the provision of effective landbridge facilities.

Landbridges, and particularly mini-and micro-bridge services, have increased in the region as a result of transport economies and also because of extensive competition with all-sea transport through the Panama Canal (Padelford and Gibbs 1975).

The transatlantic and transpacific minibridges extensively cover the trade between the USA, Canada, Europe, and Far East as about 63% of the total USA population is living in the 19 maritime states. Seven west coast states with high industrialisation have 26% of the total population (65.3 million), as well as high consumption and production. For Far East countries there are fourteen states in the east and Gulf coasts with a high population of about 93.3 million (37% of total in 1990), with even more industrial and economic activities and foreign trade than the west coast.

Of all the intermodal overland services in the world, perhaps none are more extensive than those offered in the USA (Hayuth, 1987). This outcome could not have been achieved without a major change in the USA to deregulation in the early 1980s. Previously, railways had been slow to adopt containerisation and intermodality. The radical change in regulation led to new rolling stock, dedicated cross country and double-stack container trains and, most importantly, increased co-operation with seaports and shipping lines.

Mexico as a developing country with a high population of 88.3 million in 1990, has social, economic and infrastructure differences compared with the other two major industrial North American countries, and is in heavy debt to the USA. As a result, the Mexican landbridge has less investment opportunities and developments. It has a relative distance advantage of 1405 km over the Panama Canal but, according to Mahony (1985), in spite of the large amount of investment in equipment and construction of intermodal ports and rail networks, it has not been able to attract a constant and significant traffic from either the Far East or Europe. The North American Free Trade Agreement (NAFTA) among the USA, Canada, and Mexico is intended for interregional development and co-operation of the member states, including minibridge operations. According to VIA International (1993, p. 9):

> "The treaty calls for public telecommunications and transport networks and and services to be available on reasonable and non-discriminatory terms for firms or individuals who will use those networks for the conduction of their business. .... ."

NAFTA, in fact, aims towards the creation of a single hinterland among North American countries (Hayuth, 1992) by using all potential ports in the region commonly. The Mexican landbridge, through more investment given under NAFTA for transport technology and management, should make it a stronger alternative to the USA and Canada in future.

4.3.3.3. Technical characteristics

The first Northern American landbridge came into existence in 1972 through Canadian rail piggyback services (Hayuth 1987). It is a very effective landbridge and extensively serves USA inland markets according to McCalla (1994). Three factors contributes to this: the deep water at Halifax, the opening of new facilities, and the efficient handling of containers both at dockside and by CN (Canadian National) Rail.

To make the port of Halifax more competitive and to strengthen domestic and international services, CN has developed double stack services and Electronic Data Interchange (EDI) (UNCTAD 1991). Another Canadian main rail and landbridge operator, Canadian Pacific (CP), has started to raise rail tunnel heights to permit the passage of double stack trains across Canada (Hicks 1994). According to Slack (1994) the dominance of the northern ports of Canada and particularly Montreal in serving USA midpoints is based upon the inability of US railroads to provide a comparable COFC (Container On Flat Cars) service, although the TOFC (Trailer On Flat Cars) concern has developed significantly since the 1950s (Slack 1994).

The American minibridges have received extensive investment in infrastructure, terminal systems and double stack-trains. Massive investment has been put into hub centres such as Tacoma and Oakland as a means to compete effectively with all-water transport (Containerisation International 1994). The existence of the extensive rail tracks mainly with double-stack capability has also played an important role in the development of USA landbridges. Some ports such as Oakland are served by three railroad companies allowing a number of options for eastbound or inland trade.

Rail and road networks have been developed within Mexico and particularly in the maritime provinces of the Pacific and Gulf coasts in south-north directions with seven crossings at the northern border with the USA. Among the six main ports of Mexico, Coatzacoalcos and Salina Cruz are landbridge ports and have the most important container infrastructure and facilities (Containerisation International Yearbook 1991). The NAFTA agreement has emphasised the provision of technical assistance for the operation of Mexican port facilities to develop poor existing services including passenger services (Thomas Cook-Overseas Timetables 1995). According to VIA International (1993, p. 9) under this agreement Mexico will:

> "Immediately allow 100 per cent Canadian and U.S.A investment in, ports, and operation of, port facilities such as cranes, piers, terminals and stevedoring companies for enterprises that handle their own cargo. For enterprises handling other companies' cargo, 100 percent Canadian and U.S. ownership will be allowed after screening by the Mexican Foreign Investment Commission. The U.S. and Canada will continue to permit full Mexican participation in these activities."

As a result, the financial and technical assistance of NAFTA has had a positive influence on the Mexican minibridge and the operation of international container rail movements has shown 16% growth in 1992 and 18% in the first half of 1993 (UNCTAD 1993). Another important factor in the North American minibridge development is that major shipping carriers own and operate their own terminals. As a result of the development of minibridges in many cases, they have suspended or reduced all sea carriage through the Panama Canal, and have deployed their fleets in shorter sea legs offering greater frequency to both west and east coast trade with the Far East, West Africa and Europe (Containerisation International 1994).

4.4.3.4 Organisational characteristics

Canadian National Railways (CN) and Canadian Pacific (CP) are the authorities in charge of landbridge operations in Canada. There are different types of port ownership in Canada but major ports on the east, west and deep inland ports are controlled by different national and municipal boards (Hicks 1994, Ircha 1997). According to Slack (1994), the intermodal service offered by CN and CP as railway operators, has resulted in the attraction of more minibridge trade from European markets to Halifax and Montreal for inland terminals in Canada and USA compared with USA east coast ports.

The organisation of the North American landbridges is governed by independent entities utilising ports and railways and also active in sea transport. In terms of port operations the landbridge organisation in the USA is the same as in Canada and developed European countries. However, rail networks are operated through nineteen different companies with their own rail track, intermodal equipment, trailers, electronic data exchange systems, terminals and storage, rolling stock, etc. (Hicks 1994 and UNCTAD 1989). Therefore, different shipping companies and Non-vessel operating common carriers (NVOCCs) have arrangements and agreements with different rail companies and many even have their own trucking or rolling stock along their routes in the USA. (Containerisation International Yearbook 1991). The microbridge concept involves fewer modes than minibridge or landbridge services, and shipping companies and NVOCCs are able to offer regular and direct services. Minibridge and landbridge services are mainly provided on a round trip basis along certain ports of call (Containerisation International Yearbook 1991).

The organisation in charge of the Mexican landbridge is Servicio Multimodal Transistimico (Semultra) while rail services are operated by the Mexican National Railways (Ferrocarriles Nacionales de Mexico-FNM). In contrast to the USA the Mexican service is not offered by competing organisations.

4.5 Conclusions

This chapter has introduced the general concept of a landbridge and described the specific types of landbridge (minibridge, microbridge, and airbridge). It has examined the key influences on the operation of landbridges, which are geographical, political, technological, and organisational. It has applied these influences to major landbridge zones in the world. This approach will now be applied to the Iranian Sea-Landbridge (ISLB) which is the main topic of the research.

5. The Iranian Sea-landbridge

5.1 Introduction

The purpose of this chapter is to review the potential for landbridge development through Iran to and from the Central Asian and Caucasus countries (CAC). To identify such potential it is necessary to take into account both supply and demand factors, the foreign trade outlets of CAC countries and to compare the Iran Sea-landbridge with other competitors. The physical and economic characteristics of Iran were discussed in detail in chapter two, but it is necessary to identify certain more detailed factors which have particular relevance to the landbridge concept both for Iran and the CAC republics.

5.2 Reasons for developing a landbridge system

Iran and the CAC countries have a common interest in developing a landbridge system. The collapse of the former Soviet Union as a superpower and its disaggregation into different nations, is likely to re-establish old links between Iran and the CAC republics (Herzig 1995, The Economist 1997). Iran had a long cultural, territorial, religious, and social relationship with the CAC countries which was broken during conflicts between Iran and Tsarist Russia during the 19th century. Therefore, greater co-operation is seen as one means to eliminate any future threat of the re-establishment of the former Soviet Union. Another reason is the economic locational advantage of Iran which was restricted during the period of the former Soviet Union. The landlocked CAC countries may, in particular, see access through Iran to open waters as a strengthening of their independence from Russia.

The unique maritime location of Iran, following the collapse of the former Soviet Union, has created a new role for Iran as a transit country, and potential for the development of multi-legged integrated transport bridges between the Persian Gulf and the Caspian, Black, Baltic, Mediterranean, and Red Seas for three different continents, and also through the northern land border crossings (Ogutcu 1995). For the three CAC countries on the west, east and north-east of the Caspian Sea (Azerbaijan, Turkmenistan, and Kasakhstan respectively) these transport bridges would serve foreign origins linked by sea transport routes to the two southern ports of Imam and Abass in the Persian Gulf and by using the northward Iranian road/rail routes to the Iranian port of Anzali on the south of the Caspian Sea followed by a second sea transport (Tarjoman 1995, Stone 1993).

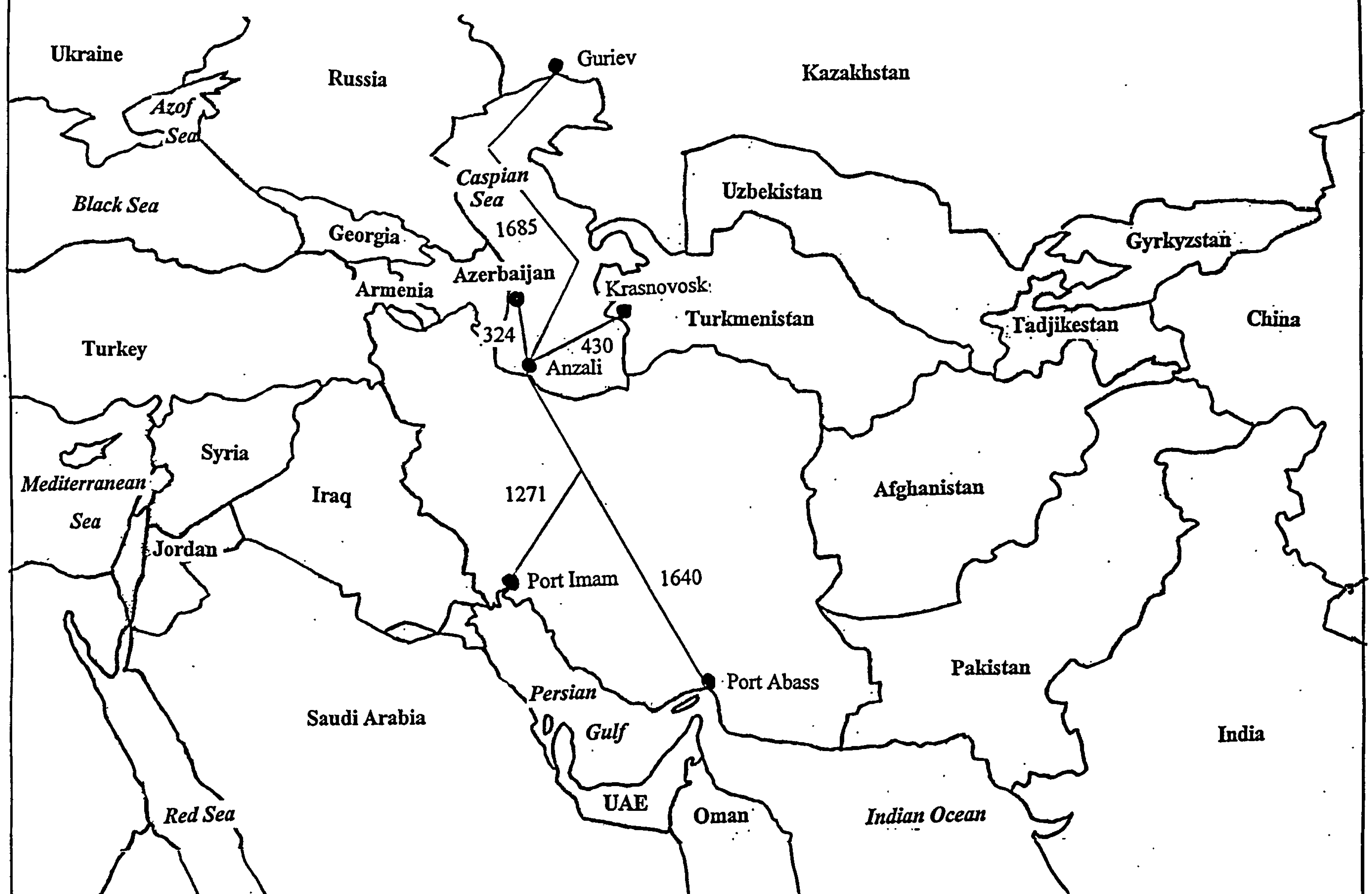
5.2.1 Geographical characteristics

The geopolitical characteristics of Iran are a key element in the connection of south-west Asia and the Middle East to other parts of Asia and Europe (Haglund 1986). Iran and the Central Asian and Caucasian republics form nine countries occupying 13.24% of the total land area of Asia (Upshal et al. 1994).

The landbridges provided by Iran between the Caspian Sea and the other international waters of the Persian Gulf and the Indian Ocean could be economic for trade with the South and Far East, African countries and also the Persian Gulf region.

The selection of the three Iranian sea-landbridge transit ports of Abass and Imam in the south and Anzali in the north is based on the maritime and cargo operational potentials of these ports as the largest regional ports in operation and capacity. Details of these ports and a justification for their selection were given in chapter two. Each port has special advantages for each region of the CAC countries in terms of proximity (Figure 5.1 shows the land and sea leg distances between Iranian ports and border crossings, and CAC countries). The port of Abass in the mouth of the Straits of Hormuz is closer

Figure 5.1 Iran Sea-landbridge road and sea legs, ports and border crossing terminals in south and north (km).



The borders on this Figure are for illustration purposes only.

to central Asian countries while Imam in the north-east of the Persian Gulf is much closer to the Caucasus region. Port Anzali in the north is the biggest and most used port of Iran in the south-west of the Caspian Sea and in fact is already planned to become a landbridge and minibridge port for the states bordering the Caspian Sea (Ports Development International 1993).

Iranian minibridges are those which originate from inland locations outside of the Iranian and the CAC region using the ports of Imam or Abass, and then go directly by Iranian road or rail ending in Anzali, or at the Iranian border crossings or directly into CAC demand centres.

Iran has nine active border crossing terminals directly linked to three of the CAC countries as shown in Figure 5.1 Four of these terminals, are connected with Turkmenistan in the north-east of Iran in the provinces of Khorasan and Mazandaran. Three of these (Sarakhs, Lotfabad, and Bajgiran) are suitable located to serve countries in different parts of the four other Central Asian countries. The closest, and one of the busiest, is Bajgiran which is 44 km from Ashghabad, the capital of Turkmenistan. Given its links to road and rail networks, Sarakhs in the extreme north-east is the focal crossing terminal for shipments to the other four Central Asian republics (Sanate-Hamlo-Naghl 1993a).

Lotfabad is linked to the Turkmenistan railway, but road is the only mode of access from Iran (Payam Darya 1994). The fourth and last crossing in this region is Inche-Boroon which serves the south-west areas of Turkmenistan and is close to the Caspian Sea. Among the other five land border crossings in the north-west serving the Caucasus republics, Astara and Pileh Savar are directly linked with the main part of Azerbaijan, while two others (Djulfa and Pol Dasht) serve the Azerbaijan autonomous republic of Nakhjavan and one (Noor Dooz) is the border crossing for Armenia. Djulfa, which is connected to the Trans-Iranian Azerbaijan railway, together with Astara are the most important border crossings in this region. Of these five border crossings two (Pol Dasht and Dejulfa) are respectively closest to Georgia (Tbilisi) and Armenia (Yerevan). The distances of the crossings from the southern Iranian ports are shown in Table 5.1.

Table 5.1 Road and rail distances (km) between southern ports of Iran and northern border crossings serving CAC countries.

Border crossings	Sarakhs	Lotfabad	Bajgiran	Inche Borun	Port Anzali
Port Imam	2110 (2014)	2014	1947	1513	1265
Port Abass	1579 (2656)	1674	1607	1811	1749
Border crossing	Astara	Pileh Savar	Noor Dooz	Djulfa	Pol Dasht
Port Imam	1414	1689	1475	1376 (1810)	1483
Port Abass	1898	2173	2197	2098 (2452)	2205

Source: MRT Road Distances Guide book, 1983. Rail distances are shown in bracket based on Thomas Cook (1995), March-April, various pages.

The major obstacles to the extension of the present rail networks are the Zagros and Alborz mountain ranges running north-west to north-east, and to the south-west respectively. A 10,000 km rail project of which about 2500 km is under construction, will increase the potential of Trans-Iranian Railways and will by-pass Tehran and make the port of Abass about 700 km closer (at present 2656 km) to the Central Asian countries. The port Imam rail route to the Caucasus region also has planned direct links from Qum to Ghazvin and Zanjan (see Figure 5.1).

5.2.2 Political characteristics

Iran has left the critical war time complications and according to Roberts (1996, p. 10) as a strong alternative among three countries for the Caspian pipeline "is arguably the most politically stable main export route". Since the independence of the CAC countries, Iran has established an open policy focusing on assistance to these republics to strengthen and support their independence through different direct bilateral negotiations and even economic, trade and transport agreements. The minibridge operation with the CAC countries is influenced by the political relationships with these countries, particularly with Turkmenistan, Azerbaijan, and Armenia which are directly connected to the Iranian network (Herzig 1995).

Apart from the conflict between Armenia and Azerbaijan, and the internal problems of Tadjikestan there is not a major issue which restricts trade. Six of the CAC countries agreed in 1992 to become members of the ECO (Economic Co-operation Organisation) treaty with Iran, Turkey and Pakistan (Shemshad Ahmad 1994). The ECO treaty was established in 1984 (The Middle East and North Africa 1994) and now functions as a significant geopolitical link between old and new parties, and in areas of economic activity such as transport, communication, and financing, banking, and energy. At its annual meeting in 1992 in Tehran, members agreed to a ten per cent cut in trade tariffs and eventually to remove all tariff and non-tariff barriers. In January 1993 the High Council of ECO Ministers approved a ten year development programme in communications and transport for the member countries (Ghaem Maghami 1994). They placed a lot of emphasis on the Mashad-Sarakhs railway for the Central Asian countries, the Kerman-Zahedan railway to link the Trans-Asian Railway (TAR) in Iran, maximisation of the present infrastructure and development of multimodal transport within member states, particularly CAC countries. Iran agreed to the Azerbaijan railway being connected to the autonomous Republic of Nakhjavan through its land, while a bridge is under construction for proper access to Armenia over the river Araks.

The Transport International de Marchandises par Route (TIR Carnets) convention (the Customs Convention on the International Transport of Goods by Road), of which Iran's Customs is a member, is an appropriate tool for sealed transit shipments of the CAC countries (vehicles or containers) through Iran, but most of these countries still have not adopted the convention (Sanat-e- Haml-o-Naghle 1994a). Consequently the present practice is solely under the administration of the Iranian Customs authorities. Iran has a road freight agreement with more than thirteen European and Asian countries, while for another eleven European countries, including the CIS and the CAC republics after 1993, there have been some measures leading to improved relations.

The other implication for CAC countries is the movement of their standard trucks along Iranian roads in accordance with the International Road Transport Union (IRU) convention. This convention covers physical and technical specifications of road freight vehicles and is in fact a pre-requisite for the TIR convention. The countries which were formerly part of the Soviet Union need to apply and adopt this convention individually.

5.2.3 Technical characteristics

A total of 16,445 rail cars pulled by 436 locomotives are in operation over Trans-Iranian Railways (Sanat-e-Haml-o-Naghl, 1993b). This mode has carried 17%, 20%, and 12% of total foreign trade during 1990, 1991, and 1992 respectively. The rail network has poor connectivity based on a spoke format with the hub in Tehran and a total length of about 5800 km in 1994 after the completion of the railway to the port of Abass. Rail freight previously supplied about 70% of the total freight traffic, and road transport was not used for long distances.(Shishe-chiha 1994). After the completion of the 560 km rail line in the south east of Iran, the present Iranian rail landbridge to the CAC countries will be a sub-branch of the Trans-Asian Railway (TAR) (World Atlas of Railways 1978). This will improve the connection of the Indian sub-continent with Europe, the CIS and the CAC countries through Iran as a potential alternative rail landbridge for TSR.

Both southern landbridge ports are connected to the Trans-Iranian Railway and consequently to all CAC countries through two border crossings at Sarakhs and Djulfa. As stated before, the hub of the present railway network of Iran is Tehran and both links from the south-west (Port Imam) and the south (Port Abass) first pass through the hub and then continue to the CAC countries. In spite of the recent restructuring in 1987 there are still operational and technical implications. As mentioned in chapter two, a single line system, and also the hub and spoke format of the rail network have made the present system slow for freight trains and also much longer than road transport, in particular those services required by the five Central Asian countries. As a pure government entity, the railway cannot respond to the short term requirements of a competitive transit freight system while there are large technical insufficiencies in terms of integrated transport systems (Sanate-Haml-o-Naghl 1995c).

Iran has an extensive road network of 167,000 km (SCI 1993) linking all capital cities, towns, and small villages. Of these, 105,000 km are main and secondary roads of which 80,000 km are asphalt (Torkan 1995). The quality of main and secondary roads differs slightly where the purpose and traffic volumes change. The following four categories are identified by MRT (1983). Corridors related to the Iranian Sea-landbridge study fall mainly into the first and third category (see Figure 5.2).

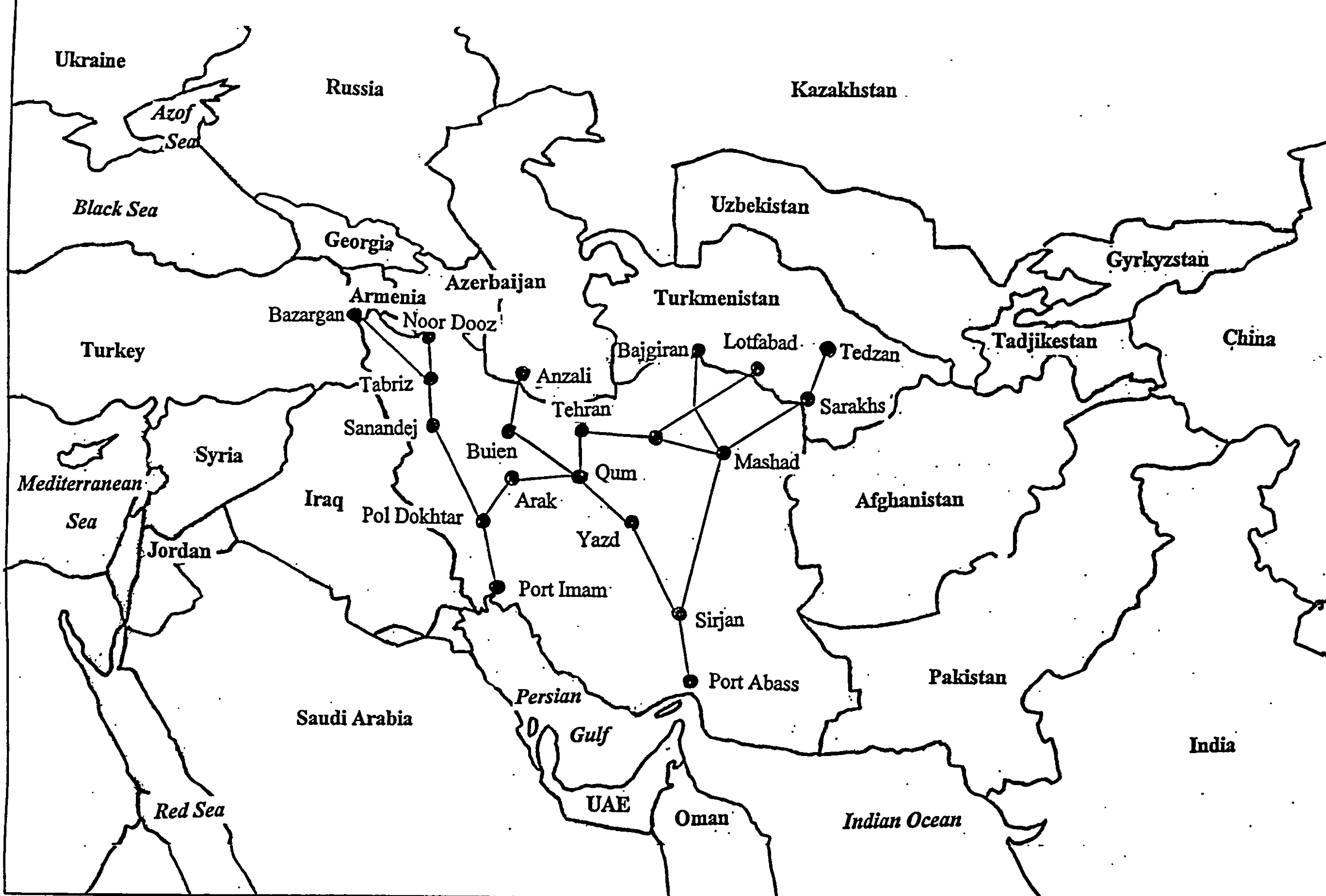
* **Foreign trade corridors**

These are the most important fifteen roads connecting the seven major ports and the key border crossing terminals with Greater Tehran or with each other. Their composition differs but includes main roads and free- and expressways with four or more lanes or wide ordinary roads with 11-13.3 metres width all of which are asphalt.

* **Tehran-capital city roads**

These are main roads which connect Tehran to all 24 capital cities and other main cities with economic importance, and account for eighteen route origins from Tehran.

Figure 5.2 Road corridors between Iranian ports of Imam and Abass, Anzali and border crossings.



* **Inter-provincial roads**

Those are roads which link provinces and main cities together and account for 37 nodes.

* **Intra-provincial roads**

The 24 provinces of the country account for 118 intra-provincial roads. Iran is renewing its major ports and in particular the ports of Imam and Abass to serve CAC countries (Ogutcu 1995). The corridor from the port of Imam to Armenia and the Autonomous Republic of Nakhjavan (Azerbaijan Republic) is a main national and inter-provincial trunk road, passing through six Western provinces of Khosestan, Lorestan, Ilam, Kermanshahan, Kurdestan, and East Azerbaijan. It has a main length of 1226 km to Tabriz and three sub-branches to Djulfa, Poldasht, and Noor-Dooz. This corridor, particularly after the first 433 km, has lighter traffic but is rather mountainous. The second corridor from the port of Imam ends at Anzali, Astara, and Pileh Savar, and has a main route of 898 km with heavy traffic up to Boein, then dividing into two routes. One sub-route runs north and serves the port of Anzali in the Caspian Sea and then as a second route along the coast to Astara. The third sub-route goes north-west to the Pileh Savar border crossing to the Azerbaijan republic via the two capital cities of Zanjan and Ardebil.

For the corridors from the port of Imam to the Central Asian border crossings, Tehran is the main common route for all four Customs border terminals as shown in Figure 5.2. One sub-branch to the north along the Caspian coast ends at the Inche-Borun terminal in the province of Mazandaran in the south west of the Turkmenistan. It has a good quality structure, although about 200 km from Tehran it becomes mountainous. Another sub-route from Tehran along the northern desert borders goes to Sabzvar in the Khorasan province and then into two other routes. A secondary road connects the two border crossings of Bajgiran and Lotfabad to the main road in Sabzvar. The more direct and better route from Sabzvar, after passing Mashad the capital city, ends at Sarakhs as the gateway to the Central Asian countries. These two corridors from the port of Imam to Gorgan in the north and to Mashad in the north-east have seasonal heavy traffic due to foreign and domestic trade, leisure and holy places, etc..

The port of Abass has road advantages over the port of Imam for the Central Asian countries. Its road runs first to the city of Sirjan as the biggest inland distribution centre in the country and the junction for Central Asian and Caucasus countries. About 533 km of the route links this port to north-east terminals for the Central Asian republics, and crosses the desert which is a main inter-provincial road. Because the copper and other mineral industries are along it, it is one of the most crowded roads over the first 400 km (MRT 1993) while from Kerman the traffic is considerably lighter. Its main leg ends at Mashad after 1211 km with three prongs towards the three major border crossings of Sarakhs, Lotfabad, and Bajgiran.

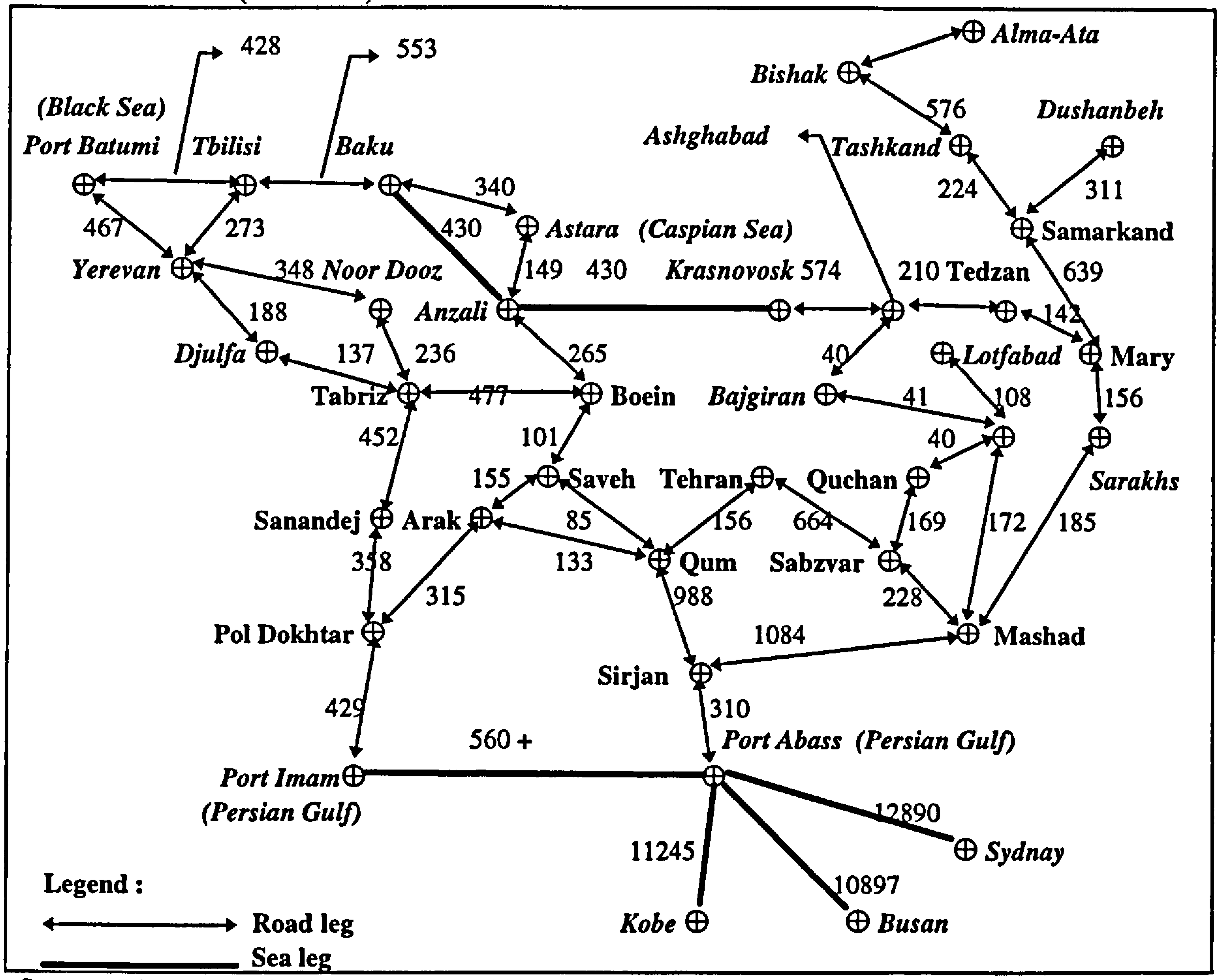
The route from port Abass to the Caucasus region after leaving Sirjan is joined with the port of Imam traffic at Qum (1174 km) as a distribution point for the Inch Borun border crossing in the north-east along the Caspian Sea and, for the Caucasus and the port Anzali region as shown in Figures 5.2 and 5.3.

A road fleet of about 147,000 heavy vehicles (13.5-22 tonnes) supports the present flows between ports and border crossing terminals with a modal share of 77.7% for 1993 (Atrchian 1995).

As discussed in chapter two, Iran has a reasonably high sea-going capacity (1.22% of world total dwt and 0.55% of total vessels in 1993) (UNCTAD 1993). After the collapse of the Soviet Union in 1992, the Islamic Republic of Iran Shipping Line

(IRISL) extended its operations into the Caspian Sea. The growing Caspian Sea fleet consists of three cargo ships and one passenger ship of 10885 dwt.

Figure 5.3 Different Iranian road landbridge and minibridge alternatives to/from CAC countries (unit: km).



Sources: Distances are based on: 1. MRT(1983), Handbook of the Iranian Road. 2. Different Persian and English road Atlases and maps of Iran: map of Iran, Gita Shenasi, No. 165, Published in 1989, Tehran. Auto Atlas of Iran, Gita Shenasi, 213, Tehran. For CAC countries Map of the Former USSR, Verlagsellchaft mbh, Frankfurt/main. Germany. World Map: Iran. Published in Germany in 1994, Geo-Centrej, RV Reiseund Verkehrsverlag, Berlin 1993/94.

5.2.4 Organisational characteristics

The Council of Transportation Co-ordination is the highest organisational body affecting the transport system of Iran, while for all prices and tariffs the Ministerial Council of Economics is also involved.

Sea ports are governed by the Ports and Shipping Organisation (PSO) as a subsidiary ministry to the MRT, based in Tehran and operated by its representative port authorities in the different southern and northern ports. The private sector is involved in stevedoring but is influenced by the PSO. The national shipping company (IRISL) is also an independent public entity under the Ministry of Commerce.

The rail industries in Iran which were restructured in 1988 are government-owned. The operation and maintenance of rail (both infrastructure and rolling stock) are run by the I.R.

Railway company but construction of new rail projects is under direct MRT control and rail manufacturing is private, although mainly shared with the railway company. For rail to function effectively there is a need for more direct rail lines to both regions of the CAC countries, an increase in the number and composition of rail cars and operating locomotives, and a faster service.

Freight forwarders and road carriers in Iran are based mainly in the private sector although there are some government companies acting as domestic or international carriers, also carrying a part of their own foreign trade. Of 2340 passenger and freight companies in 1992, 1355 are involved in freight of which only 220 function as international carriers under the "Syndicate of International Transportation Companies" (Sanat-e- Haml-o- Naghl, 1989). Shipping services and agencies are privately owned. The IRISL, as the national shipping line, operates its own and chartered ships which constitute most of the Iranian maritime traffic, but there are about 52 shipping agents engaged in ship owning and forwarding services of a maritime trade nature (Sanat-e-Haml-o- Naghl 1993c).

Since rail networks at present cannot directly influence Iranian landbridge flows to the main ports in the Caspian Sea (see Figure 5.4), the road freight industry must play an important role as an overland mode. The road freight industry, mainly privately owned, works independently, or for carriers issuing their own bill of lading. The last major link in the chain of the Iranian landbridge concept is the Customs administration. All border crossings are supervised and operated by Iran's Customs as an affiliate to the Ministry of Finance and Economics. The Customs Authority of Iran are signatories to the TIR convention. Therefore, within Iranian territories and gateways the transit shipments of foreign countries are under an international regime with MRT following IRU regulations.

5.3 Identification of the CAC countries' foreign trade routes and ISLB competitors

For the Caucasus countries the access to free international waters is much easier than for the Central Asian republics as they are closer to the Black and Mediterranean Seas and to the port of Imam in the Persian Gulf. Apart from Iran, the corridors with road /rail modes and also of a landbridge nature are road/rail Georgia, the Russian Federation, the Caspian Sea-bridge, Turkish-Iran bridge, Pakistan, India, China, and finally TSR.

The bridges most likely to have an impact on the ISLB project have the following geographical characteristics:

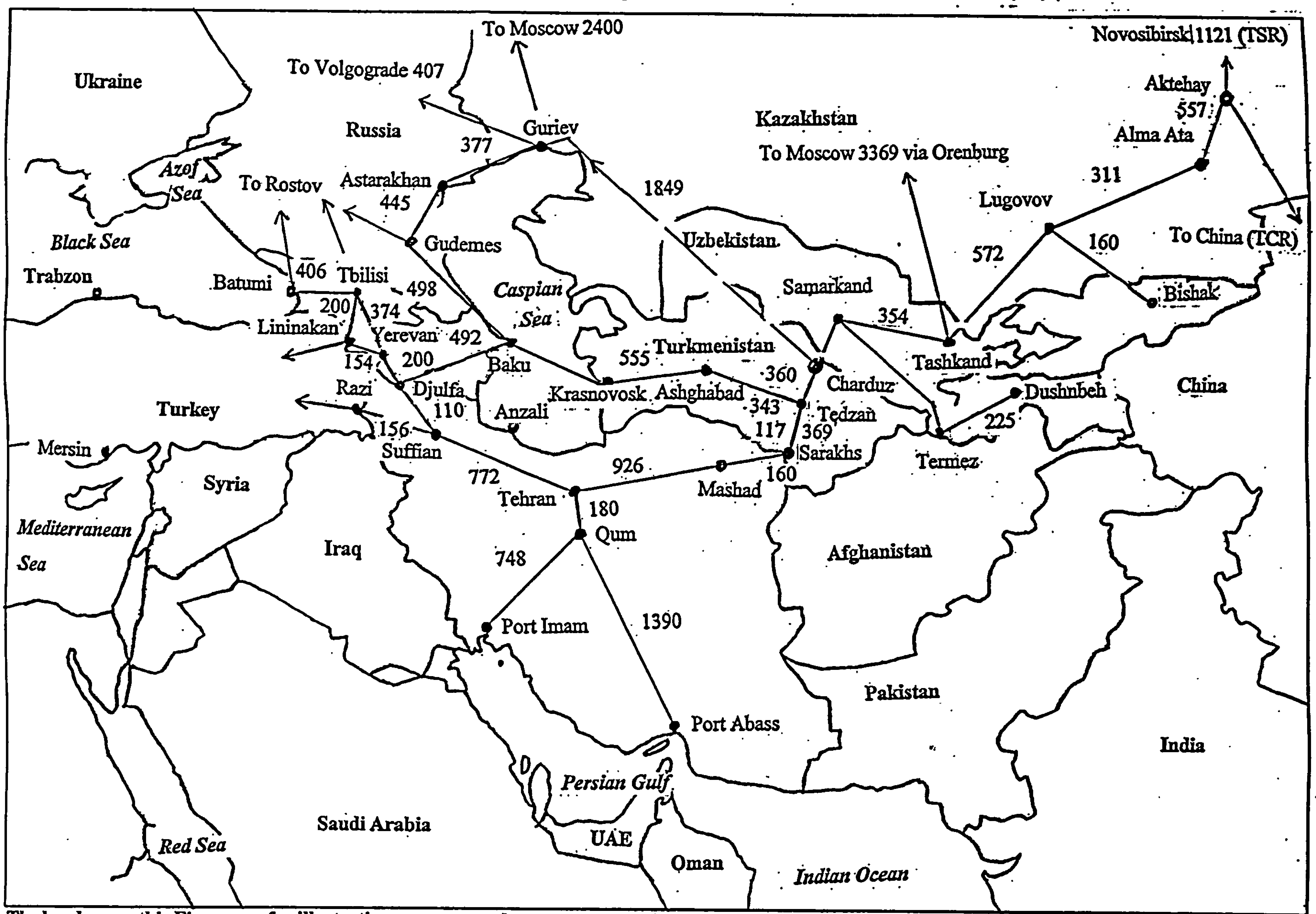
* Euro-Georgian and Turkish landbridges, Caspian Sea bridge, India and Pakistani landbridges, and Far East landbridges.

5.3.1 European markets via Georgian and Turkish ports

The Caucasus region is much closer to European markets as it is near the Black and Mediterranean Seas directly via Georgia and Turkey or through the Iran-Turkey road-rail bridge for the southern Turkish Mediterranean landbridge port of Mersin.

The Georgian ports of Batumi and Sukhomi on the Black sea coast (if current disputes are settled) will provide all the other CAC countries with services from Europe, Africa

Figure 5.4 Iranian rail minibridge and microbridges between southern ports of Imam and Abass, and CAC countries (km).



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and America. Armenia (Yerevan) and Azerbaijan (Baku) via Northern Tbilisi routes and also through Yerevan can be served by the port of Batumi directly for European traffic as shown in Figures 5.5 and 5.6 and Table 5.2 . The five Central Asian countries may have access to Batumi as the nearest port in the Black Sea through the two alternatives of the Caspian Sea-bridge and the rail and road route to Batumi.

Table 5.2 Caspian Sea east-west rail-bridge between CAC capitals and port of Batumi in Black Sea (km).

	CAC countries capitals							
	Tbilisi	Yerevan	Baku	Dush-anbeh	Ashgh-abad	Tash-kand	Bishak	Alma Ata
Distance from port Batumi	406	780	955	3216	1760	2843	3575	3841

Source: Same as table 5.1

5.3.1.1 Caspian Sea-bridge

There is a ferry system operating between the port of Baku in the west and Krasnovosk in Turkmenistan in the east with a total sea leg of about 250 km. The closest capital city of Central Asian countries to Batumi via the Caspian Sea-bridge is Ashghabad and the furthest Alma Ata (see Table 5.2).

5.3.1.2 Rail and road route to Batumi

The second route is an overland rail (also road) route which connects Batumi through Tbilisi, and along the north west Caspian coast via Baku, Astarakhan, Guriev (Atycrou), Makat Urgench and Chardzhou, to all five Central Asian countries. The longest distance as shown in Table 5.3 is to Alma Ata and the shortest is Dushanbeh. The same table shows that between the same origin and destination the Trans-Iranian Railway via Yerevan, Djulfa and Tehran is considerably shorter.

Table 5.3 Rail-bridge between CAC capitals and port of Batumi in Black Sea (km).

Distance from port Batumi through:	CAC countries capitals							
	Tbilisi	Yerevan	Baku	Dush-anbeh	Ashgh-abad	Tash-kand	Bishak	Alma Ata
CAC rail networks	406	780	955	5220	4827	5579	5579	5845
Trans-Iranian Railway[1]	Not applicable	Not applicable	Not applicable	4521	3408	4148	4880	5146

Source: Rail distances based on Thomas Cook (1995), March-April, various pages. 1. Rail bridge through Trans-Iranian Railway via Djulfa- Tehran-Mashad, Sarakhs to Central Asia.

Road distances from Central Asia to the port of Batumi are considerably shorter than rail and there are two alternatives. The first route first runs north and then along the Caspian Sea to Tbilisi and Batumi. The second route is through Iran via Batumi to Yerevan, Djulfa, Tehran, Sarakhs. This route is also considerably closer than all the northern roads via the north Caucasus and Caspian coasts as shown in Table 5.4.

The Turkish corridor can also serve as a direct minibridge for the Caucasus region, while for Central Asia there are two alternatives using the Caspian Sea bridge and Iranian rail/road modes. The route using rail/road modes to Baku creating another sea leg over the Caspian Sea to the port of Krasnovosk to reach Central Asia is shown in Figure 5.5 and Table 5.5. The second alternative is to use the Iranian road/ rail links via the Bazargan and Razi land border crossings in the west and Sarakhs in the north-east of Iran.

Table 5.4 Road-bridge between CAC capitals and port of Batumi in Black Sea and St Peters burg in Baltic (km).

CAC countries capitals	CAC countries capitals							
	Tbilisi	Yerevan	Baku	Dush-anbeh	Ashgh-abad	Tash-kand	Bishak	Alma Ata
Batumi	428	467	981	4080	3433	3623	4222	4456
Batumi and Iran	-	-	-	3605	2380	3523	4099	4329
St Petersburg via Moscow-Charduz	3159	3533	3807	3793	3869	4006	4738	5001

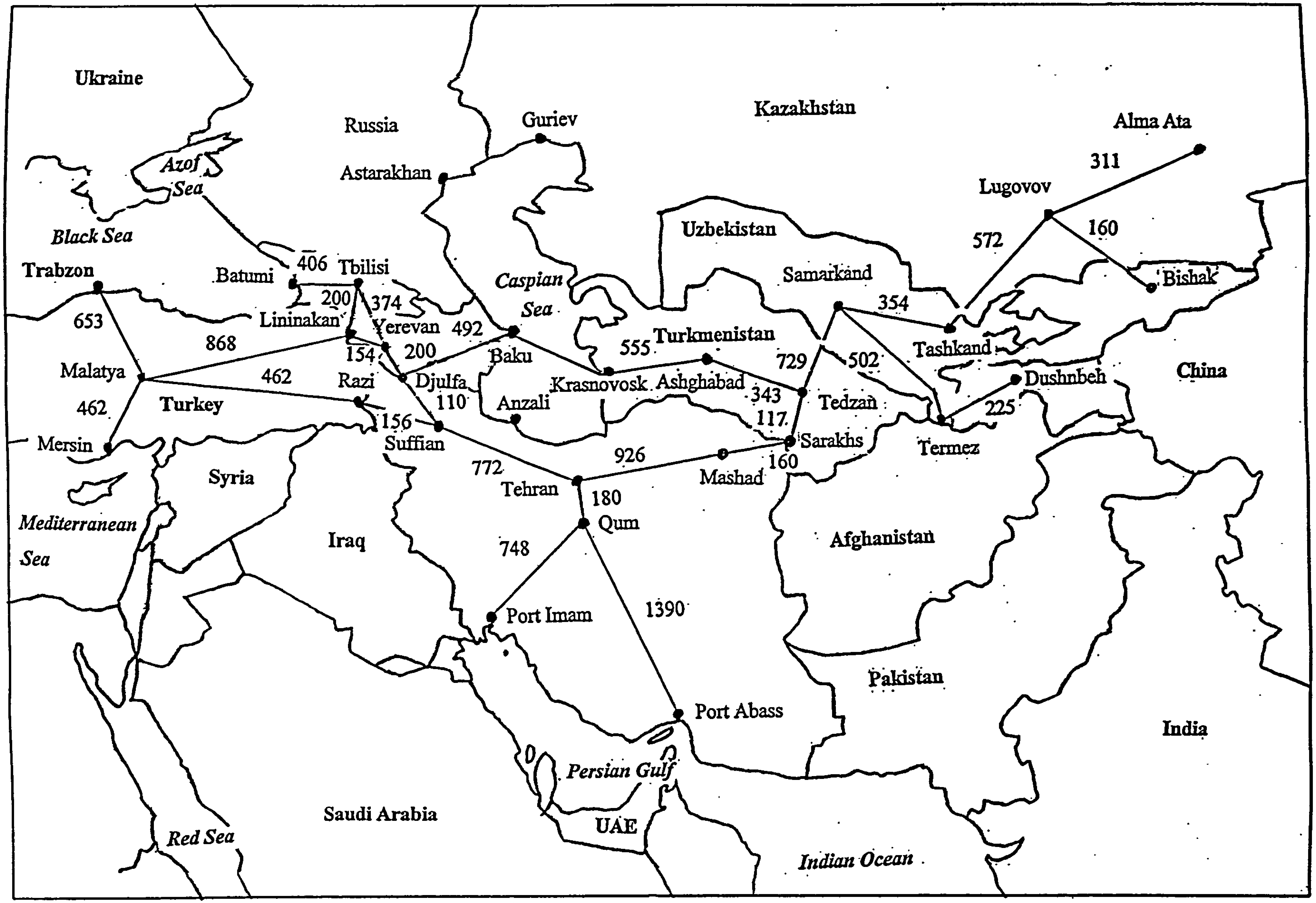
Source: Same as table 5.1. 1. Road bridge through Trans-Iranian Roads via Yerevan, Djulfa-Tabriz, Tehran-Mashad (Sabzvar, Quchan, Ashghabad) Sarakhs to other Central Asian countries.

Table 5.5 Rail-bridge distances between landbridge port of Mersin in East Mediterranean coasts of Turkey, and CAC countries using Caspian Sea landbridge and Iranian rail (km).

	CAC countries capitals							
	Tbilisi	Yerevan	Baku	Dush-anbeh	Ashgh-abad	Tash-kand	Bishak	Alma Ata
Caspian Sea landbridge	1550	1484	1976	4580	2781	4207	4939	5205
Trans-Iranian railway	-	-	-	4747	3634	4374	5106	5372

Source: Same as table 5.1

Figure 5.5 Routes to European markets through Georgian and Turkish and Iranian ports, border crossings, railways and Caspian Sea-bridge (km)



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5.3.2 Indian Ocean and African markets via Pakistan and India

Two routes, either consisting of all-road or combined rail-road, exist between the port of Karachi in Pakistan and Central Asia through Afghanistan as shown in Table 5.6 and Figure 5.6. The combined rail-road route has a common interface in Peshawar in Pakistan. From Peshawar there are two alternatives: one road link is connected to Dushanbeh through Kabul to Termez where again there are rail links and warehousing facilities available to Central Asian Rail networks. The second choice on the same route is to use the road at Termez for east Central Asian areas. Road conditions in Pakistan are relatively good but connections in Afghanistan are poor, unsafe and mountainous and require frequent terminal handling.

To/From	**Table 5.6 Road and rail bridge distances between CAC capitals and four closest ports in Black Sea, Persian Gulf, and Indian Ocean (km).**							
	Ashgh-abad	Dush-anbeh	Tash-kand	Bishak	Alma Ata	Baku	Yerevan	Tbilisi
Port Karachi (road)	2297	2345	2802	3378	3608	4486	4451	4724
Port Karachi[1]	3873[2]	2801	3258	3857	4091	-	-	-
Port Karachi[3]	4129	2780	3411	4143	4419	-	-	-
Port Bombay (road)	3188	3236	3693	4269	4499	5377	5342	5615
Port Bombay[4]	4898	3449	4180	4912	5178	-	-	-
Port Abass(road)	1647	2685	2603	3179	3413	2238[7]	2261[8]	2534[9]
Port Abass[5]	3116	4229	3856	4588	4854	2944	2652	3026
Port Imam (road)	1987	3216	3134	3710	3944	1754[7]	1838[8]	2111[9]
Port Imam[6]	2474	3587	3214	3946	4212	2302	2010	2384
Port Batumi (road)	3433	4080	3623	4222	4456	981	467	428

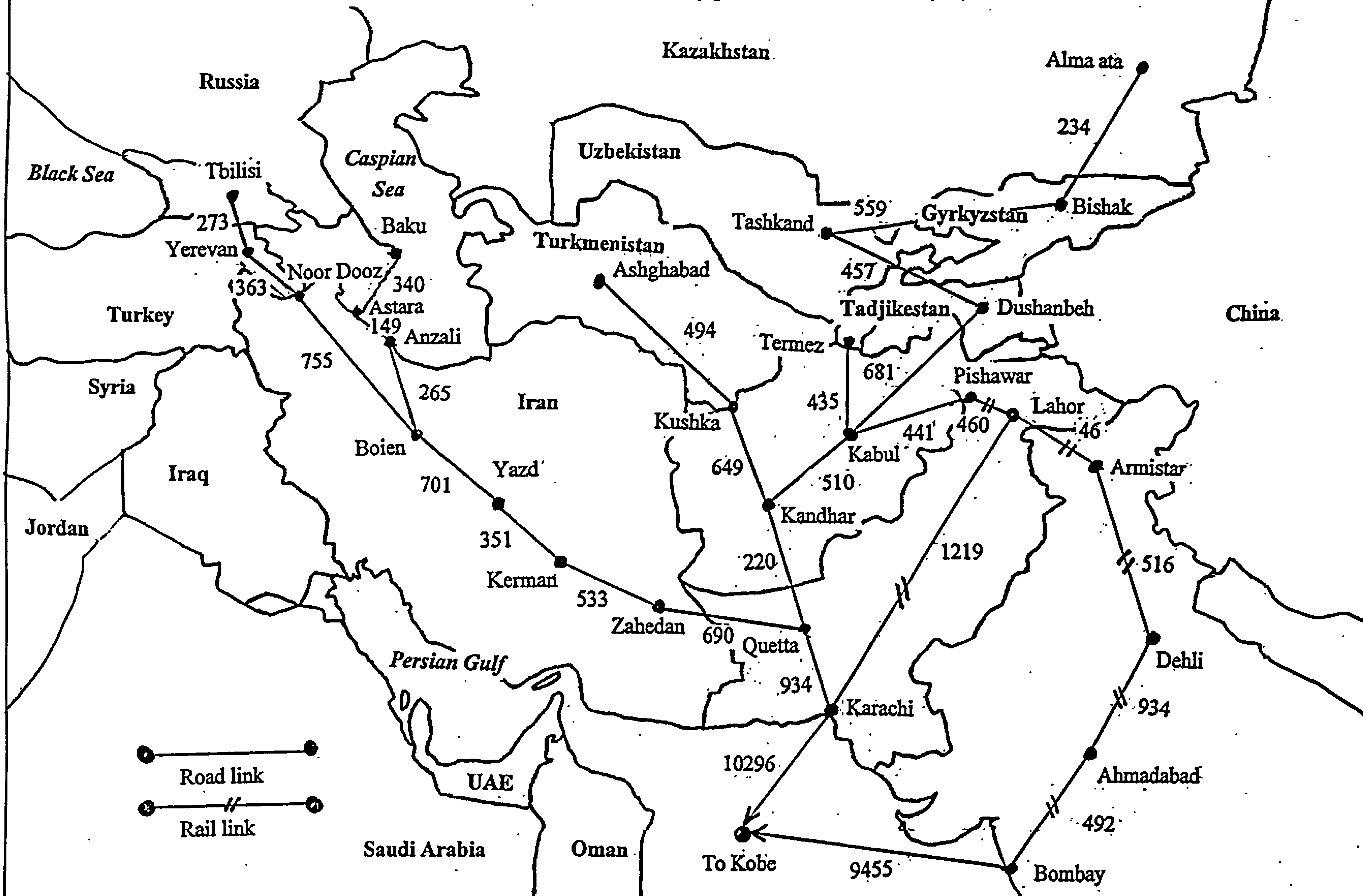
Source: Same as table 5.1.

1: Via Rail to Peshawar and all road through Afghanistan and Central Asian countries. 2: Rail to Peshawar and Via Kabul, Qandhar, Harat, Kushka. 3: Rail to Peshawar and Via Kabul, Termez by road and then by rail. 4: Rail from Bombay to Peshawar via Lahore, Road from Peshawar to Termez changes into rail at Termez. 5: Rail from port Abass to Sarakhs via Tehran with changes in border into broad gauge lines. 6: Rail from port Imam to Sarakhs via Tehran with changes in border into broad gauge lines. 7. through Astara 8: through Noor Dooz. 9: through Noor Dooz-Yerevan.

For the most direct road routes from Karachi to CAC countries as shown in Figure 5.6 use is made of the junction where one route deviates to Qandahar and then to Central Asia, and the other to Zahedan in Iran for the Caucasus region.

The most important Indian port, which can serve CAC countries and particularly Central Asia, is Bombay. India, which has an extensive country-wide rail network with a connection in Armistar as shown in Figure 5.6, is able to serve Central Asia via Lahor

Figure 5.6 Pakistani and Indian alternative routes via Karachi and Bombay ports to CAC countries (km).



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over the same routes for Karachi. The most direct road route from Bombay is through Karachi in Pakistan with an extra leg of about 891 km. Generally the Indian corridor is longer than those of Pakistan and Iran as shown in Table 5.6 and it has more border crossings, handling or modal changes during the journey.

5.3.3 Far East via TSR and TCR

The Far East outlets of the CAC countries are limited to the TSR and the TCR. The former is more compatible and longer but the latter has a different gauge. For the TCR Khazakhstan will be the major distribution point. Apart from the landbridge port Lianyungang in China and Hong Kong, the two ports of Shanghai and Dalian have the potential to serve CAC countries as shown in Figure 4.7. All legs are connected by rail in the major city of Zhengzhou and the rail lines intersect the TSR branch to Central Asia at Aktehay, about 557 km north of Alma-Ata as the gateway of the TCR in Central Asia (see Table 5.7). The other corridor used by CAC countries for trade with the Far East, Russia and Japan is the TSR. It is assumed that currently a long distance road infrastructure of a high quality is uneconomic.

Table 5.7 Rail-bridge distances between CAC capitals and four main ports in Yellow and Japan Seas (km).

	TCR				TSR
CAC countries capitals	Dalian	Lianyungang	Shanghai	Hong Kong	Port Vostochney
Tbilisi	11014	9644	10223	10857	11108[1]
Yerevan	11157	9787	10366	10857	11251[1]
Baku	10465	9095	9674	10308	10559[1]
Ashghabad	7999	6629	7208	7842	9785
Dushanbeh	7654	6284	6863	7497	9813
Tashkand	6573	5203	5782	6416	8732
Bishak	6161	4791	5370	6004	8320
Alma Ata	5575	4205	4784	5418	7734

Sources: Based on Thomas Cook (1995), March-April 1995, CIS, China, and Hong Kong sections.
- Measurements based on Junior Atlas (1979), WHSMITH, John Bartholomew & Son Ltd, Edinburgh and Esselte Map Service, Stockholm,.
1. Shortest route between Astarakhan, Guriev, Oktyabrsk, Orenburg, Kurgan, Omsk and Vostochney.

The Central Asian countries receive four main rail lines of which two leave the TSR at Petropav and Novosibirsk, both of which end at Chu in Kazakhestan and are 1514 km and 1989 km long respectively. Another rail line originates from Moscow and at Oktyabr'sk diverts into two links, passing the north-east and north west sides of the Aral Sea. It is connected to the Central Asian rail lines at Chu (3746 km) and Charduz (3283 km) in Kazakhestan and Uzbekestan respectively as shown in Figure 4.8 .

5.3.4 Identification of ISLB competitor landbridges

The ISLB will be compared with the five most competitive landbridges (TSR, TCR, North American, Turkish and Caucasus) in terms of origin-destination distances, technology and storage facilities, and organisational structure.

The ISLB is seen to serve primarily eight CAC countries which were previously used to trading via the TSR. Therefore, the TSR is the first real and potential competitor for ISLB because of its strong background, and compatibility with the CAC countries' transport system and geography. The ISLB has great potential for future operations with Russia and Ukraine, and other CIS countries, and with Turkey and even European countries via the Persian Gulf, and the Black and Mediterranean Seas. European/Asian landbridges already have a long operational history at the international level and sometimes use the overland modes of many countries as a bridge; but they are not likely to present any competition with the ISLB for CAC countries.

The North American landbridges have many similarities with European/Asian landbridges for technical, political and organisational issues. While the distance is longer, they could divert the Far East trade of the Caucasus countries including Iran through North America via the Mediterranean and Black Sea ports. Consequently, they can be considered as competitive with the ISLB to serve the three Caucasus countries through the Georgian port of Batumi or even the Turkish Mediterranean landbridge ports of Mersin or Eskandarun for trade with the Far East.

China is a vast, highly populated country and composed of many local economies. It has a poor transport infrastructure and sometimes uses other markets (e.g. Hong Kong) for the distribution of the domestic trade between north and south (Speece and Kawahara 1994). Also, the first ISLB transit shipment (1906 tonnes cotton) in 1994 was consigned from Turkmenistan to China (Payam Darya 1994). However, the TCR, which has been operating from 1992, can be considered as the second competitor for Central Asia as it is linked to the Kazakhstan rail networks; while the TSR is the main competitor due to the compatibility of its networks, past experiences, and the common economic background of Russia with the CAC countries.

The landbridges through India and Pakistan have the major problem of transit passage through Afghanistan (which is interface between Central Asia, and Pakistan and India) to ensure access to Central Asian countries. Due to the lack of rail networks in Afghanistan, shipments originating in Karachi or Bombay must have a double unloading stage and move by truck to or from the Central Asian Republic borders, which in terms of time and cost of services provided can be regarded as uncompetitive with ISLB.

5.3.5 Comparison of ISLB with competitor landbridges

In this section the ISLB is compared with the four main competitor landbridges in terms of:

* Origin and destination distances
* Technology and storage facilities
* Organisational structure

5.3.5.1 Origin and destination distances of landbridges

A comparison is made first between the two ISLB ports of Abass and Imam and then for eight capital cities of the CAC countries between the ISLB system and the TSR and

TCR as shown in Table 5.8 (Macomber 1969, Wronski, 1975, Padelford and Gibbs, 1975, and Hayuth, 1982).

Table 5.8 indicates that, of the two ISLB ports, the port of Imam with a total 24129 km rail distances from all CAC capitals is much closer than the port of Abass with 29265 km but due to its maritime distance (1037 km) offers longer journeys in total to all eight CAC capitals. Port Abass can offer much shorter journeys when the direct rail Bafgh-Mashad project is completed. At regional CAC levels the port of Abass is closer as a road minibridge to Central Asia, while Imam is closer for the Caucasus area. For road minibridges the port of Abass in both total overland distances and minibridge operations (as shown in Table 5.8) is closer than the port of Imam.

Comparing the ISLB minibridge system with the TSR and the TCR, the results show that the ISLB offers longer journeys as routes have a much longer sea leg and quite short rail or road journeys. Road transport is faster and more expensive than rail, but both are more expensive than water transport. Therefore, the ISLB can act as a feeder system offering mass sea transport trade in cheaper and generally faster services compared with TCR and TSR. This is due to much shorter rail and road routes which provide more frequent journeys and particularly when the block train method is employed by the ISLB.

Assuming that block trains operate on all the landbridge routes of Table 5.8, another comparison with ISLB can be made when there are container ships with 16 knots or 30 km speed moving along sea legs (e.g. for TSR a sea leg of 1487 km can be travelled in 2.1 day: 1487/30/24. see column 1 of Table 5.8 for all landbridges). Two transfer points for each landbridge with two days operations; the block trains transit time for all landbridges is based on Damas (1992a) for 14 days between Vostochney-Chop as the main rail leg of the TSR with about 11,173 km distance. Therefore, the block trains

Table 5.8 Comparison of ISLB rail and road minibridge system with the TSR and TCR landbridges from Kobe, Japan (km).

First sea leg distance and time		Overland distance, time & final destination: Distance and transit time (days)			Final leg distance and transit time	
From Origin	to 2nd port	Rail distance and transit days	Road	Final destination	Rail distance and transit days (column 3 + 2 days for each border crossing or port)	Road
1	2	3	4	5	6	7
Kobe 1487 (2.1 days)	TSR via Vostochney (two days terminal operations)	10559 (days 13.2)	-	Baku	12046 (days 19.3)	-
		11251 (days 14.1)	-	Yerevan	12738 (days 20.2)	-
		11108 (days 13.9)	-	Tbilisi	12595 (days 20)	-
		9785 (days 12.3)	-	Ashghabad	11272 (days 18.4)	-
		8732 (days 10.9)	-	Tashkant	10219 (days 17)	-
		9813 (days 12.3)	-	Dushanbeh	11300 (days 18.4)	-
		8320 (days 10.4)	-	Bishak	9807 (days 16.5)	-
		7734 (days 9.7)	-	Alma Ata	9221 (days 15.8)	-
	Total CAC distance	77302	-		89198 (Average 18.2)	-
Kobe 1570 (2.2 days)	TCR via Lianyungang (two days terminal operations)	9095 (days 11.4)	-	Baku	10665 (days 17.6)	-
		9787 (days 12.3)	-	Yerevan	11357 (days 18.5)	-
		9644 (days 12.1)	-	Tbilisi	11214 (days 18.3)	-
		6629 (days 8.3)	-	Ashghabad	8199 (days 14.5)	-
		5203 (days 6.5)	-	Tashkand	6773 (days 12.7)	-
		6284 (days 7.9)	-	Dushanbeh	7854 (days 14.1)	-
		5791 (days 7.3)	-	Bishak	7361 (days 13.5)	-
		4205 (days 5.3)	-	Alma Ata	5775 (days 11.5)	-
	Total CAC distance	55638	-		69198 (Average 15.1)	-
Kobe 12282 (17.1 days)	ISLB via Imam (two days terminal operations)	2302 (days 2.9)	1754	Baku	14584 (days 24.0)	14036
		2010 (days 2.5)	1838	Yerevan	14292 (days 23.6)	14120
		2384 (days 3)	2111	Tbilisi	14666 (days 24.1)	14393
		2474 (days 3.1)	1987	Ashghabad	14756 (days 24.2)	14269
		3214 (days 4)	3134	Tashkand	15496 (days 25.1)	15416
		3587 (days 4.5)	3216	Dushanbeh	15869 (days 25.6)	15494
		3946 (days 4.9)	3710	Bishak	16228 (days 26.0)	15992
		4212 (days 5.3)	3944	Alma Ata	16494 (days 26.4)	16226
	Total CAC distance	24129	21694		122385 (Average 24.9)	119946
Kobe 11245 (15.6 days)	ISLB via Abass (two days terminal operations)	2944 (days 3.7)	2238	Baku	14189 (days 23.3)	13483
		2652 (days 3.3)	2261	Yerevan	13897 (days 22.9)	13506
		3026 (days 3.8)	2534	Tbilisi	14271 (days 23.4)	13779
		3116 (days 3.9)	1647	Ashghabad	14361 (days 23.5)	12892
		3856 (days 4.8)	2603	Tashkand	15101 (days 24.4)	13848
		4229 (days 5.3)	2685	Dushanbeh	15474 (days 24.9)	13930
		4588 (days 5.8)	3179	Bishak	15833 (days 25.4)	14424
		4854 (days 6.1)	3413	Alma Ata	16099 (days 25.7)	14658
	Total CAC distance	29265	20560		119225 (Average 24.2)	110520

move roughly 798.1 km daily (11155/14 = 798.1 or about 33.3 km per hour) along all sample landbridges. The results indicates that there are on average for eight CAC countries 15.1, 18.2, 24.2 and 24.9 days transit times for a block train for TCR, TSR, ISLB $_{Abass}$ and ISLB $_{Imam}$ respectively. Due to longer sea legs for both the ports of Imam and Abass, transit times for these two ports are much longer than those for TSR and TCR, while the 14 day transit times for the latter two landbridges seems to be very optimistic. The importance of faster container ships, with a speed of higher than 16 knots, can effectively reduce ISLB sea leg transit times which in terms of current shipping technology is easily obtainable in Iran and the CAC countries.

5.3.5.2 Technology and storage facilities

The technical comparisons were made between ISLB and six other landbridg countries and areas in terms of four major available measures as shown in Table 5.9 (Miller 1978).

Table 5.9 Comparisons of the ISLB road and rail transport networks and fleet with major landbridges of the world.

Transport indicators and rankings	Landbridges						
		1	2	3	4	5	6
	Iran	USA	Canada	European countries	Turkey	China	FSU
Road networks, km	157,794	6,237,290	392,000	4,287,888 (25 countries)	367,409	1,056,707	1,737,000
Length of railways	4,847	199,900	194,000	227,065 (24 major countries)	10,386	53200	258600
Rail freight tonnes-km per year (million)	8,002 (1992)	1,480,205	242,439	342,534 (22 major countries)	16,000,000 tonnes (7571 tonnes / km in 1989)	1,037,295	3,827,700
Road freight vehicles	875,452	47,095,000	3,680,000	25,052,339 (22 major countries)	861,005	N/A	3,250,000

Source: The Economist-Pocket World In Figure (1993), edition. p 56 and 59. For Turkey. Holt (1993), p. 91 for former USSR. Europa World Yearbook (1995), Volumes. I & II various pages. Jane's World Railways (1990), for rail freight tonnes-km of Turkey.

The ISLB was compared with other major landbridges in terms of relevant port infrastructure and superstructure, road and rail networks, rail freight performance, and road freight vehicles. Ports play a key role in the operation of any landbridge, as they are a major determinant of two important elements of the landbridge operations (cost and time) in all countries. The number of landbridge ports depends on the maritime geography of the relevant countries. Iran, like the TSR, the TCR and the Caucasus, is dominated by one or two ports suitable for landbridges, while Turkey is in a better situation and north American landbridges are served by a series of capable ports on the east, west, and Gulf coasts. The output of landbridge ports largely depends upon container facilities. Comparisons were made of the seven elements of container berth length, number of gantry cranes, depth of water at container berths, covered area for container stripping and stuffing, total area for containers, and container traffic in 1993. All these measures are significant indicators of a potential landbridge port and the results are shown in Table 5.10. The port of Anzali was excluded from the comparisons as it uses general cargo berths and facilities for containers.

The ISLB ports with 8.3% of the container berths rank higher than the TSR and the TCR with 5.4% and 3.9% respectively, and close to Turkey (9.8%). However, they are not comparable with four USA ports which have about 53.3% and Canada with 19.3% of the total number of container berths of the 18 landbridge ports considered for comparison (Table 5.10).

The ISLB ports have 3% of the total 131 gantry cranes for the 18 landbridge ports, and ranked lowest close to the TCR and Turkish ports, while the USA and Canadian ports with 84% and 17% have the highest number. In terms of depth of water at container quays, both ISLB ports can be categorised among the high ranking ports with deep water quays of 12-14 metres.

In terms of container (TEU) traffic the ISLB ports handled about 2% of the total TEUs. The port of Abass ranked much higher than many other of the eighteen landbridge ports in terms of both TEU and tonnage, and closest to the port of Mersin in Turkey (Miller 1978 UNCTAD 1991).

Landbridge ports in Iran are comparable to Turkish landbridge ports in terms of infrastructure and superstructure, communications, ownership and management

Table 5.10 Comparison of the ISLB ports infrastructure and superstructure with main landbridge ports of the world.

	Land bridges	Ports	Container facilities			Container throughput p.a. 1993	
			Berth length (metre)	Depth (metre)	Gantry crane	TEU	Tonnage
		1	2	3	4	5	6
1	ISLB	Imam	1051	12	2	8268	50237
		Abass	1000	14	2	82920	758278
		Anzali	-	0	0	4083	56078
		Total	2051	12	4		
2	TSR	Vostochney (1990)	980	11.5	4	185000	2,000,000
		Nakhodka	195	9.75	2	000	000
		St. Peters burg	525	9.5	4	73620 (1992)	825890
		Total	1335	9.5-11.5	12		
3	Canada	Halifax	1664	13.8-15.2	7	300933	2518603
		Toronto	1017	8.2	2 (one mobile)	12922	158941
		Vancouver	2072	10.7-14	8	434004	3458242
		Total	4753		17		
4	Turkey	Mersin	710	12	5	84456	1,211,069
		Trabzon	300	9	1	N/A	N/A
		Izmir	1414	12-13	2	212,949	1438163
		Total	2424	9-13	8		
5	China	Lianyungang	540	11	2	25000	52638
		Shanghai	425	10.5	4	900256	6524300
		Total	965	10.5-11	6	925256	6576938
6	USA	New York/New Jersey	7056	10.7-12.2	40	1972692	N/A
		Houston	457	11.6-12.19	11	541497	4617231
		San Francisco	748	12.2	4	119324	2904000
		Seattle	4898	12-15	29	1151000	8445000
		Total	13159		84		
		Grand Total	24687		131		

Sources: 1. Containerisation Yearbook (1995), London: Emap Business Communications Ltd. 2. Hicks (1994), Jane's Containerisation Directory for 1994-1995, (ed), Twenty-sixth Edition, Jane's Information group Inc, 1340 Braddock Place, Suite 300, Alexandria, VA 22314-1651, USA. 3. Russian ports except St Petersburg are based on Fraser (1993), p. 103. TEU for Vostochney in Korean Maritime Institute study project p. 56. For port of Izmir in Turkish State Railways (1994), Handbook of the Turkish ports operated by TCDD, Istanbul.

- Difference in the number of ports is due to the variable availability of data for any particular comparison.

systems, but differ from the TSR and the TCR and the North American landbridge ports. In particular the latter employ different systems of port operational management and there is comprehensive involvement of the private sector. The alternative routes and the quality of roads for the ISLB and Turkish landbridges are limited with mainly two-lane asphalt roads.

The TSR, TCR and Caucasus landbridges are not suitable for commercial long distance road transport with limited road networks. Basically, road services are not offered and light trucks suitable for short distances constitute the bulk of the road freight fleets. In contrast, the composition of the road networks in North America are complex and extensive providing many options of a high quality and standard.

In terms of traffic ISLB has densely loaded truck and rail movements mainly in a south-north direction for both domestic and foreign trade, leaving a considerable spare capacity for flows from the CAC countries.

5.3.5.3 Organisational structure and productivity

The organisational structure of the landbridges concerns managerial and ownership aspects. e.g. types of port ownership and operational systems, including infrastructure and productivity (UNCTAD 1989 and Damas 1992a).

There is a variety of ownership and operational systems in landbridge practice and, for the purposes of this work, the two ISLB container ports are compared with seventeen landbridge ports for total trade, the average daily productivity of each port, and also container traffic and gantry crane output as shown in Table 5.11. The ISLB transport system is similar to the Turkish landbridges, and to some extent similar to the TSR and the TCR, in terms of ownership, but differ from the North American landbridges which have private ownership based on competitive long term management and operational schemes.

The comparison of the general port productivity for eighteen ports indicates that the port of Shanghai with an average throughput of about 3.8 million tonnes is the most productive followed by the ports of Houston and Los Angeles. The two ISLB ports are ranked at eleven (Abass) and fourteen (Imam) as indicated in Table 5.11. These comparisons were made when both ISLB ports, despite their great storage capacity, were dependent on ships' gear to load and unload general cargo trade.

Table 5.11 Comparison of the ISLB ports maritime and cargo traffic and productivity with main landbridge ports of the world.

				Ports' productivity		
	1	2	3	4	5	
	Land-bridges	Ports	Port total cargo traffic (000 MT) in 1993 unless otherwise specified (both foreign & domestic)	Daily /tonnes (365 days work) and ranking	per container gantry crane/day (tonnes unless otherwise specified)	
					Tonnes day/p.a. & ranking (5.1)	TEU/day/ p.a. & ranking (5.2)
		Imam	11047	30265.8 (14)	68.8 (24)	11.3 (25)
1	ISLB	Abass	13224	36230.1 (11)	1038 (11)	113.6 (13)
		Vostochney	11600 (1990)	31780.8 (13)	1369.9 (1990) (8)	126.7 (11)
2	TSR	Nakhodka	12000 (1990)	32876.7 (12)	000 (25)	000 (27)
		St Petersburg	10900 (1990)	29863 (15)	565.7 (18)	57.2 (20)
		New York / New Jersey	41352 (only foreign trade)	113293 (7)	N/A	135.1 (9)
		Houston	71842 (only foreign trade)	196827.4 (2)	1150 (10)	134.9 (10)
3	USA	Los Angeles	68664	188668.5 (3)	N/A	196 (3)
		San Francisco	N/A	N/A	1989 (2)	81.7 (16)
		Seattle	N/A	N/A	797.8 (14)	108.7 (14)
		Philadelphia	57322 (only foreign trade)	157046.6 (5)	356.4 (19)	80.2 (17)
		Halifax	14112	38663 (9)	985.8 (13)	117.8 (12)
		Toronto	N/A	N/A	217.7 (21)	17.7 (24)
4	Canada	Montreal	16500	45205.5 (8)	1018.4 (12)	102.4 (15)
		Vancouver	60762	166471.2 (4)	1184.3 (9)	148.6 (6)
5	Turkey	Mersin	13966	38263 (10)	663.6 (17)	46.3 (21)
		Izmir	5268	14432.9 (15)	1970.1 (4)	291.7 (2)
6	China	Lianyungang	45241 (container tonnage 1992)	123947.9 (6)	72.1 (23)	34.3 (22)
		Shanghai	139590 (1990)	382438.4 (1)	4468.7 (1)	616.6 (1)

Source: 1. Containerisation Yearbook (1995), London: Emap Business Communications Ltd. 2. Hicks (1994), Jane's Containerisation Directory for 1994-1995, (ed), Twenty-sixth Edition , Jane's Information Group Inc, 1340 Braddock Place, Suite 300, Alexandria, VA 22314-1651, USA. 3. for San Petersburg, Vostochney and Nakhodka are based on Peters (1993, p. 290).

- Difference in the number of ports is due to the variable availability of data for any particular comparison.

Landbridge ports differ in the number of gantry cranes (column 5) and therefore, in the volume of container traffic. The productivity of ISLB ports was compared (Table 5.11) with other ports on the basis of average container handling per gantry crane.

Each of the ISLB ports has two gantry cranes as have Izmir and Liagyungang. However, although the container output of Imam and Liangyungan (Table 5.11) are similar (column 5.1), Izmir has nearly twice the throughput rate of Abass.

Productivity of the two ISLB ports in terms of TEUs per gantry crane per day on an annual basis was made among 19 ports (Table 5.11, column 5.2). It is very low for Imam (11.3 TEU/day/gantry crane) showing that containerisation has not been developed adequately in Iran. The container is still considered a type of product by Iran's Customs administration (Sanate-Hamlo-Naghl 1995c) and not as a unit load device. Abass ranks about the middle with 113.6 TEU/day/gantry crane.

A comparison was made (Table 5.12) between the ISLB and other landbridge ports. The management and operation of the ISLB modes and interfaces are government run and supervised by the PSO through a deputy minister of the MRT. Therefore, to a large extent, Iran has a government financially supported system based on central planning. Iran's landbridge system functions in a much simpler way than the TSR, but there are strong similarities with Turkish transport systems. In North America, landbridge ports are governed mainly at port and municipality levels.

Both ISLB ports and three other Iranian major ports have one administration and management to run and supervise all operations, its own infrastructure and superstructure.

Table 5.12 Comparison of the ISLB container ports and terminals ownership and management with other landbridges and ports of the world.

			Type of port and management		
	Land-bridges	Ports	Port ownership	Operation management	Landbridge operators
1	ISLB	Imam	Port Authority	Port Authority	Islamic Republic Iranian Shipping Line & other national and international operators
		Abass	Port Authority	Port Authority	Same as Imam
2	TSR	Vostochney	Port Vostochney	Port Vostochney	SOTRA & different other national and international companies
		Nakhodka	Vladivostok Commercial Port Corporation	Vladivostok Commercial Port Corporation	Same as Vostochney
		San Peters burg	Port Authority		Same as Vostochney
3	USA	New York/New Jersey	Port authority of New York & New Jersey	Eight different terminal operators	Various shipping and NVOCC operators
		Houston	Port of Houston Authority	2 private terminal operators	Various shipping and NVOCC operators
		San Francisco	Port of San Francisco	One stevedoring terminal operator	Various shipping and NVOCC operators
		Seattle	Port of Seattle	Six terminal operators	Various shipping and NVOCC operators
		Philadelphia	Philadelphia Regional Port Authority	Two terminal operators	Various shipping and NVOCC operators
4	Canada	Halifax	Halifax Port Corporation	Halifax Port Corp & two terminal operators	Canadian Pacific(CP) and Canadian National (CN) Railways & Various shipping and NVOCC operators
		Toronto	Toronto Harbour Commission	Toronto Harbour Commission	Same as Halifax
		Montreal	Port of Montreal	Five terminal operators	Same as Halifax
		Vancouver	Vancouver Port Corporation	Three terminal operators	Same as Halifax
5	Turkey	Mersin	Turkish State Railways	Turkish State Railways	Various shipping and NVOCC operators
		Trabzon	Turkish Maritime Organisation	Turkish Maritime Organisation	Various shipping and NVOCC operators
		Izmir	Turkish State Railways	Turkish State Railways	Various shipping and NVOCC operators
6	China	Lianyungang	Lianyungang port Container Co.	Lianyungang port Container Co.	Trans-Chinese Railways, Chinese National Shipping Line & Various shipping and NVOCC operators
		Shanghai	Shanghai Harbour Bureau	Shanghai Container Terminals Ltd	Same as port Lianyungang

Source: 1. Containerisation Yearbook (1995), London: Emap Business Communications Ltd. 2. Hicks (1994), Jane's Containerisation Directory for 1994-1995, (Ed), Twenty-sixth Edition, Jane's Information group Inc., 1340 Braddock Place, Suite 300, Alexandria, VA 22314-1651, USA. 3. for San Petersburg, Vostochney and Nakhodka are based on Peters (1993, p. 290).

5.4 Conclusions

This chapter has presented a general description of the reasons and the national motivation of Iran in establishing landbridge services for CAC countries. It has described the general and specific characteristics of the Iranian Sea Landbridge and its different modes and interfaces in geographical, political, technical, and organisational terms. Then, alternatives routes for CAC countries were assessed. Finally, a comparison was made between the ISLB and five other main landbridges of the world on the basis of certain criteria. These will provide the foundation for the conceptual model presented in the next chapter.

6. Scenario approach and the Iranian Sea landbridge conceptual model development

6.1 Introduction

The preceding five chapters have examined the transport and trade of Iran and the Central Asian and Caucasian (CAC) countries, and have undertaken a review of the landbridge concept as well as the main characteristics of the Iranian Sea-landbridge (ISLB). The purpose of this chapter is to discuss the scenario building approach and examine its relevance to the ISLB study.

6.2 Planning and analysis under uncertainty

Johnson and Scholes (1988) note that uncertainty is a result of complexity in the system within a context of:

* The sheer diversity of environmental influences

* The nature of management skills to cope with uncertainty

* The interaction of environmental influences.

Uncertainty arises from several distinctive sources. According to Frenkiel and Goodal (1978) these can be discussed under two major areas:

* Inherent uncertainties, relating to the system components which cannot be treated in a deterministic way. e.g. pollution.

* Superimposed uncertainties, arising from modelling and observational processes which may lead to some error in the structure or estimation of the parameters of the model, thus affecting the model output.

Business projects are affected by a series of internal and external elements resulting from changes in decision making or from uncertain environments. Researchers and planners require techniques to understand the main attributes and variables of an uncertain future and their potential for proper decision making. According to Wigg (1982) the objectives of planning for uncertainty can be categorised into two main areas:

* To decide which strategy should be pursued to the organisation's greatest advantage.

* To develop contingency plans.

Before the 1970s in a relatively stable era and prior to the first oil crisis in 1973, forecasters in econometric modelling employed mainly the rate of economic growth as the only uncertainty (Mandel 1983). The oil price crisis in the early 1970s had a great impact on normal economic and political life, and consequently led to vast technological and social changes in all countries. In developed nations it also increased the unreliability of projections and forecasting methods based on past data for their outcomes. This led to the development of alternative techniques (Mandel 1983).

In order to develop the ISLB into a reliable and modern landbridge, many types of problems must be identified and overcome. The CAC countries as customers and Iran as the supplier of the landbridge capacity and services exist under severe uncertainty. The CAC region is composed of eight countries with about 60 millions population and over three million square/km land which have obtained a nominal independence but politically, economically, territorially, and socially are and will be for a long time under the influence of the future changes and events in Russia, the leading country of the former USSR. Iran has unstable oil revenues and problems in its relations with the USA. Landbridge operations, with a complex international hinterland, like any other economic or service entities, have to face up to the issue of uncertainty during the long range planning stages. There are some techniques like sensitivity analysis, simulation techniques (e.g. Monte Carlo Simulation), spread sheet modelling, etc. that deal with uncertainty. However, the most suitable technique to deal with uncertainty is the application of scenario analysis (Foster 1993).

6.3 The scenario approach

A landbridge has many internal and external environmental factors confronting the reliability of its political and economic operation. The CAC countries are passing through the preliminary stages of a free market restructuring while Iran is still in a war reconstruction period and has unstable oil revenues. Both the CAC countries and Iran are in their different ways, passing through political and economic instability. Therefore, a valid approach to the study is to consider some potential scenarios under conditions of uncertainty. Consequently the ISLB environment will be investigated under a set of multiple plausible scenarios (Mandel 1983, Wigg 1982, King 1986) to divulge the probable future situations. The plausibility of the scenario depends on the content and consistency of the scenario components as best predictors of the future situation. A scenario explains a plausible future while two or more scenarios consider probable alternatives for the uncertain environment under study. Therefore, decision makers can see a probable version of the future and are able to design desired strategies.

6.3.1 Scenario characteristics

The scenario approach is among a variety of techniques that have been developed in fields where the environmental or future services are uncertain for different long-term periods. Scenarios must include sufficient data to confine the range of the different uncertainties. The reliability of the scenario results depend upon the nature and strength of the data involved. Each scenario is composed of both quantitative and qualitative data and descriptions of different natures, e.g. social, political, economic, geographical, etc. under certain assumptions and conditions aimed at the future by the use of past and present information.

Allport et al. (1986, p. 232) mention the following definition accordingly due to Ayres (1969):

> "A logical and plausible set of events, both serial and simultaneous, with careful attention to timing and correlation wherever the latter are salient."

Jungermann and Thuring (1987, p. 247) quote Mitchell (1979) and (Kahn, 1965), the pioneer of the concept, for two well known definitions:

> "An outline of one conceivable state of affairs, given certain assumptions about the present and the course of events in the intervening period". (Mitchell 1979)

> "Hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points". (Kahn 1965)

Wack (1982, p. 18) noted that a scenario:

> "Is an archetypal description of a possible future based on a mutually consistent grouping of determinants. .... is intended to be regarded as a tool to assist understanding - as a backdrop to the decision making process, rather than as an integral part of the decision itself".

Nijkamp and Blass (1994, p. 82) have indicated the role of the scenario and its differences from other techniques in transport planning:

> " It is one of the methods and techniques of perspective policy research that have become very popular since the late sixties. Especially in the case of unstructured decision problems with uncertain outcomes, scenario analysis may be an appropriate instrument. It does not only contain a description of one or more future situations, but also a description of a consistent series of events that may connect the present situation with the described future situation (s)."

Shearer (1994 p. 112), in defining a scenario, compared the Delphi technique with the scenario method and pointed out that the Delphi technique contributes to some "idea of several possible futures" with a long-term time horizon but the scenario approach serves for a lesser period and:

> "Concerns the transition to a new long-term position rather than the final position itself and explores the impact of these possible futures on the company."

Millett (1988, p. 61) in addressing the role of scenario analysis points out:

> "Scenarios can be an excellent approach to some forecasting and strategy making problems, but they will not answer all questions. No analytical tool can. There are proper times to use scenarios, and proper times to use statistical models. Scenarios are best suited for long-range time spans (5-20 years), highly complex situations of many factors of which some are unquantifiable, highly uncertain situations where virtually every factor is a variable and none is a constant, and where there are few or no reliable data available for quantitative models."

According to Wack (1985b, p. 140):

> "Scenarios structure the future into predetermined and uncertain elements. The foundation of decision scenarios lies in exploration and expansion of the predetermined elements".

Amara and Lipinski (1984, p. 5) have defined a scenario as:

> "Representation of an interconnected sequence of trends/events describing an internally consistent alternative future."

The differences between the Mitchell (1979) and Kahn (1965) definitions according to Jungermann and Thuring (1987, p.247) lie:

> "In their emphasis on the course of events between the initial state and the final state".

Scenarios as practicable and logical alternatives are clear straightforward devices used in studies where there are uncertainties. According to Mandel (1983, p. 10-6): "Scenarios don't reduce uncertainty, they clarify it". When using scenarios the forecaster must be certain about the existence of the indications of uncertainties in each scenario, which can be found through analysis of the past internal and external variables.

According to Parente and Anderson (1987, pp. 149-150):

> "The content validity of the scenarios is as important as the representativeness of the sample. Perhaps the best way to ensure content validity is to adequately survey the literature (and expert) prior to developing a tentative list of relevant scénarios. Scenario statements should be no longer than 20 words and should be in such a way that they can be easily verified."

Kleiner (1995, p. 275) adds that:

> "Contrary to what many people believe about scenario exercises, their purpose is not prediction. You don't predict what will happen: you posit several potential futures, none of which will probably come to pass, but all of which make you more keenly aware of forces acting on you in the present ... A scenario planning exercise is a bit like a storytelling workshop, set up to bring forth distinction and phenomena that the conventional wisdom ignores."

Ginter and Duncan (1990, p. 97) based on Wack (1985) concluded that:

> "Scenarios at least as they are used at Royal Dutch Shell are fundamental aids to changing the mental models and alerting the corporate microcosm in ways that allow managers to generate options for the future while assuming acceptable levels of risk."

The scenarios and their individual sub-sets in one study must be sufficiently different from each other, consistent, and highly related to the area of interest to cover most probable outcomes (King, 1986).

6.3.2 Scenario elements

A scenario composition has three elements which are called scenario description, scenario variables and scenario sub-titles. The scenario description consists of the general explanations about the scenario purpose and its future. It is a description of each scene in detail and may cover a few pages. Mitchell et al. (1979) mentioned three types of variables in any scenario as:

* "Event-trend" (e.g. rates, percentages, etc.)

* "Events" which occur unexpectedly and once only influencing the future output.

* "Trends" which are time series data or any other measuring units.

Scenario sub-titles cover different events and trends within a similar area of activity or sector. According to Verroen and Jansen (1993) and Mitchell et al. (1979) sub-titles are called "themes" and cover different internal and external environments of the scenario (Schnaars 1987, Shoemaker 1995). Vlek and Otten (1987) developed societal discussion on (nuclear) energy policy (SDEP) scenarios under three areas or "themes" as socio-economic policy, energy policy, and environment policy. Veroen and Jansen (1993) in an attempt to study passenger transport developed their scenarios under five headings: economic, social-cultural, technological, infrastructure supply, and pricing and regulation. Naylor (1983) has made another distinction for the scenario elements as: *key determinants,* which are events and variables and conceptually can make a future situation and *principal impact factors,* which are the result of the scenario events and the adopted strategies. According to Amara and Lipinski (1984) the external environment affecting scenarios of a system have the six following major areas of influence with different geographical characteristics (international, national, regional, local, etc.).

* Economic/resources including macroeconomic indicators,

* Consumer/demographic changes,

* Labour force/ work place,

* Regulatory/political including government/private sector interfaces,

* Competitive/institutional, and

* Technological/capital.

Methods of developing the scenario elements differ, and as pointed out by Mitchell et al. (1979) in Jungermann and Thuring (1987), fall within the two following approaches:

* Bottom-up: it is inductive, the elements are first generated and then, using matrix and graph theoretical procedures, their relationships are gradually developed;

* Top-down: it is deductive, clusters of interrelated elements are used as input for scenario developments.

The uses of these methods depends "upon the agency and forecasting purposes" Jungermann and Thuring (1987, p. 248). For example, the top-down method is suggested by Kahn (1989) for long range planning studies. According to Saunders et al. (1987, p. 324), the Trend Impact Analysis approach can be used to identify the scenario sub-titles and:

> "Once the most probable scenario has been chosen other boundary scenarios can be generated by examining deviation from the core. Alternatively several individual theme scenarios can be chosen automatically or by groups".

6.3.3 Scenario efficiency and effectiveness

Vleg and Otten (1987) have suggested that a good scenario consists of:

* A basic analysis of the status quo and its developmental trends,

* A projected or a desired image of the future at an adopted time horizon, and

* A description of developmental processes (whether controllable by deliberate policies or not) by which the status quo is going to be connected to the imagined future.

Mandel (1983) suggests that the number of scenarios is important in the validity and effectiveness of the scenario technique and advised the application of two to four scenarios; while Howard (1990) points out that the number of scenarios in any situation can be two to the power of the number of options; but all cannot be executed and many might be infeasible. Stokke et al. (1990, p. 3) in the scenario planning for Norwegian Oil and Gas have commented that:

> "For scenarios to be more useful they must be 'decision focused'. That is, their analysis of alternative futures must focus on the specific trends and issues that are important to the decision being made. Accordingly, the team first selected the 'key decision factors': that is, what insights must the research manager have about the future business environment to make the decision needed? These factors, in turn, must form the basis for the scenarios' stories of the future."

6.3.4 Scenario dimensions and types

Different scenario approaches may have different dimensions in terms of the purpose and objectives and cause and effect. Jungermann and Thuring (1987, p. 248) note that:

> "Unfortunately, the authors of scenarios rarely state, ..., which type of scenario they want to develop and why this particular type is adequate for this purpose. In fact, most scenarios are not of any distinct type at all but represent mixtures of the various types."

Nijkamp and Blass (1994, pp. 83-84) state that Van Doorn and Van Vight (1981) have indicated the four following types:

* *Descriptive scenarios* are based on the digging of the past and present knowledge as causes into probable future situations as effects, irrespective of their desirability or undesirability.

* *Normative scenarios* are based on the writers' or users' ideas; therefore, the future paths and pictures are selected in advance by giving means or goals and obtaining others (e.g. Ozbekhan, 1969 and Van Doorn and Van Vight, 1981). According to Becker (1983) the future scenario is determined and then the events and trends are developed to achieve it.

* *Projective scenarios* with both descriptive and normative characteristics are those in which their future forecasts are based on the present situation as causes into future paths as effects.

* *Prospective scenarios* are those with normative characteristics and the values of their forecasts and paths leading to that future are predetermined. They work from the future to the present situation in reverse.

Both these types of approach to scenarios are projective while *trend scenarios* forecast the future by extrapolation of the present situation and paths from a feasible point of view.

If a scenario is constructed by the choice of the "majority of people" it is "common opinion" otherwise it is called *happy few* scenarios.

Ducot and Lubben (1980) made the distinction between scenario types as shown in Table 6.1.

Table 6.1 Four basic types of scenarios.

Scenario types	Exploratory	Anticipatory
Descriptive	Given the causes, what are the effects?	Given the effects, what are the causes?
Normative	Given the means, what goals can be reached?	Given the goals, what means can be used?

Source: Based on Ducot and Lubben (1980, pp. 51-54)

Howard (1990) suggests that the scenario technique can be developed under the five following types in sequence:

* *Status quo scenario:* which considers the future as was seen in the past.

* *The present scenario:* considers the changes in the *status quo scenario* with present time intentions according to the interactions of the scenario composers.

* *Position scenario:* reflects the "diplomatic negotiations" and results from the interaction among actors in a given situation.

* *Compromise scenario:* considers the "compromise between two actors' position, ... which is preferred by each to the other's position".

* *Conflicts scenario:* In this scenario one actor may force others to accept his position through strikes, boycotts, deadlocks, etc.

Foster (1993) has categorised scenarios at two levels:

The global scenario concerns global economic issues and variables while the industry scenario covers the competition and technological trends.

Allport (1986) has classified scenarios according to their parameters into two types:

* *Time trend scenarios* which are complex and composed of "an explicit dynamic path for changes" with high costs.

* *Discrete events scenarios* which are more popular in transport planning and applied in a single "design year". Their parameters have static end-states and concentrate on dynamic elements.

6.3.5 Scenario ranking, probabilities and criteria

Mandel (1983) suggests three types of ranking for scenarios:

* Optimistic (high growth)

* Most probable (moderate growth)

* Pessimistic (recession or low growth).

Foster (1993) notes that ranking is dependent upon the number of scenarios and should be relative to the base or central scenario. Amara and Lipinski (1984) point to three types of scenario rankings as "upper", "central", and "lower" band, all of which should be developed around the central scenario. Mitchell et al. (1979) note that for a scenario to explain the future it must be ranked with its best assessment. This is done by "act of faith", "heuristic rules", "simulation" or "methodological programming techniques". According to Schnaars (1987, pp. 108-109), labelling the scenario events or ranking the likelihood of the occurrence of a scenario may be conducted through quantitative methods such as cross impact analysis which "attach probabilities to the scenarios they drive" or by "some judgmental schemes".

In any environment the number of scenarios must be limited logically to be managed and studied. Wilson (1978) quotes Zenter (1975) on scenario selection as consisting of credibility, utility, and intelligibility.

6.3.6 Scenario analysis techniques

Application of the scenario method may involve the use of other techniques, and in particular a quantitative approach linked to a qualitative scenario method is very common practice. The application of mathematical models to the scenario gives "greater internal quantified consistency" (Cole and Chichilnisky 1978, p. 22) and any forecasting technique can be employed (Zenter 1982). The range of these supplementary techniques for forecasting the future values of the independent and dependent variables vary depending upon the time, availability of data, purpose and knowledge of the researcher. The six following techniques were suggested by Taylor (1992):

* trend analysis
* computer simulation
* decision analysis
* sensitivity analysis
* Delphi study and
* impact analysis.

Shearer (1994) developed the scenarios as a planning model relating economic and company assumptions to be linked and forecast through the application of a computer spreadsheet. Tongzon (1991) applied multiple regression to three scenarios of an Australian ports study. Picard and Nguyen (1987) and Dagenais (1987), applied input-output and regression techniques to two scenarios to measure the impacts of changes in the transport and economic attributes, and long-term container traffic forecasting of the port of Montreal. According to Huss and Honton (1987) and Stover and Gorden (1978) the Centre for Futures Research Group applied trend impact analysis and interactive cross-impact analysis (INTERAX) and Mont Carlo Simulation when using scenario analysis, while the Battle Scenario Inputs to Corporate Strategies (BASIC) used trend impact analysis with sensivity analysis. According to Martino (1978, p.389) there are two differences between the scenario approach and the cross-impact matrix (CIM):

> "First it is less rigorous, since it is primarily a verbal description of some future situation. Second, it is more detailed and provides a rich description rather than simply a list of events that are to take place. The scenario can be considered a written description of a single future history, which might have come from a single play of a cross-impact matrix.

Zenter (1982) proposed two approaches to scenario development, covering qualitative and mathematical models, distinguishable with soft and hard methods; in the soft method the scenario is based on human capability and environment using Delphi or cross-impact analysis (CIA) to identify events and trends and their relationships and importance. The hard method is based on computer application and is a dynamic behaviour model called system dynamics, and its components have cause-and-effect relationships with feedback loops. Schnaars (1987) points out that the main difference between the scenario approach and other analytical methods is:

* It usually provides a more qualitative and contextual description rather than just seeking numerical predictions.

* It identifies a set of possible plausible events for the future.

6.3.7 Scenario development and construction

Scenario construction covers the range of activities and investigations to systematically identify and combine the components of each scenario ending with the forecasting of the future scenario variables and events (Twiss 1992).

A scenario must be seen as a single framework containing components with logical socio-economical links with each other. According to Howard (1990, p. 242) the preliminary task in the scenario development is to prepare the:

> "List of actors and options [which] once achieved, is a mechanism for generating scenarios. The object is to prepare for interaction with others by looking at what may lie ahead, what they may and you should aim at, and how to exert or resist pressure".

An aspect of the scenario is to how satisfactorily it is designed. Scenarios of different studies may use common data but they are developed to answer different questions. Leemhuis (1990) mentions that, in the development of scenario descriptions, the relationships and interactions of four components (social, political, economic, and technological) in an internally consistent manner is of significant importance.

Different authors explain scenario construction differently and in the form of a few systematic stages (see Figures in Table 6.2) leading to the application and interpretation of the scenario results. Scenario construction involves the use of a series of systematic works about past, present and future situations which may differ slightly in format, but are generally common in concept. Construction and development of scenarios take place in different stages. Table 6.2 shows the most important cited approaches to scenario writing by fourteen authors.

To construct scenarios, the scenario builder needs to have some knowledge of macroeconomics to identify the key factors and also data processing to find out the interrelationships between variables.

Table 6.2 Different scenario construction procedures.

	Steps/Authors	Ogilvy and Mandel	Jungermann and Thuring (1987)	Norse (1979)	Gordon et al. (1974) (Futures Research Group)	Schofer and Stopher (1979)	Schoemaker (1995)
1	Review of the background, other strategic planning activities		1		2		
2	Selection of critical indicators or key factors, organisational and environmental variables	3	1 & 2	2	1	1 & 4	3
3	Establishment of past behaviour for each indicator, analysis of key factors	4	3 &4		3	2	
4	Verification of potential future events		6		5		3
5	Forecast each indicator or future directions		3	3	4	6	
6	Scenario writing	6	7			7	
7	Strategic decision factors, selection of objectives	1					1
8	Key decision factors or issues	2					4
9	Scenario logic and themes	5	5		8	5	5
10	Scenario elaboration	6					
11	Strategic implications in each scenario	7					
12	Scenario selection or construction of minor scenarios		5		8	3	
13	Corporate strategy and matching the resources with results, identification of strategies		8				8
14	Assessing current and future events and trends	8	7			6	6
15	Plan implementation						
16	Estimation of event/ time dependent probability				6		
17	Modification of extrapolation of trends				7		7
18	Development of conceptual models			1			
19	Major stockholders						2

Table 6.2 continued.

	Steps/Authors	Mercer (1995)	Schaers (1987)	Jauch & Glueck (1988)	Mendal (1983)	MacNully (1970)	Ginter and Duncan (1990)	Kleiner (1995)
1	Review of the background, other strategic planning activities			1	1	1	1	
2	Selection of critical indicators or key factors, organisational and environmental variables	1 & 2		2	4	3 & 4	2	2
3	Establishment of past behaviour for each indicator, analysis of key factors			3	5		4	
4	Verification of potential future events			4				
5	Forecast each indicator or future directions			5			3	
6	Scenario writing	4		6		6		3
7	Strategic decision factors, selection of objectives				2	2		1
8	Key decision factors or issues				3			
9	Scenario logic and themes				6			
10	Scenario elaboration				7			
11	Strategic implications in each scenario	5			8	7		
12	Scenario selection or construction of minor scenarios	3				5		3
13	Corporate strategy and matching the resources with results, identification of strategies	4						4
14	Assessing current and future events and trends					4		
15	Plan implementation					8		
16	Estimation of event/ time dependent probability							
17	Modification of extrapolation of trends							
18	Development of conceptual models							
19	Major stockholders		2					

Wigg (1982, p. 79), stated regarding scenario construction that:

> "Planning for uncertainty typically is an iterative process, which requires a repeated refinement of the characterisation of the strategic options that are available, the project specifics, and the uncertainties to allow better analysis of their relative preference".

Norse (1979) describes his approach to scenario development in five steps as:

* Definition of the conceptual models, in his case, concerning the socio-political and economic situations of the OECD and third world changes after World War II;

* Selection and specification of the key assumptions, covering the qualitative and quantitative assumptions pointed out in the conceptual models;

* Production of the quantitative framework;

* Enrichment with materials from complementary studies; and

* Analysis of the dynamic path leading to the end state.

Mercer (1995b) emphasises "simpler scenarios" both in creation and application while Ginter and Duncan (1990) point out the importance of macroenvironmental analysis as it assesses all socio-political and technological forecasting. According to Schofer and Stopher (1979, p. 205):

> "The ultimate objective of any scenario-generation scheme is to produce a framework which supports directly a new long-range transportation planning process, including generation of sensible alternatives, forecasting travel demand and system performance, and impact and cost evaluation".

Schofer and Stopher also argue that as the scenario-generation technique has a significant subjective input, the identification of the key quantitative variables is of significant importance. Therefore, it must be flexible enough to cover "the freedom of choice in the selection of theme variables" (Schofer and Stopher 1979, p. 206). Verroen and Jansen (1993), develop scenario building into a systematic process in two phases consisting of a thematic procedure and a translation model, relating to four components:

* Themes,

* Steering variables,

* Scenario variables, and

* Model variables

Each of the above-mentioned components described by Verroen and Jansen explain variables from broad to specific values. For example "themes" include five major influential areas derived from the external environment of transport (economics, social and cultural, technological, infrastructure supply, and pricing and regulation).

Allport (1986) suggests three steps in the construction of scenarios:

* Identification of scenario parameters

* Combination of scenario parameters

* Development of plausible parameter values.

According to Fahey and Narayanan (1986, p. 216):

> "A scenario displays in a dramatic and persuasive fashion a combination of possibilities about the future. ...typically [it] includes some trends, patterns, and events, assumptions pertaining to these, conditions in the current environment, and the dynamics that lead from the present state of the environment to some future state."

According to Saunders et al.(1987, p. 324), the trend impact analysis approach can be used to identify the scenario sub-titles and:

> "Once the most probable scenario has been chosen other boundary scenarios can be generated by examining deviation from the core. Alternatively several individual theme scenarios can be chosen automatically or by groups".

The plausibility and consistency of trends and events are characteristics of any scenario as they determine the future situations. Vlek and Otten (1987, p. 273), in the evaluation of the four SDEP scenarios, argued that:

> "Potentially the most controversial part of scenario construction, however, would be the modelling of developmental processes comprising both uncertain factors and conditional decisions whose combined probable effects have to be assessed."

Abeelen et al. (1984) in a study of scenario development for traffic and transport have suggested two scenarios. One is where the context scenario is related to the factors explaining the future, and consists of the description of the problem, selection of variables, and preparing a basic analysis and creating the prospective picture. The other is where the policy scenario covers all actions and measures by which government seeks to influence traffic and transport, and affects both the scenario context and other environmental variables.

Methods of developing the scenario elements differ as pointed out by Mitchell et al. (1979) in Jungermann and Thuring (1987). Mitchell et al. (1979) also have suggested that the "bottom-up" and "top-down" approaches to scenario construction are "emergent" and "imposed".

6.3.8 Strategy formulation

Scenarios are developed to investigate and disclose, under different political, technological, social, and other conditions, the various future situations of an uncertain environment. After the completion of the scenario structuring, a group of related strategies should be formulated where each of the scenarios comes into practical analysis (Nutt and Backoff, 1987). The design and formulation of these strategies are of significant importance as they must reflect support for the scenarios. Therefore, they must be interrelated and consistent with other decisions and relate to the scenario future events and trends. The decisions involved have technical, geographical, organisational and political environments.

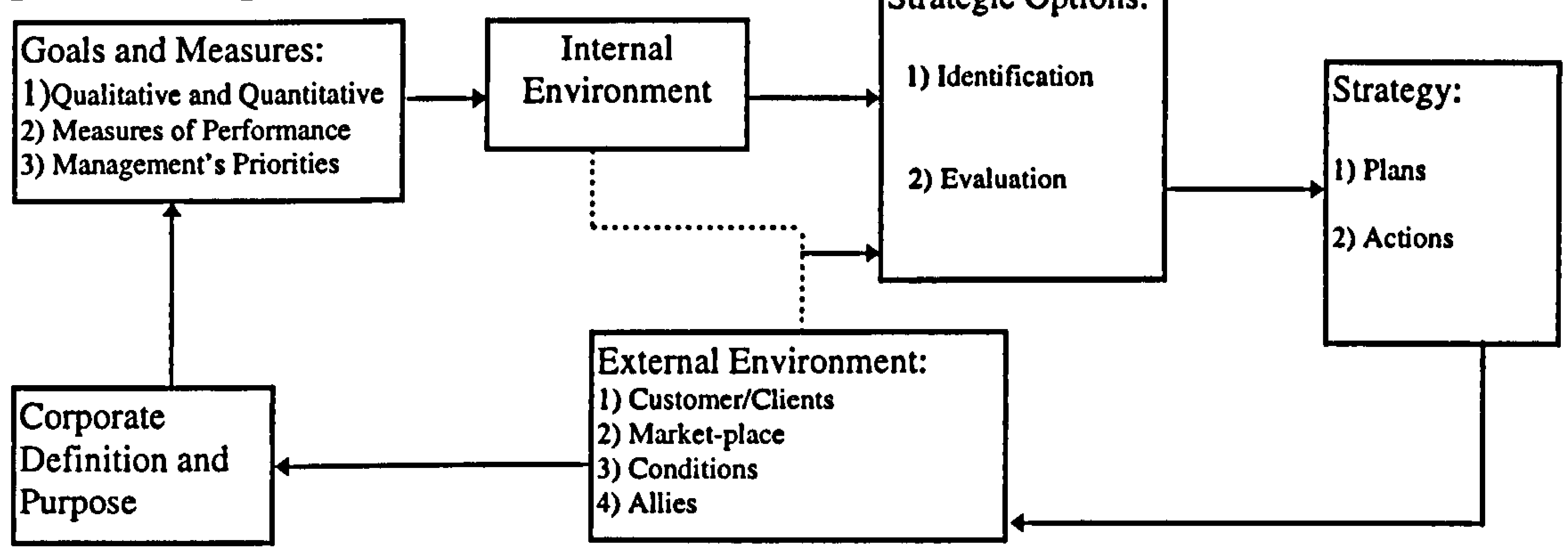
Allport (1986) has suggested two steps:

* Isolation of non- important or indirect decisions or strategies: The number of decisions is related to the level of detail of the study (aggregate or disaggregate), but in either case some decisions might be isolated relative to their importance.

* Integration and formulation of strategies in accordance with their priorities from top to bottom.

Millett (1988, p. 62) presented a systematic model (see Figure 6.1) for "a typical corporate strategy system" which is used in formulating internal and external business strategies.

Figure 6.1 Corporate strategy system



Source: Millett, M. S. (1988), How Scenarios Trigger Strategic Thinking, p.62.

6.3.9 Examples of scenario analysis

Scenario modelling nowadays has emerged in the context of different long term regional, national and international studies, or at industry level. The aim of this section is to discuss research cited in areas, particularly transport, which have relevance to the ISLB study. However, it must be stated that most scenario studies cover general applications of a non-transport nature.

Stokke et al. (1990) in a case study for the Norwegian oil and gas industry developed four scenarios and assessed the dynamic external environment of the industry which led to the identification and interpretation of strategy alternatives. Esterhuyse (1992) investigated the implications to South Africa for the transitional period and discussed the strategic problems, priorities and future of South Africa from the political, social, and economic points of view for a ten year time horizon.

Lensink (1995) developed a simulation model using four scenarios as a baseline and three others as alternative scenarios for the foreign exchange constraints and the economic performances of developing countries; two of the alternative scenarios were of an economic and capital flow nature, and another featured technology with an increase in total factor productivity growth. Goldfarb and Huss (1988) used the seven steps of the BASIC group for Georgia Power's planning process in USA and developed three scenarios with high, moderate, and low economic growth labels. These were purposely directed to see the effects of a few future assumptions influencing the company's load and energy growth under the five social, political, economic, technological and physical resource areas. Norse (1979), with six scenarios of different socio-economic aspects of the OECD and third-world countries, studied the development of the world economy in the 20 years horizon. Dewhurst and West (1990) with the construction of two scenarios studied the Queensland economy for the year 1985/86 and then projected the base run sixteen times for eight years. Another application was made using the Georgia econometric model by Legler and Robertson (1976) in the USA. They first developed a macroeconomic model on the basis of national variables and exogenous state variables and forecast the estimated relationships through the application of the regression technique. Then three scenarios were developed and applied to identify the impacts of the alternative national economic policies.

Galer and Kasper (1982) were assigned by Shell Australia to develop a two scenario survey study to see the effects of changes on long-term economic, social, political-strategic and technological sectors for Australian development to the year 2000 to give a "greater depth to Shell Australia 's planning scenarios for the next 20 years" (Galer and Kasper 1982, p 55).

6.3.9.1 Examples of scenario analysis in transport

Mitchell et al. (1979) applied the scenario technique to the state government railway organisation of Australia. Wolf (1981) in a freight demand study used a three scenario analysis of the truck and rail modes for five Canadian maritime provinces for the period of 1980-2000 to estimate the effects of each mode on equipment, labour, energy use, infrastructure, and capital investment. It was based on nine assumptions with the three influential areas of economic, energy and technological innovation. The first scenario covered the current situation of the Canadian freight industries while the two other scenarios raised the profile of trucking and rail respectively and quantified differently against the assumptions.

Several attempts have been made to apply the scenario approach to ports and shipping traffic and operations. A medium term model developed by Tongzon (1991) aimed to develop an analytical tool for forecasting the number and characteristics of ships visiting Australian ports. It provided three scenarios to identify the economic determinants of the supply of shipping services. These were based on world shipping trends of ship size, length, beam, and draught, and the effects of these trends on Australian ports. It forecast, with the use of a regression technique, a range of shipping services for Australian ports. Its findings suggested that international trends do not have immediate impacts on shipping services to Australian ports, and these trends are most likely under the influence of demand rather than overseas technological developments. In another study using scenarios in the ports and shipping industries, Darzentas and Spyrou (1996), by the use of simulation, applied three scenarios (with seven variables of ports characteristic). These scenarios focused on the design, implementation and testing of a model for the ferry traffic in the Aegean Islands in Greece. In the first scenario the current ferry fleet was compared with a hypothetical situation where all ships were replaced with new ones. The second scenario considered and compared the current fleet with having new technologies, and in the third scenario traditional routes were compared with new routes.

Picard and Nguyen (1987) studied the interregional freight flows for 64 commodities among 67 zones of Canada by the use of two scenarios aided by the input-output (I/O) technique. Scenarios were applied to measure the impacts of changes in transport and economic attributes. In the first scenario a decrease of 20% was applied to the transport cost for every good originating from the province of Quebec; then the impacts of the effects of the I/O technique on the regression model calculations were assessed. In the second scenario the effects on personal income of a 10% increase in the demand for one of 64 commodities within the province of Quebec were investigated. Dagenais and Martin (1987) made a long-term container traffic forecasting study for the port of Montreal in Canada in two scenarios and phases. The study included 78 commodity groups for 7 world regions and 11 North American regions. Verroen and Jansen (1993) in Holland conducted a study as a "scenario explorer for passengers" with three sequential phases. The first was the scenario building module, followed by the travel demand model, designed as the core phase with four main outputs (trips and passenger kilometres, travel times, and car ownership). In the third phase the evaluation module was designed to identify the impacts of travel demand by using such indicators as aggregate travel demand, accessibility and traffic accidents.

6.4 Development of the scenario themes for the ISLB study

The environment of a landbridge contains many factors influencing its viability and operation within different fields, which broadly can be divided into external and internal forces. The external forces of a landbridge include those factors which are outside the transport system, but which support the output of the landbridge system. (e.g. GDP, investment, national revenues, etc.). Internal forces are those which determine the transport demand and supply such as number of berths, capacity of fleet, etc. The variables to be identified and included in any scenario approach must adequately reflect and cover different aspects of landbridge demand and supply and also be applicable to other quantitative techniques. Therefore, to identify uncertainties and variables in a top down method (Jungermann and Thuring 1987) and then to carry out scenario analysis, the landbridge environment is divided into four themes (areas of influence): geographical, political, technical, and organisational domain areas. The selection of these themes coincides with much of the literature review.

6.5 Relevance of the scenario approach to the ISLB study

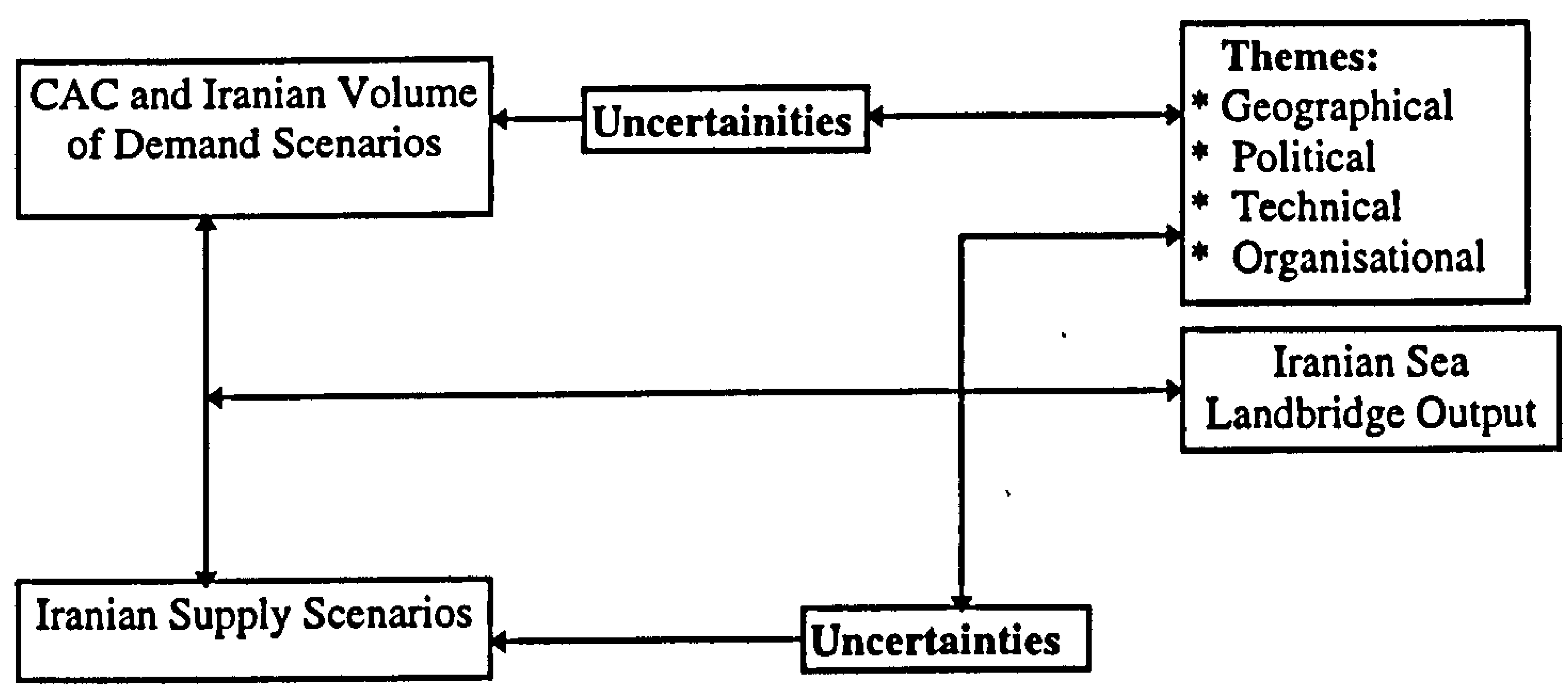
The ISLB model mainly aims to explain how demand for transport and its changes over time in terms of internal and external factors can affect directly the supply requirements in Iranian transport and associated infrastructure system.

The ISLB as a long term multi-landbridge project in a transitional environment can be considered as a suitable problem to be studied using the scenario approach. However, it is first necessary to develop an ISLB conceptual model as a preliminary and reliable tool to represent the main areas of the study (Ackoff and Saieni 1968). To accomplish this task, and based on the literature reviews undertaken in previous chapters, a number of key decision areas suitable for scenario analysis must be identified (stokket et al. 1990). These are, what insights must the research manager have about future business environment to make the decision needed? These key issues were identified and shown in Table 6.3 and later expanded into different questions in Table 6.4.

Based on the key issues identified and shown in Table 6.3, the broad ISLB conceptual model was developed under the heading of the four adopted themes described in section 6.4 and the uncertainties (questions) derived from the fifteen key decision areas (see Table 6.4) and attributes as shown in Figure 6.2. The purpose of the conceptual model is to illustrate and explain key attributes and their relationships in a dynamic way. It can be seen that the ISLB conceptual model is influenced by CAC and Iranian demand for transport, and Iranian supply of transport. Each of these areas will be subjected to scenario analysis. At the operationalisation stage (see chapter 7) these decision areas will be converted into measurable variables to enable testing of the scenario hypotheses.

	Table 6.3 Key ISLB decision areas.
1	CAC and Iran volume of demand for transport
2	Population growth
3	Land enrichment and significant agricultural-based developments
4	Iranian domestic politics and foreign relations
5	CIS, CAC countries and Russia future political environment
6	Iran and CAC countries' economic growth
7	Exchange rate stability
8	Employment
9	Significant changes in Iran's oil and the CAC countries revenues
10	Sectoral changes in human, modes and ports productivity
11	CAC origin-destination travel distances
12	Iran's transport investment
13	Transport capacities, services and competitions
14	Transport technology
15	Institutional elements and developments of ECO

Figure 6.2 The broad structure of the ISLB conceptual model.



6.5.1. ISLB Model uncertainties

There are two distinctive kinds of uncertainty, independent and dependent. According to Porter (1985, p. 455):

> "Independent uncertainties are the scenario variables on which scenarios are based and are an appropriate basis for constructing scenarios because they are true sources of uncertainties. Dependent uncertainties are resolved once assumptions about the independent uncertainties have been made, and thus become part of each scenario."

The occurrence of uncertain events (external variables) is independent from the internal variables of the system (e.g. world oil prices are not likely to be dependent on the ISLB or Iran's actions) while the growth of the economy of Iran as an uncertain future event is dependent on oil prices. The list of uncertainties in Table 6.4 are derived from the key areas and have been identified as the basis for the development of the trend statements of all the ISLB scenarios. These uncertainties are categorised and developed under the four headings of the themes (geographical, political, technical and organisational) to identify clearly the decision and impact areas (Shoemaker 1992, Shoemaker 1995). They are justified in more detail in the following section.

	Table 6.4 Major uncertain questions in the ISLB project.	
	Themes	**Demand uncertainties**
1	**Geographical**	
1.1		Will there be a significant change in CAC demand through ISLB?
1.2		Will there be a significant change in Iran's trade ?
1.3		Will there be a significant change in CAC and Iranian population?
1.4		Will there be land enrichment and significant agricultural-based developments?
2	**Political**	
2.1		Will there be a fundamental positive/negative change in Iran-USA political elations?
2.2		Will there be a fundamental positive/ negative change in the CAC countries foreign political relations?
2.3		Will there be a fundamental positive/negative change in Iran's economic conditions?
2.4		Will there be a fundamental positive/negative change in the CAC economic conditions?
2.5		Will there be significant changes in the domestic politics of Iran and CAC ountries?
2.6		Will there be significant changes in Iranian and CAC employment levels?
2.7		Will there be significant changes in Iran's oil and the CAC countries revenues?
4	**Organisational**	
4.1		Will there be significant changes in sectoral human productivity?
	Themes	**Supply uncertainties**
1	**Geographical**	
1.5		Will there be a significant reduction in the CAC origin-destination distances?
2	**Political**	
2.8		Will there be significant priorities in ISLB transport network investment?
2.9		Will there be significant discounts for the CAC countries in using ISLB services?
3	**Technical**	
3.1		Will there be a significant increase in the transport infrastructure and superstructure capacities?
3.2		Will all rail networks be double tracked?
3.3		Will there be a significant increase in the rail rolling stock?
3.4		Will there be a significant increase in the number of road freight vehicles of Iran?
3.5		Will there be a significant increase in the deployment of new transport technologies in ports, border crossings and other parts of the transport system of Iran?
3.6		Will other landbridges provide significant competition with the ISLB system ?
4	**Organisational**	
4.2		Will there be a significant increase in the operational performance of the transport system of Iran?
4.3		Will there be significant success for ECO transport and economic programmes to integrate the CAC countries with existing member states of the treaty?

6.5.2 CAC and Iranian volume of demand for transport

In Iran and the CAC countries freight transport demand analysis has not been developed as extensively as for passenger transport due to data difficulties. According to Ogden (1992, p. 70):

> "freight demand is a derived demand, the movement of goods being an input in the production and consumption process ... and is expressed in terms of two variables - commodities, and land use".

The CAC countries' demand for freight and their possible choice in using the ISLB service is the main reason for investigating the Iranian landbridge concept. Therefore, this demand, together with Iranian demand should be varied according to changes in different macroeconomic indicators and environments.

According to Kanafani (1983, p. 3):

> "Transportation demand analysis is the process of relating the demand for transportation to the socio-economic activities that generate it. In this process, the type, level, and location of human activities are related to the demand for movement of people and goods between different points in space where these activities take place. The results of this analysis are relationships, often in the form of models, between measures of activity and measures of transport demand".

Kanafani (1983, p. 285) also identified the six following points as important factors for choices in transport demand. They are total quantity, supplies, mode, shipment size, frequency of shipment, and reorder point.

6.5.2.1 Geographical

1. Changes in the CAC countries' demand through ISLB

As with many former Communist bloc countries, the CAC republics aim to diversify their trade with free world market countries to obtain a higher standard of living and technology for better quality products (Michalak 1994). Therefore, they are recovering from the sharp decline in trade in 1992 and 1993 by expanding their exports and imports in 1994, and particularly with neighbouring non-CIS countries. The foreign trade commodity structure of these countries as they pass through a transitional stage appears to be declining to a few classes of exports: raw materials, base metals, chemicals and energy (UNCTAD/UN 1994).

For a long time, Iran and the former Soviet Union as neighbouring countries have had a bilateral transport agreement for the transit of foreign trade goods using the transport modes and ports of each other. Iran rather than the FSU mainly was one of the major users(for both Trans-Siberian Railway and also Volga-Don Canal). The recent demand of the CAC countries for transport through Iran is essentially due to the collapse of the former Soviet Union and the new political and economic region.

Factors affecting the changes of CAC demand through ISLB corridors (question 1.1) are both endogenous and exogenous. The latter are those transport supply influential factors, which generally the CAC countries have options to use or not and also their quality and reliability may stimulate the future CAC demand.

The endogenous factors are mainly national and regional macroeconomic indicators e.g. size and economic dynamism of the CAC countries including political issues; success of the CAC countries will expand the economic structure and consequently increase either imports or exports or both which the ISLB can accommodate partially to the flows of these demand; while failure of these countries in the current political and economic approaches can lead to the decline of the production and consumption or entire collapse of the political system. They are factors related to the ability of each of the CAC countries to perform moderate, stable and growing economic activities, production and consumption functions. Trade from CAC countries through Iran may change over time due to the differences in commodities and goods which, according to Ogden (1992), may vary according to the state (bulk, general, etc.), mass, volume, number of pieces, portability, fragility, hazard, urgency and irregularity of shipments. Each of these attributes can affect ISLB performances in terms of annual tonnage and the utilisation of transport supplies. The impact of the CAC countries' trade on a limited transport infrastructure and services will also affect the quality of ISLB services. Another major area which may have an influence on the demand for ISLB services is the extent of production costs and prices in different industry sectors. Government expenditure in a centralised developing country like Iran may also affect the volume of trade and costs of production.

Iran's foreign and domestic trade (question 1.2) despite sharp variations during the war has followed steady growth since 1988 when war was ended. While domestic production was restricted by production capacities of the firm, intermediate import goods, level of rainfall, natural climates e.g. flood and earthquake, etc. it does not seem to decline and it does grow slowly under normal conditions.

The foreign trade of Iran (question 1.2) can be boosted due to the increase in foreign revenues, foreign investment or the significant improvement of the political issues and relationships of the country with the USA as it can give more and longer term foreign trade credits to Iran.

2. Population growth

Demand is largely determined by the level of population (question 1.3). The economic activities of each of these countries (CAC countries and Iran) is below the future population growth. Both Iran and the CAC countries, for religious reasons and following the liberalisation of tight birth control policies after the collapse of the former USSR in the CAC countries, are among the moderate or high fertility rate countries. Therefore, population may be an important issue in changing the volume of future demand for both Iran and the CAC countries (Sampson and Farris 1979, Lerman, Garcia-Garcia and Wichelns 1996). High population rates, may affect negatively the success of the developmental programmes as domestic production and revenues are limited and usually cannot match the demand. This is particularly important as Iran is in the process of reconstruction after the war and the CAC countries are in transition to market economies.

3. Land enrichment and significant agricultural-based developments

Both Iran and the CAC countries have vast areas for agriculture on which they are largely dependent. Therefore, any development programme such as building dams will result in a higher demand for land and better irrigation through the application resources such as fertiliser or through the use of tractors and agricultural machinery and may cause higher domestic production, imports and in particular agricultural-based exports (question 1.4).

6.5.2.2 Political

1. Iranian domestic politics and foreign relations

Iran is passing through a difficult transitional period after a long war with Iraq and continuing problems in its foreign relations with the USA. According to Tarock (1996, p. 150) the USA is accusing Iran in five areas as:

* its alleged efforts to acquire nuclear and other weapons of mass destruction;

* the threat that, once these offensive capabilities are acquired, could (in fact it is assumed will) be posed to its neighbours, i.e. the Persian Gulf states;

* its alleged engagement in and sponsoring of international terrorism with a view to destabilising the Persian Gulf states friendly to the USA;

* its opposition to the peace agreement between the PLO and Israel;

* its alleged poor record on human rights.

Disagreements with Arab states in the southern Persian Gulf region about three Iranian islands appear unlikely to have serious political repercussions. The more economically stronger Iran the more advantageous and stable will be the Persian Gulf Arab states as they are usually third and fourth trade partners for Iran's foreign trade (EIU 1994b, Amirahmadi 1996).

The future of foreign relations with the USA (question 2.1) will depend largely on the long term interests of both countries. For the USA, Iran has a unique political location and role in the Middle East after the collapse of the USSR and the creation of independent CAC countries to its north (Askari 1994, Tarock 1996). Since the end of the war with Iraq in 1988, Iran has followed some aspects of liberalisation and democratisation in domestic politics, development of the private sector, assurance of foreign investors and stability in the oil and gas industry. All of these developments would affect the future environment of the ISLB (Agazadeh 1996, Amirahmadi 1996). A change in the macro-policies of Iran with an impact on foreign relations may be tackled in the elections in 1997 where there is the likelihood of non-clerical candidates campaigning to become the future president of Iran (EIU 1996). The nature of Iranian domestic and foreign politics can significantly affect both demand and supply for ISLB services.

2. The CAC countries foreign political relations

Changes in power between political parties in the CAC countries (question 2.2) can restrict or stimulate the volume and direction of demand for the ISLB. On a larger scale, changes in the Russian political environment may lead to the restructuring of a new "USSR" with strong border crossing controls and restrictions on trade with or through neighbours. Six of the CAC countries have an Islamic heritage, while two (Georgia and Armenia) are Christian. All of them have different interests with neighbouring countries (and other adjacent Russian autonomous republics) including ethnic, religious and language issues which may, as external factors, destabilise the future of the geoeconomic conditions of the CAC countries as the "Islamic-Christian crescent between Asia and Europe" (Barylski 1994).

3. Changes in economic growth of Iran

The development and improvement of the economic sector in Iran (question 2.3) as a mineral-rich country (in particular oil with 8.8%, and gas with 14.9% of total world output) depend upon imports and foreign revenues (World Energy Yearbook 1996, Agazadeh, 1996 and Rafsanjani, 1996). In Iran real GDP in 1994 rose by 1.8%, while the expected future rise is 2% per annum (EIU 1996, Amirahmadi 1996). Iran's future long term growth depends on the outcome of the privatisation programmes started in 1988. Intermediate domestic-related industries are also significant in international trade. A sharp devaluation of Iran's currency at the end of 1993 and its volatility in 1995 led to the exchange control of the Rial.

Iran's foreign aid and debt repayments are influenced by its political relations with the USA and its opposition to the Arab-Israeli peace process. The USA continues to impose sanctions and pressurises EU members and Japan against aid for macroeconomic development projects in Iran (EIU 1994b). Since 1995 the successful rescheduling of Iran's debts has cleared about $4 bn per year up to 1998. The repayment of the foreign debts was accomplished with allocating about 15%-20% of foreign exchange earnings (EIU 1996, Amirahmadi 1996). However, insufficient and increasing demand for currency has led to frequent devaluation of the Iranian Rial and has produced inflation, which increases the costs of domestic and international services including the transport provided in Iran.

The fixed Rial exchange rate in Iran after the Islamic revolution, and in particular with the beginning of war, has been abolished and gradually multi-exchange rate systems have been adopted (EIU 1993b). The recognition of the single U.S dollar exchange rate of 1993 of about 1600 Rials, and the policy of paying for imports directly with export revenues, led to the setting up of the Foreign Exchange Market Regulation Committee controlling all imports. This, to a great extent, indicates the instability of the Rial and discourages foreign investors or Iranian citizens living abroad from investing (EIU 1994b).

4. Changes in economic growth of the CAC countries

The CAC countries, as part of the former USSR and eastern bloc, have recovered a large amount of aid from international bodies (IMF and World Bank) and aid from individual countries (mainly Germany and USA) in the form of credits and grants. The aims of this aid were to encourage and assist these countries towards a market economy and a democratic political system, and to enable reconstruction and development of their weak macroeconomic position and infrastructure, but progress has been limited (Michalak 1995). Among the CAC countries, the Central Asian Republics are much richer, mainly in gas and oil, but due to various domestic and regional factors their future prospects are uncertain (Gharabaghi 1994, Barylski, 1994).

Since the collapse of the former USSR, all CIS countries including the CAC countries have taken significant measures to leave the Rouble zone and adopt their own national currency. Because of the previously highly integrated economy and inter-republic trade, currency changes affect greatly the volume and value of the foreign trade of these countries (question 2.4) and their balance of payments (UNCTAD/UN 1994).

5. Changes in the domestic politics of Iran and the CAC countries

The economies of both Iran and the CAC countries (question 2.5) depend on the outcome of presidential and parliamentary elections, although there is not a strong parliamentary tradition of political parties. In particular, the CAC republics are new to the experience of democratic systems. Consequently, this implies any change in government or parliament may significantly affect the ISLB operations and development programmes (Starr 1996). Both Iran and the CAC countries have experienced different types of economic and political liberalisation by moving towards privatisation (Esterhuyse 1992). According to Hunter (1994), at the beginning of 1991 about 70% of Iranian industry was owned by government. The new and partial re-privatisation policies of Iran, after the war with Iraq ended in 1988, resulted from pressure to reduce the financial burden of the massive expansion of the government sector after the Islamic revolution in 1979 (Payam Emrooz 1995). The aim of government after the war in 1988 was mainly to free the economy of the strict controls that were imposed on it during the war (Europa World Yearbook 1994a).

The concept and process of privatisation has a long record in the history of Iran with differing levels of success and failure since the constitution in 1906. This has resulted from the poor legal basis and implementation, and also because of contradictions between religious and national beliefs and capitalism (Razaghi 1994). For instance, the new privatisation process after 1988 led to a concentration of power with the bazaar (traditional private marketers in Iran) or with some government-based individuals (Amirahmadi 1995). Following such experiences there is resistance to the privatisation of the major government-owned industries (EIU 1994b).

In the CAC countries, (question 2.4) privatisation at different levels has been taking place since the disintegration of the FSU in 1991; in the Central Asian countries it was minor in the first year (Ledger and Roe 1993, Wright 1994, Rashid, 1994).

Georgia in the Caucasus and four of the Central Asian republics (excluding Turkmenistan) will be served indirectly by ISLB services. This means that any serious local disagreements, especially along transit corridors to other countries, would disrupt ISLB services. The CAC countries may in future have territorial conflicts similar to the war between Azerbaijan and Armenia over Naghorno Karabakh and South Ossetia, and over Abkhazia between Russia and Georgia. This has resulted in a stop to rail transport between Iran and both of these countries as well as Georgia, and a disruption of road and rail inter-republic trade flows. There has been a cease fire since 1994, but fighting due to deep-seated disputes is always a possibility and these countries are along from a permanent settlement (EIU 1994a).

6. Levels of employment in Iran and CAC countries

New investment affects both quantity and quality of employment and brings higher earnings for individuals and nations. The level and changes in employment of a country (question 2.6) may reflect the changes in total physical demand at national and industry sector levels. Employment is also affected by the education of the labour force and better deployed technology. Both Iran and CAC countries are developing nations with extensive future programmes and investment which will create employment. Employment in Iran after 1988 was increased due reopening of some industries. In the CAC countries the employment rates declined due to the structural changes caused by the collapse of the Former USSR and the loss of foreign markets.

7. Future revenues of Iran and the CAC countries

Foreign revenues are key sources for acquiring imports and the new investment of Iran and the CAC countries. Iran and CAC countries (in particular Azerbaijan in the latter) are among some of the world's largest mineral rich countries (oil, gas, gold and uranium) (Starr 1996). The economy and foreign revenues of these countries depend mainly upon the mineral resources of oil and natural gas, and agricultural products (question 2.7). The former is under the influence of world demand, and their supply will be key drivers of demand in these countries. Therefore, while these countries are rich in some mineral resources, they will need high employment and investment for exploitation of raw materials or agricultural products.

6.5.2.3 Organisational

1. Changes in sectoral human productivity

According to Gillen et al. (1985, p. 67):

> "Perhaps the most commonly used measure of the productive performance of firms is output per employee".

Therefore, at national levels the productivity of different economic sectors is considered in the form of people per tonne output or people per unit revenue or cost (question 4.1). One influence over productivity is systematic education and training programmes for people. The relationship of this theory is supported by research (The Economic Review 1995). While general education levels in the CAC countries were better during the time of the FSU, in Iran there are various programmes to systematically reduce and replace unskilled workers through training. With the availability of data, different productivity measures of the above-mentioned types can be prepared and applied to the analysis.

6.5.3 Iranian supply of transport

6.5.3.1 Geographical

1. CAC origin-destination distances

The CAC countries may use different types of modes (i.e. rail or road or both) and ports and border crossings according to their options and availability of the ISLB corridors. Natural barriers like mountains and rivers and also the importance of urban areas as production centres influence the directness of routes. The present Iranian transport infrastructure was designed and constructed to serve Iran and to facilitate a reasonable access for the current 24 provinces. Potential exists, however, for further cuts in travel distance (question 1.5). The geographical distance between each of the

CAC countries and the ISLB landbridge ports greatly affects travel time and consequently the costs of freight transport. Therefore, the present road and rail distances of routes serving CAC countries reflect the level of demand in each of these countries. Consequently, any shortening of the origin-destination distance via the ISLB may stimulate additional freight volume through Iran (Jin 1993). For example, a major reduction in distance is expected to be seen by rail for Central Asian countries between Bafgh and Mashad through the desert. Improvements in time and frequency, and the costs of a freight journey if necessary, in particular for the rail network that when compared with road is less developed. Improvement in ISLB services might be a strong reason for more direct north-south rail links for both Central Asia and Caucasus regions. This can make these services more economical and advantageous compared to other routes. such as the TSR and TCR.

6.5.3. 2 Political

1. ISLB Network transport investment

The transport system of any country has vast areas of investment in the carriage of passengers and freight. Transport investment is long-term and strategic in nature, as well as expensive. In terms of geography, urban and inter-urban contexts are distinguishable. In physical terms, both the above-mentioned categories have their own special network infrastructure including modal and nodal, mobile vehicles and fixed facilities and technologies, and traffic system. Each of the modes and nodes have their own physical elements that signify the capacity performance of that mode or node. Therefore, in the transport sector, like the general economy, investments are possible in four different forms: capital (networks, vehicles, etc.), labour, entrepreneurship (e.g. education and training), and land to improve the quantity and quality of the transport services (Bamford, 1995, The Economic Review, 1995). When transport investment decisions are made, all these four areas, either for freight or passengers, need to be seen as a chain otherwise weak links will negatively affect the expected performance. Among different elements of an inter-urban transport system, network, ports and border crossing investment are long-term and very expensive (question 2.8). Therefore, any future ISLB project needs a strong justification to receive investment funds priorities compared with other national transport, industrial, or agricultural, sectors.

Iran has mainly used its own financial resources for transport investment. In particular after the Islamic revolution, it has used less foreign aid. The annual Central Bank of Iran reports reveal that investment in transport infrastructure and vehicles accounts only for about 5.7% of the total national investment during 1989-1993 (question 2.8). In an earlier period, according to Kaufmann (1962), approximately one-third of public investment was allocated to transport.

After the collapse of the USSR and the new role of Iran as a transit land, UN agencies associated with the Trans-Asian Railway and ECO became involved in Iran's transport infrastructure. Particularly, the opening of the ECO Trade and Development Bank by the three main members is aimed partially at Iranian-based transport projects which can assist Iran in its regional long-term plans (OPEC Bulletin 1996).

The landbridge concept requires Iran to look at its transport system at a more regional rather than a national level (e.g. the 160 km Mashad-Sarakhs rail connection to Central Asia during 1992-1994 was due to the new transport investment priorities, while renewal port projects received the highest resource allocations (PBO 1993)).

2. Governmental discounts for ISLB services

Transport infrastructure including ports, rail tracks and rolling stock are owned, operated and maintained by Iranian governmental organisations. While ISLB services have mainly two private operational costs and fixed government charges and dues, similar to the KEDAM landbridge, the government may offer some generous discounts to all user countries (question 2.9).

6.5.3.3 Technical

1. Future transport infrastructure and superstructure capacities

The capacity determinants of landbridge supply include all physical elements of the modes and interfaces as well as the carrying and handling technologies. An unexpectedly high increase in demand for the ISLB transport system will produce an imbalance and put the existing infrastructure under pressure to meet the demand which may lead to malfunction and high costs. On the other hand, expansion and upgrading of the landbridge supply is time consuming and expensive. Therefore, as the ISLB offers international services, on the one hand, it must have enough short term surplus capacity to be used and prevent excessive demand on the system and a systematic increase in the ISLB physical capacities (question 3.1).

For Iran, road and rail networks have played an important role in the distribution of domestic and foreign trade of the country and, therefore, roads are reasonably wide and well developed with hard asphalt surfaces, while a single track railway connects the capital Tehran to different parts of the country.

According to their aim, various studies have investigated different features in terms of transport capacity. Sheffi et al. (1982, p. 212) noted that:

> "The capacity of a transportation facility is the maximum flow that can go through the facility".

ESCAP (1967, p. 16) defined port capacity as:

> "The capability of the port to handle a determined quantity of cargoes within given periods of time, usually one year."

ESCAP (1967) suggested the following five measures of port capacity:

* Length of berths

* Amount of surface water

* Depth of water

* Shed and storage space

* Equipment

Imakita (1978) considered ports as transit gateways and not end points. Their capacity cannot therefore, be measured separately from other links on land or sea. Imakita considered that factors affecting port operations can be categorised as follows:

* Navigational aids system

* Quay handling and transfer system

* Storage system, and

* Co-ordination with inland transport.

Sinclare (1977) suggested that quay crane capacity, transfer capacity, and storage capacity in cargo handling operations determine the total performance or practical capacity of a port.

Kondratowicz (1992) in a study about modelling seaports and inland freight terminals observed the five following broad classes of variables:

* Terminal resources

* Storage facilities

* Cargoes

* Means of transportation and

* Service systems.

Tongzon (1995) has employed the six following principal quantitative measures of port performance:

* Total throughput

* Number of commercial ship visits

* Vessel size and cargo exchange

* Nature and role of the port

* Port functions and

* Infrastructure provided.

2. Double track rail

The present ISLB rail mode capacity is restricted mainly by the number and capacity of rolling stock as well as by the single rail track. Gradients, signalling systems, the number of stations and daily available trains are also important issues. The rail network of Iran is mainly single track but doubling and renewing the lines has been started since the revolution (question 3.2) although progress is slow . The present double line rail project can effectively increase the annual performance of the ISLB by increasing the speed of trains, reducing costs, increasing the availability of block trains, etc. as long as it is paid for by further investment.

3. Rolling stock

The supply of train services was studied by Ramamohan Rao and Sriaman (1985) and the five following variables were identified as capacity determinants of the rail mode:

* Wagons in use for freight movements

* Wagon loading

* Speed of freight trains in train kilometres per engine hour

* Turnaround time of wagons in days

* Empty wagon movements (percentage of empty wagon kilometres to total kilometres).

Lansdowne (1981) in a study of the rail freight traffic assignment for the Federal Rail Administration (FRA) of USA has employed three types of variables:

* Distance and ownership of each link

* Carrier accessibility to each node

* Origin-destination demand matrix (number of carloads or tonnes of freight between each pair of O/D nodes).

The inadequacy in the number of rolling stock (locomotives and wagons) has played a significant role in the dissatisfaction of the TSR landbridge services despite the fact that the FSU was among one of the main manufacturers of these vehicles. With the present rolling stock and renewing policies the ISLB services seem to be inefficient and requires deployment of the CAC countries and other train-owned operators together with the imports and development of the domestic rolling stock plants (question 3.3).

4. Road freight vehicles

Heavy road freight vehicles are effective in providing the ISLB services required particularly by the three CAC countries close to Iran and are also the most important carrying elements of Iran's foreign and domestic trade. The present fleet is over 15 years of age. Therefore, an effective and comprehensive heavy road freight vehicle renewing system must support ISLB operations and reduce the cost of dervices services (question 3.4).

5. Transport technology

The transport technology of the ISLB covers a range of activities from port installations and equipment to the road and rail fleet and traffic control systems. Changes in transport technology in general, and innovations in handling operations and rolling stock in particular, have taken place extensively during the last three decades after the development of containerisation. The best achievements have been obtained in the developed world by applying these changes to all modes and interfaces. Iran, as a developing nation, has not been successful in keeping pace with the supply of transport technology and in particular for foreign trade demand in the major ports and border crossings (question 3.5). In this context, primarily quay cranes for general cargoes and other effective and efficient electromechanical installations (e.g. for different types of bulk cargoes) train signalling and communication systems, etc. are of significance for increasing present capacities and reducting costs.

6. ISLB competitors

In chapter five it was seen that ISLB has certain advantages under different scenario themes in distance, transit time, ports infrastructure, container facilities, etc.. Both main competitors of the ISLB (TSR and TCR) suffer from long distance rail legs and supply of rolling stock and levels of services but they can offer more co-ordinated and skilled management or politically reduced freight rates (question 3.6). By prioritising the Bafgh-Mashad by-pass rail link the ISLB transit time and costs can be improved greatly against similar competitor services.

6.5.3.4 Organisational

1. Increase in the productivity of transport system

How much the present Iranian labour intensive transport sector is capable of providing efficient national and transit services for CAC countries depends on the future conditions of ownership, managerial styles, the quantity and sophistication of the transport technology and government policies (question 4.2). While the road mode and ports carry most of the domestic and foreign trade of the country, rail has the most poorly educated workforce. The quantity and quality of ISLB services can be promoted by systematic investment in the education and training of labour and management at all levels of sector (Wollf 1981, The Economic Review 1995).

2. Role of the Economic Co-operation Organisation

The Economic Co-operation Organisation (ECO) as a regional and international body since the collapse of the FSU in 1991, has played a significant role in the promotion of regional affairs, and in particular for new member states and observers of the CAC countries as well as Afghanistan. The functional system of the ECO is based on the three early members and Iran is the centre for transport matters. It works to establish a common ECO transport policy for the 10 present member state, but due to the physical and regulatory differences between the three main members and the CAC countries there is massive work to be done. Iran has been keen in promoting the ECO in general, and in particular in transport, by providing funds and other physical aids like a cargo ship for the shipping division of the organisation (question 3.6).

6.5.4 Outputs

The output of the ISLB conceptual model is the Iranian transport supply in the form of annual tonnage (and also, where available, costs and prices for users).

6.6 Conclusions

This chapter started by considering planning under uncertainty. Then as a means for gaining more insight, the scenario approach was reviewed in detail. It appears to be a suitable analytical technique for the further analysis of the ISLB. Certain themes as an initial part of a scenario study were developed, and essential key areas for future ISLB decision making were identified, examined and justified.

The ISLB conceptual model was then investigated under the four basic geographical, political, technical and organisational themes. The scenario characteristics, themes and key decision features now will be developed into an operational model capable of being analysed.

7. Operationalisation of the Iranian Sea-landbridge model

7.1 Introduction

The conceptual model needs to be converted into a working model for the later stages of the work. Therefore, it is necessary to specify and define all the variables required for further phases of the study, the broad variables which were conceptualised and developed in previous chapters. The operationalisation determines the final step in preparing, processing and splitting up data (Madison 1980, Smith 1991, Neuman 1994).

The Iranian Sea-landbridge (ISLB) scenario modelling and analysis will consider the following four main headings separately (based on Mercer 1995a):

* ISLB study characteristics
* Time period and level of aggregation
* Description of ISLB methodology, data collection and sources
* Selection and identification of ISLB scenario variables.

7.2 ISLB study characteristics

7.2.1 Time period and level of aggregation

The modern concept of the ISLB both in theory and practice is very new and was only initiated after the collapse of the former USSR. It is intended to cover the study as a long term policy project up to the year 2005 and, based on 1979-1993 data, it will be considered as a longitudinal time series scenario study (Babbie 1995, Neuman 1994).

The future time frame of a research study depends upon its objectives. Long term projects commonly fall within 5 to 20 years, but it was decided to limit the time frame of the ISLB between 1994 and 2005 and allow reasonable application of the scenario technique (Porter et al. 1991). The research period must also be taken into account (end of 1993 to the beginning of 1997).

The study is based on the use of data for Iran during 1979-1993 and the most recent available data for CAC countries before and after their independence (1985-1993). While it would have been desirable to have had data from a longer period for estimating the models, the data for earlier years were either not available or too incomplete to include in the ISLB models. Consideration of the time period in the study of scenario developments and forecasting is fundamental, and it is planned to construct the base year scenario with forecasts into the future as a "single-period model" instead of breaking the horizon into fractions (multiperiod) (Mitchell et al 1979).

According to Kanfanani (1983, p. 90):

> "The purpose for which demand analysis is performed determines the level of detail to which it needs to be carried out".

Goods traffic modelling can be analysed at different levels. Some models analyse certain links while others apply to a region or country with microeconomic and macroeconomic natures having disaggregate or aggregate levels of detail (Quinet, Reynaud, and Marche 1983). The level of detail selected for the ISLB model is aggregate for several reasons. They are the lack of relevant studies about Iran and CAC countries; the long time period of the study; application at national and international levels; and broad geographical dimensions of the study (Cole and Chichilnisky 1978).

The ISLB is both a qualitative and quantitative study. The qualitative nature of the model will help to understand and develop different aspects and impacts of the landbridge on the transport system of Iran, while the quantitative model attempts to provide greater integration and internal consistency.

7.2.2 Data measurement and level of accuracy

Data, according to its nature, can be measured by different scales or units (Neuman 1994). According to Wilson et al. (1979):

> "Measurement is a procedure for classifying individuals, groups or other units and putting them into previously defined categories".

Demand for transport or the performance of a transport mode can be measured through various indicators in terms of time, value, volume (tonnage), distance, cost or a combination of some of these units. e.g. tonne/km. (Hicks 1977). According to Quinet et al. (1983, p. 141):

> "As far as transport operators are concerned, the quantity of freight is naturally measured by weight, or more exactly mass, in tonnes, quintals or kilograms, but this measurement varies considerably according to what is involved: net or gross weight; actual or chargeable tonnage".

The trade passing through ISLB corridors is considered to be the dependent variable of the study and a function of capacities and services in the transport network of Iran. The metric volume of trade is the main unit which is commonly used to determine the infrastructure and superstructure of transport networks and interfaces. Therefore, the unit of measurement of demand is the total metric tonnes handled and transported annually. Different explanatory factors using different units of measurements (mainly costs) are the independent variables of the ISLB demand.

Consequently, the output of the ISLB demand model uses the following two indicators:

* Freight demand in tonnes by mode and interfaces
* Freight transport supply in terms of infrastructure - capacities and frequency.

A regression technique is selected for the quantitative analysis of the ISLB study. To develop the operational definitions for ISLB variables they were listed and classified under the geographical, political, technical and organisational themes. Their numerical values can be seen in Appendix 2.

7.3 Description of ISLB methodology and data sources

7.3.1 Data sources

Some of the data was collected before the beginning of the study but most of it was received during the research period through direct correspondence with different administrative departments in Iran. Existing research on the operational aspects of transport in Iran is poor. Published data mainly comprises the annual performance reports of the different ministries and governmental organisations. Some organisations like the Central Bank of Iran, the Statistical Centre of Iran, and the Programming and Budgeting Organisation were more forthcoming with data than others.

The nature of the research means that the ISLB study is heavily reliant on recorded data included in the publications of international organisations such as the United Nations, the World Bank, and the various Iranian agencies. The newly independent CAC countries, formerly part of a centralised Communist administration, had the most limited data (Fischer, Sahay and Vegh 1996). There were also some limitations in the data available from Iran. Sources for the data collection can be seen in Table 7.1 .

7.4 Selection of variables

This section is concerned with the determination of the variables for the ISLB models and multiple regression analysis carried out in the next chapter. The identification of the key quantitative variables due to the subjective nature of the scenario-generation technique is of significant importance (Schofer and Stopher 1979).

7.4.1 The dependent variables

For the purpose of this research the demand for transport in Iran is based on three broad categories:

* General cargo and oil products (foreign trade)

* Domestic trade

* CAC foreign trade

7.4.1.1 General cargo and oil products (foreign trade)

Iran is a semi-market-economy with a high degree of government control over foreign trade. The economy of Iran combines traditional economic values based on culture and religion with a blend of both capitalist and socialist economies. Economic health, including, therefore, foreign trade, is largely dependent on a relatively high population, a vast land area and crude oil revenues.

The total volume of Iranian general cargo and oil products is a major flow through ports and across borders as shown in Table 7.2 (see also section 2.3.4.6). The methodology used to calculate the annual tonnage of the general cargo and oil products of the foreign trade of Iran for the period of 1979-1993 is shown in Table 7.2. The export of oil is a completely separate issue, not directly relevant to this study, since it differs in the type of production management, the nature of the transport (domestic consumption, production and the exporting is carried out completely by pipeline) and the export terminals.

The volume of Iranian general cargo and oil products is shown in Figure 7.1 as a function of time. It indicates sharp reductions in the volume of trade at three different times. The first drop was due to the Islamic revolution in the period 1979-1980, which was followed by a recovery with the start of the war in the middle of 1981. This growth continued up to 1983 when oil prices fell significantly causing the second downturn in this trade. Because of the war, this situation continued until the end of the war in 1988. After the war, reconstruction resulted in continuous growth except for a minor decline in 1992.

Table 7.1 Data sources of the ISLB study.

	Data item	Sources
1	Value of macroeconomic indicators, at fixed prices 1982	Central Bank (Bank Markazi) of the Islamic Republic of Iran (IRI), various years between 1974-1993, "National Accounts of Iran".
2	Raw data related to Iranian ports at national and regional levels as well as volumes of the oil product foreign trade through ports	Ports and Shipping Organisation of IRI (PSO): various annual and intermittent performance reports between 1988-1993.
3	Rail transport data on networks, rolling stock and operations	Islamic Republic of Iran Railway Company (IRIRC) official publications: 1. IRIRC (1984-1993), "Performance Report of the IRIRC for 1984-1990". 2. IRIRC (1986-1990), "Facts & Figures of the IRIRC for 1986-1990".
4	Macroeconomic indicators, ports and rail transport, foreign trade, directions, tonnage and types, and domestic sector productions, road networks, and shipping fleet and performance, Road passenger and freight fleet	1. Three Statistical Centre of Iran (SCI) publications: Iran Statistical Yearbooks for 1981, 1992 and 1993. 2. Seven occasional Persian and English reports: "A Statistical reflection of the Islamic republic of Iran", between 1982-1994, for Bahman (February) 1360, and No. 6, 7, 8, 9, 10, and 12.
5	Detail of Iranian general cargo trade, tonnage and cross borders and foreign destinations	Islamic Republic of Iran Customs Administration for 1990 and 1992
6	Distance of Iranian Roads	1. Road distances of the country published in April 1983 by the Statistical and Mechanical Services of the Ministry of Roads and Transport (MRT). 2. Different Persian and English road atlases and maps of Iran: 2.1. Two maps of the I.R. of Iran, Gita Shenasi No. 165 , published in 1989 in Tehran 2.2. Auto Atlas Iran, Gita Shenasi, 213, Tehran. 2.3. World Map: Iran Published in Germany in 1994, GeoCentre, RV Reise- und Verkehrsverlag, Berlin 1993/94.
7	Landbridge road and rail in the CAC countries, Turkey, Afghanistan, Pakistan and India.	1. Map of the former USSR, Verlagsgesellschaft mbH, Frankfurt/Main, Germany. 2. Junior Atlas, (1995) Whitsmith, John Bartholomew & Son Ltd, Edinburgh. 3. Map of Turkey, SABAH: "Turkiye'nin en iyi gazetesi",

Table 7.1 continued.

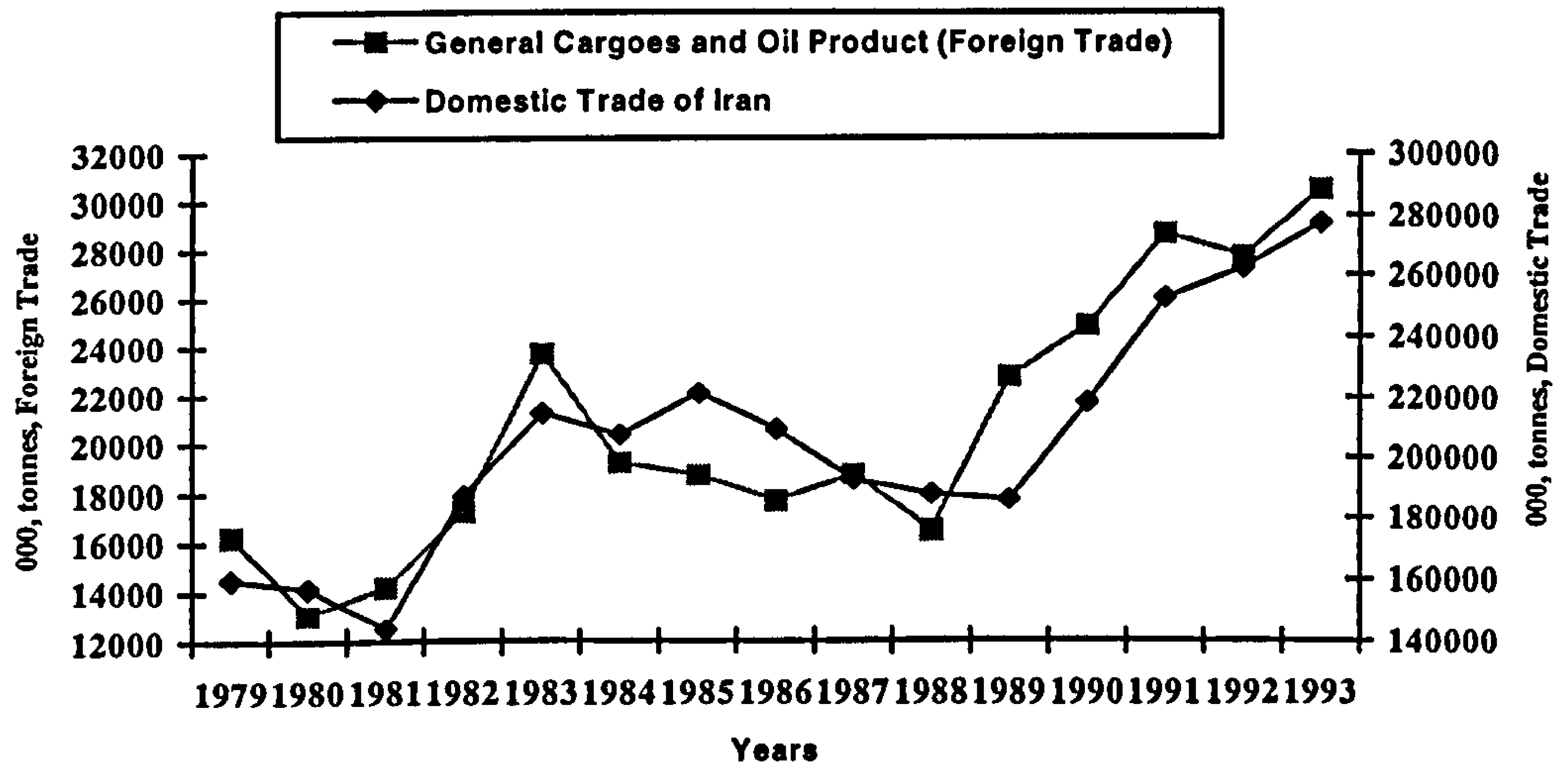
		4. "Thomas Cook Overseas and the European Timetables: Railway and Shipping services throughout Europe, May-June 1995 5. Noble, J. and King, J. (1991), "USSR: a Travel Survival Kit", Lonely Planet Publications, Australia. 6. Stretfeild-James, D (1993), "Silk Route Rail", Trailblazer Publications, Surrey, UK. 7. Strauss, R. (1993), "The Trans-Siberian Rail Guide", Compass Publication, USA
8	Landbridge sea leg distances	1. Caney and Reynolds (1981), "Reed's Marine Distance Tables", Thomas Reed Publications Limited, London 2. Beresford and Dobson (1987), "Lloyd's Maritime Atlas of Ports and Shipping Places", 17th ed. (1993), Lloyd's of London Press Limited. 3. Gavan (1987), "The Ships Atlas 1987", shipping Guides Ltd, Surrey, England.
9	Maps of different Landbridges, Iran and CAC countries	1. CD ROM: World Atlas and U.S Atlas, The Software Tool Works Inc. 1991-1993
10	1. CAC trade values and directions of trade 2. Iran domestic trade volumes	1. E.I.U (The Economist Intelligent Unit),(1994), "Country Report, 4th quarter for CAC countries 2. E.I.U, (1993), "Country Report", 4th quarter for CAC countries 3. E.I.U, (1992), Country Profile, for CAC countries 4. The Europa World Year Book 1994 and 1995 , volumes I & II. 5. Michalopoulos (1993), "Trade Issues in the New Independent States", A World Bank Study. 6. U.N, (1985), "Industrial Statistics Yearbook 1982: Commodity Production Statistics 1973-1982", Vol. II. 7. U.N, (1993), "Industrial Statistics Yearbook 1991: Commodity Production Statistics 1983-1991". Vol. II. 8. UN (1992), " Statistical Yearbook 1989/89". 9. UN (1993a), " Statistical Yearbook 1990/91". 10 UN (1995), " Statistical Yearbook 1993". 11. International Trade Statistics Yearbook (1987), U.N 12. Handbook of International Trade and Development Statistics (1992), UNCTAD. 13. Economic Bulletin for Europe (1994), Economic Commission for Europe, volume 46, U.N.
11	CAC volume and values of trade with Iran	Ministry of Economic and Finance (1993), "Assessment of the Economic Co-operation of the Islamic Republic of Iran with CIS countries in 1992", A Publication of Public Relations of the Export Promotion Centre of Iran. Tehran, Safir Publications.

Table 7.2 Loading and unloading operations (general cargo, bulk trade and oil products) in major Iranian ports (000 tonnes).

	Total Iran					Ports								
	Border crossings (2-14)	Total general cargo, bulk and oil products (5+13)	Import general cargo and bulk (non-oil)	Export general cargo and bulk (non-oil)	Total non general cargo and bulk (3+4)	Unloaded			Loaded				Total oil products trade (6+9)	Total ports (13+10)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						Oil products	Imports	Total unload	Oil products	Total non oil (7+11)	Non-oil	Total loaded		
1979	4621	16247	12996	1138	14134	2113	8773	10776	-	9623	850	850	2113	11736
1980	2577	13027	12438	579	13017	10	10012	10022	-	10450	438	438	10	10460
1981	2809	14166	13952	154	14106	60	11128	11227	-	11297	169	169	60	11357
1982	5013	17289	15003	162	15165	2124	10037	12161	-	10152	115	115	2124	12276
1983	6666	23756	21219	224	21443	2313	14777	17090	-	14966	189	189	2313	17090
1984	6396	19250	17322	264	17586	1664	10970	12634	-	11191	221	221	1664	12855
1985	5616	18723	16100	654	16754	1969	10691	12660	-	11138	447	447	1969	13107
1986	5501	18656	12540	1133	14669	3987	8630	12617	-	9168	538	538	3987	13155
1987	2145	18747	13536	1224	14760	4363	11160	15523	-	12239	1079	1079	4363	16602
1988	2794	16489	10742	1455	12197	4222	8225	12447	70	9403	1178	1248	4292	13695
1989	6509	22850	19241	1241	20482	2255	12764	16277	113	13968	1204	1317	2368	16341
1990	6239	24956	19542	2865	22407	2345	15034	19303	204	16168	1134	1338	2549	18717
1991	6944	28700	23044	2395	25439	3000	16378	19378	261	18495	2117	2378	3261	21756
1992	2626	27773	19091	3351	22442	5014	16734	21748	317	19816	3082	3399	5331	25147
1993	2980	30555	18069	5137	23206	6923	15728	22651	426	20226	4498	4924	7349	27575
Total							181041	226514			17259	18650		

Source: PSO(1993), annual report, p. 36 for 1984-1993, First developmental economic, social, and cultural programme of country, sub-sector marine transportation, 1989-1993. p. 5. Various Statistical Reflections of the Islamic Republic of Iran No. 9, p. 140, No. 10, p. 158, and SCI, (1982), A Statistical Reflection of the Islamic Republic of Iran for the Third Anniversary of the Islamic Revolution, Bahman 1360, p. 80.

Figure 7.1 The volume of general cargo and oil products (foreign trade) for Iran



Source: Various PSO, SCI and Iranian Customs Administration for the period of 1979-1993.

7.4.1.2 Domestic trade of Iran

In order to forecast the future volume of the domestic trade of Iran, attempts were made to collect and group all available important commodity data. Although the ISLB project is a study at the level of national planning, it is developed for the domestic trade of Iran in a bottom-up manner. The total statistical composition of the domestic trade of Iran includes 112 commodities and goods. All detailed and available data from 1979 to 1993 about cargoes, commodities and products were collected and then sorted into seven major classes as shown in Table 7.3.

The main differences between these classifications is the different handling, transport and packaging requirements. The volume of total domestic production, as well as the total volume and shares of these seven categories of Iranian domestic trade, are presented in tonnes in Figures 7.1, 7.2 and 7.3 and in Table 7.4.

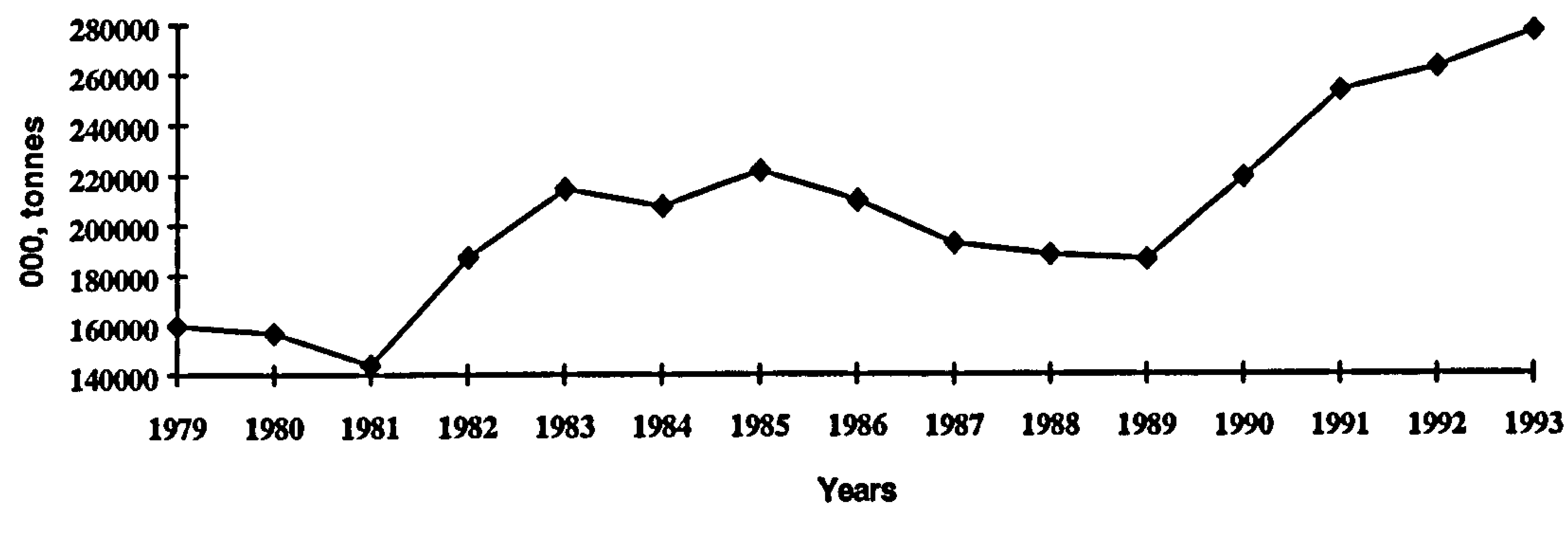
Table 7.3 The seven broad categories of products of Iranian domestic trade.

1	2	3	4	5	6	7
Agricultural crops and products	**Minerals**	**Light industry products**	**Heavy industry products**	**Reefer**	**Food products**	**Oil products**
Wheat	Coal	Cotton	Copper products	Red meat	Sugar	Liquid gas
Barely	Copper	Fabrics	Aluminium products	Sausages	Food oil	Petrol
Lentils	Iron-ore	Leather	Steel products	Milk	Flour	Kerosene
Rice (paddy)	Lead zinc	Napkins	Agricultural machinery	Cheese	Vaifers	Gas oil
Fodder crops	Chromium	Towel	Industrial machinery & appliances	Butter	Processed caned & seafood	Furnance oil
Potato	Manganese	Blanket	Road construction vehicles	Chicken	Dry tea	Motor oil
Onion	Decorative stones	Carpet	Heavy cargo, passenger & service vehicles	Eggs	Fish meal	Bitumen
Fruit	Construction stones	Cloth knitters	Cars & vans	Diary	Beverages	Others
Peanuts	Lime stones	Shoes		Honey	Cigarettes	
Maize	Gravel & sand	Jute		Fish		
Sugar beet & cane	Gypsum	Paint				

Table 7.3 Continued.

1	2	3
Cotton seed	Bentonite & fuller earth	Water & electric metres
Tobacco (green)	Magnesit & whiting	Soap & detergents
Tea (leaf)	Dolomite	Tyre
Log	Silica & quartzite	Plastic
Timber	Feldspar	Plastic pipes
Rail-sleepers	Barytes	Fibber glass
Round wood	Flourspar	Glass
Mine timber & beam	Sulphur	Bricks
Fuel wood	Salt	Cement
Charcoal	Slag	Plaster quick lime
	Talcum	Plywood
	Kaolin	Paper
	Shell	Cardboard
		Stationary
		Wall paper
		House hold furniture
		Batteries
		Lamps
		Gas cylinder
		Cables
		Fertiliser

Figure 7.2 Scattergram of the actual volume of the domestic production of Iran.



Sources: Various SCI annual and occasional (Statistical Reflection of Iran) reports for 1979-1993. U.N Statistical Yearbook 1993, International Trade Statistics Yearbook, and UNCTAD (1993a) Handbook of International Trade and Development Statistics for 1992, various pages.

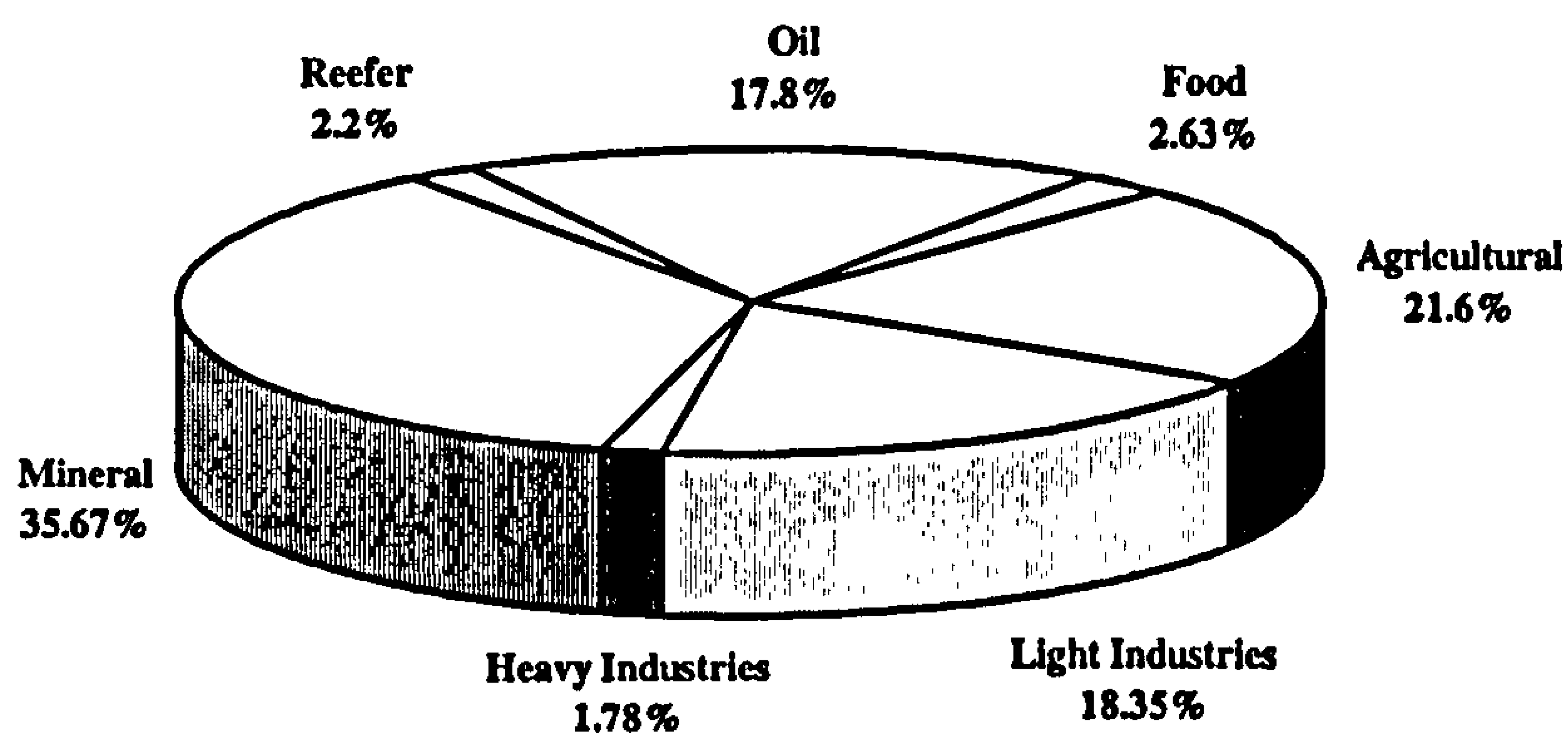
Unlike general cargo and oil products (foreign trade), the domestic trade of Iran has two significant points in 1981 and 1989; it gradually declined from 1979 until 1981 and again from 1985, a critical year in the war with Iraq, until the end of the war in 1988. The fluctuation in the forms of Iranian production, caused by revolution or war, has meant that the importance of some sectors, the volume and the type of road and rail vehicles utilised, has varied especially in terms of required capacities. The contributions of the seven product classes to the total domestic trade of Iran is shown in Table 7.4. The average share in domestic production of each of the seven production categories can be seen in Figure 7.3.

Table 7.4 Volume of seven groups of domestic production and trade of Iran (million tonnes).

Year	Volume of agricultural production	Light industries	Heavy industries	Minerals	Reefer	Food production	Oil products	Iran's total domestic production
	1	2	3	4	5	6	7	
1979	34.64	28.11	3.65	59.56	2.85	4.78	26.14	159.71
1980	34.02	29.88	2.04	56.72	2.89	4.85	26.27	156.66
1981	29.03	35.03	1.78	46.45	3.00	4.24	24.38	143.91
1982	39.14	40.85	2.47	64.37	3.85	7.85	28.52	187.05
1983	48.81	49.16	2.89	71.99	3.98	5.12	32.55	214.48
1984	38.26	46.50	3.16	74.91	4.05	5.56	34.98	207.42
1985	42.17	50.49	3.73	77.86	4.18	5.72	36.90	221.04
1986	47.07	47.67	2.28	69.07	4.37	5.45	33.39	209.30
1987	48.06	27.73	2.43	71.43	4.39	4.68	33.51	192.22
1988	44.02	27.15	2.60	71.00	4.61	4.51	33.75	187.63
1989	40.84	29.09	2.83	63.25	4.53	4.10	41.01	185.74
1990	52.22	34.40	4.47	73.45	5.95	5.14	42.31	217.94
1991	51.41	38.08	6.19	96.17	6.32	5.87	48.55	252.59
1992	56.10	38.59	6.43	101.59	5.98	6.38	47.33	262.40
1993	57.88	41.61	7.82	99.13	6.75	6.70	57.34	277.22
Total	66.36	564.32	54.75	1096.95	67.68	80.96	547.01	3075.31
%	21.58	18.35	1.78	35.67	2.20	2.63	17.79	100

Sources: Various SCI annual and intermittent (Statistical Reflection of Iran) reports for 1979-1993. U.N (1995), Statistical Yearbook 1993, International Trade Statistics Yearbook, and UNCTAD (1993a) Handbook of International Trade and Development Statistics for 1992, various pages.

Figure 7.3 Share of different sectors in the volume of the domestic production of Iran.



Source: Various SCI annual and occasional (Statistical Reflection of Iran) reports for 1979-1993. U.N Statistical Yearbook 1993, International Trade Statistics Yearbook, and UNCTAD (1993a) Handbook of International Trade and Development Statistics for 1992, various pages.

7.4.1.3 Central Asian and Caucasus foreign trade

The statistics of the former republics of the USSR on trade are compiled "as a whole" since, a long and continuous series of detailed data is not available. There are some relevant data after 1985 for different republics, but they differ in structure and continuity. This paucity of data is because of the nature of the former structure of the USSR system, and also because of the "absence of customs borders between Russia and other former Soviet republics." (UNCTAD/UN 1994, p. 69). Due to the limited published data the dependent variable for the trade of the CAC countries through Iran is as the volume aggregate tonnage of each of the CAC countries' trade with Iran (Fischer et al. 1996) . The annual value of trade with Iran for each of the CAC countries was converted into volume (Leontief 1979) by using the value and volume of trade with Iran in 1992 and 1993 as the basis.

The methodology used to compute the volume of trade of the CAC countries is summarised as:

1. The conversion of all CAC foreign trade values (excluding inter-republic trade) from Roubles to US $ where necessary.

2. Applying a share (%) of the Asian foreign trade of each of the CAC countries for import and export separately to the total international trade (mainly on the basis of available CAC direction of trade data for 1990) to acquire the probable inflow and outflow trade of the CAC countries through the ISLB.

3. Summing the latest available figures for Iran's foreign trade volume and value with each of the CAC countries, and categorising this total volume and value to different product groups. The shares which result are used as the basis for determining the cargo types of all CAC trade with the rest of the world.

4. Data for the whole period 1987-1997 for each CAC country is generated from using the product type categorisation obtained in step 3 for Iran (for the latest observed years 1992 and 1993). The ratio between total volume and total value is assumed to persist through time, as

the split of total volume and value into product categorisation and, thereby data (by product categorisation) is derived for the period 1987-1993.

5. Extrapolation between each available value and volume of Iran's trade with each of the CAC countries and the value of the proportional foreign trade of each of these countries to obtain import and export tonnage for each year as total Asian international trade.

It is assumed that the future international trade of the CAC countries will have the same composition as the trade with Iran in 1992 and 1993. The composition of the trade with Iran varies between 4 and 46 commodities and products, all of which are transported by road and rail only. Therefore, it will be assumed that the future potential for CAC trade with other countries within the range of the ISLB services are the same as those during 1992 and 1993 with Iran. The result of these computations are shown in Table 7.5 and Appendix 2.

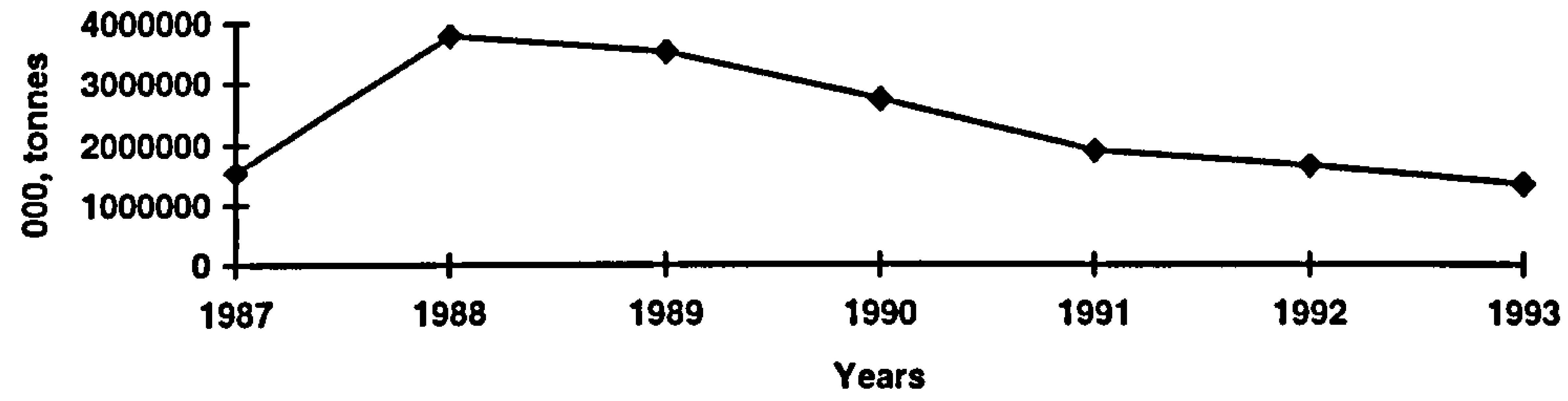
Table 7.5 Description of the converted volume of international trade of the CAC countries for Asia (000 tonnes).

	1987	1988	1989	1990	1991	1992	1993	Total (%)
Azerbaijan	272	292	293	299	169	112	61	1499 (8.1)
Armenia	116	134	168	184	78	12	10	701 (3.8)
Georgia	26	26	33	29	29	29	29	202 (1.1)
Gyrkyzstan	118	133	145	124	70	8	40	637 (3.4)
Kazakhstan	891	931	966	965	668	819	592	5831 (31.5)
Tadjikistan	68	85	103	117	43	7	42	465 (2.5)
Turkmenistan	72	112	143	139	48	157	150	820 (4.4)
Uzbekistan	2066	2066	1658	870	791	502	426	8378 (45.2)
Total CAC	3629	3779	3508	2726	1895	1646	1350	18532 (100)

Sources: Same as Figure 7.4.

Figure 7.4 shows the trend of the CAC countries' Asian foreign trade volume with a sharp increase during 1987-1988 and a gradual decline with the beginning of political democracy and unrest in 1989.

Figure 7.4 Total volume of the CAC Asian Foreign Trade.



Sources: based on and converted from:
1. Trade values for 1992 and 1993 in: Michalopoulos (1993), Trade Issues in the New Independent States, p. 26, The World Bank, Washington.
2. UNCTAD (1993a), Handbook of International Trade and Development Statistics, p. 565
3. UNCTAD/U.N (1994), Economic Bulletin for Europe, p. 85.

The converted trade statistics of the CAC countries as shown in Table 7.5 has some deficiencies; for Georgia, data for 1988 was assumed for 1987, and data for 1990 assumed for 1991, 1992 and 1993. The data of Georgia for 1990 seems to be unreliable and very inconsistent with previous years and also with other republics; while for Uzbekistan only, the data of 1987 was applied for the year 1988.

7.4.2 Selection of independent variables

A number of suitable independent variables were tested during different runs of the estimation procedures (see section 8.3) for the three sub-models of general cargo and oil products (foreign trade) of Iran (GOPFT), domestic trade of Iran (DOMTI), and CAC countries foreign trade (CACFT) (Sun and Bunamo 1973). The choice of independent variables relates directly to questions raised by the study. Miller and Wichen (1977, p. 291-292) according to Cox and Snell (1974) accounted for the following four factors influencing the nature and number of independent variables:

1. Is the study intended to examine a rather specific hypothesis about the phenomenon under investigation, or is the study simply concerned with screening out important variables from a large number of potential variables, the important variables to be investigated in a subsequent experiment?

2. Can the response (dependent) variables be observed quickly, so that later parts of the study can be modified, if necessary, in view of the earlier results?

3. The time available, the ease with which the measurements can be made, the availability of good official statistics, the amount of money appropriated for the study, and so forth are often crucial in deciding how many variables can be measured.

4. Will the study be used to establish comparisons with earlier, related studies?

They are described later in terms of their strengths and weaknesses under each of the four themes: geographical, political, technical, and organisational (see Appendices 4, 8 and 13 for the coefficient of correlation between independent variables and three dependent variables of GOPFT, DOMTI and CACFT respectively).

Based on the literature review, twenty variables were chosen as possible explanatory variables for the GOPFT, 25 for DOMTI, and one for CACFT. These are listed and classified under the four themes in Table 7.6.

7.4.2.1 Geographical characteristics

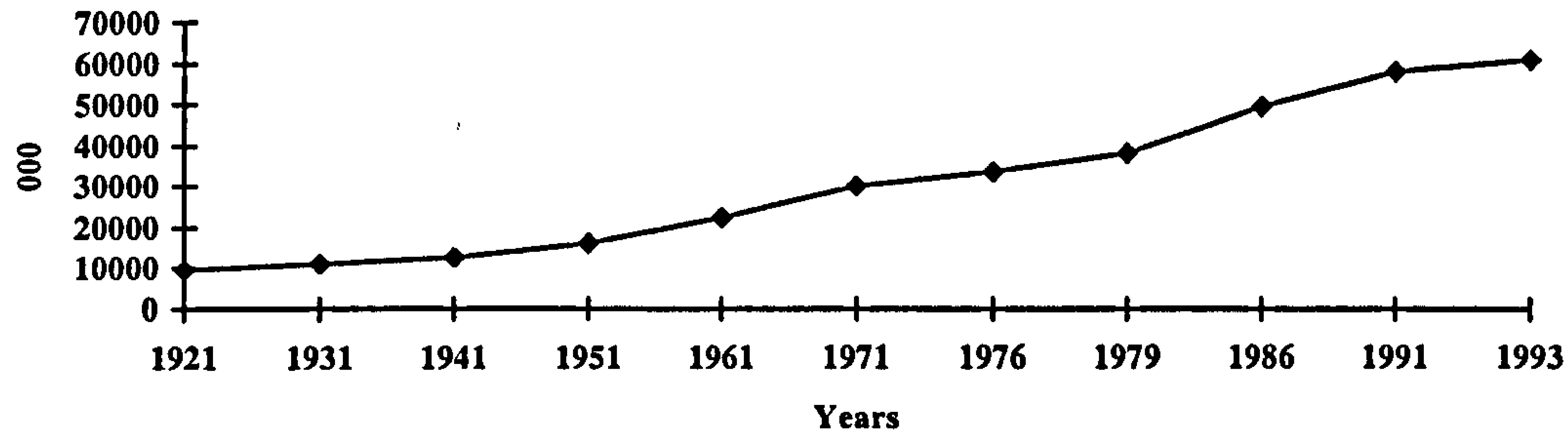
1. Population

Population is an important indicator in most econometric modelling and in particular in long range planning and analysis as its uncontrolled growth concerns consumer demand and unemployment that are major political issues (Amirahmadi 1996). It has had a rapid growth (see Figure 7.5) with an increase of about 22 million during only 12 years. Its general effects on both GOPFT and DOMTI during 1979-1993 was an approximate doubling of demand. In the latter, it can be more influential as the result of the direct involvement of people in the production and consumption process. The GOPFT is more concerned, however, with capital and intermediate goods.

Table 7.6 Description of the selected variables for the scenario analysis of GOPFT, DOMTI and CACFT.

	ISLB Scenario theme / Dependent variables	Description of variable	Variable name	Units
		General Cargo and Oil Products Foreign Trade of Iran (GOPFT)	Y_{GOPFT}	000 tonnes
		Domestic Trade of Iran (DOMTI)	Y_{DOMTI}	000 tonnes
		CAC countries Foreign Trade (CACFT)	Y_{CACFT}	000 tonnes
	Independent variables	**Description of variable**		**Units & areas of demand**
1	**Geographical**			
		Population	X_{20}	million people GOPFT, DOMTI
		Land under cultivation	X_6	000 hectare, DOMTI
		Fertiliser used in agricultural	X_8	000 tonnes, DOMTI
2	**Political**	**Description of variable**	**Variable name**	**Units & areas of demand**
		GDP per Capita	X_1	000 Rials at 1982 fixed prices GOPFT & DOMTI
		GDP per Capita	X_1	million, US $ CACFT
		$ /Rials exchange rate	X_2	Rials GOPFT & DOMTI
		Crude oil revenues	X_3	million $ GOPFT & DOMTI
		Value added of all major industries	X_4	million Rials, GOPFT & DOMTI
		Fixed gross national investment	X_5	million Rials, GOPFT & DOMTI
		Foreign trade goods value	X_6	million Rials, GOPFT& DOMTI
		Employment	X_7	000 GOPFT & DOMTI
		Final GDP	X_{14}	million Rials, GOPFT & DOMTI
		Government expenditure	X_{17}	million Rials, GOPFT & DOMTI
		Value of intermediate goods (total input)	X_{18}	million Rials, GOPFT
3	**Technical**	**Description of variable**	**Variable name**	**Units & areas of demand**
		Number of locomotives	X_8	GOPFT
		Value added of agricultural	X_9	million Rials, DOMTI
		Number of wagons	X_9	GOPFT
		Fixed gross investment in agricultural	X_{10}	million Rials, DOMTI
		Number of heavy goods vehicles	X_{10}	GOPFT
		Investment in agricultural machinery	X_{11}	million Rials, DOMTI
		Value added of light industries	X_{12}	million Rials, DOMTI
		Value added of transport sector	X_{13}	million Rials, GOPFT & DOMTI
		Value added of basic metals, machinery & non-metal industries	X_{15}	million Rials, DOMTI
		Value added of food industries	X_{16}	million Rials, DOMTI
		Investment in oil & gas machinery	X_{18}	million Rials, DOMTI
		Transport investment	X_{19}	million Rials, GOPFT & DOMTI
		Value added of oil sector	X_{21}	million Rials, DOMTI
		Value added of crude oil sector	X_{22}	million Rials, DOMTI
4	**Organisational**	**Description of variable**	**Variable name**	**Units & areas of demand**
		Ships service days in berths	X_{11}	Ship service day/annual, GOPFT
		Berths productivity of non crude oil foreign trade of Iran	X_{12}	Tonnes/berth, GOPFT
		Ports/employee productivity	X_{15}	Tonnes/employee, GOPFT
		Rail/employee productivity	X_{16}	Tonnes /employee, GOPFT
		Productivity of agricultural sector/ employee	X_{23}	Tonnes/employee, DOMTI
		Productivity of industry, mine, and food sector/employee	X_{24}	Tonnes/employee, DOMTI
		Productivity of oil sector/employee	X_{25}	Tonnes/employee, DOMTI

Figure 7.5 Growth of the population of Iran.

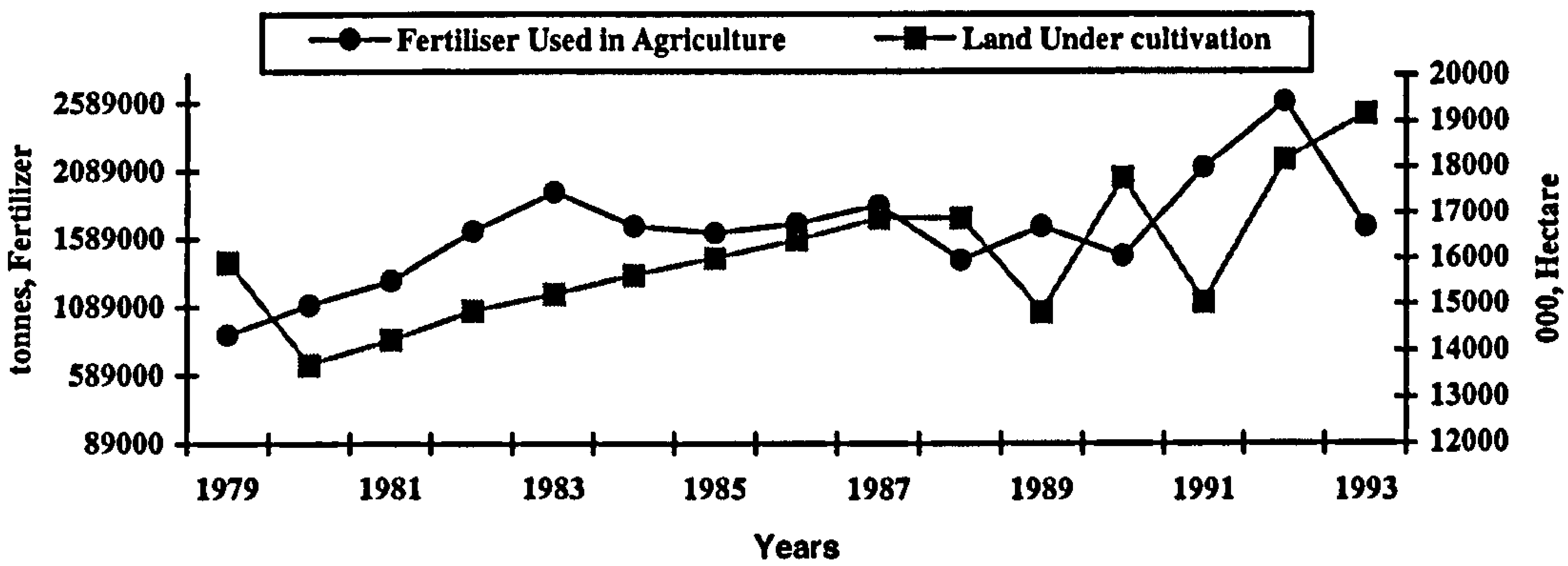


Source: SCI (1982), A Statistical Reflection of the Islamic Republic of Iran for the Third Anniversary of the Islamic Revolution, Bahman 1360, p. 6; Central Bank of Iran, for 1991, 1992, 1993, 1994a, and 1994b. various national accounts.

2. Land under cultivation

Its growth (see Figure 7.6) is slow since it depends on national development programmes supervised by the Ministries of Agriculture, Jahad Sazandagi, and Power.

Figure 7.6 Land under cultivation and fertilizer used in Iran.



Sources: SCI (1982), A Statistical Reflection of the Islamic Republic of Iran for the Third Anniversary of the Islamic Revolution, Bahman 1360, p.33; SCI (1990a), A Statistical Reflection of the Islamic Republic of Iran for 1988, No. 8, p. 102. SCI, (1991b), A Statistical Reflection of the Islamic Republic of Iran for 1989, No. 9, p. 104; SCI (1993), Iran Statistical Yearbook for 1992, p. 274; and SCI (1994a), Iran Statistical Yearbook for 1993, p. 96.

3. Fertiliser used in agriculture

Fertiliser has been one of the important components of the imports of Iran while domestic refineries also produce large amounts (8.1% of total GOPFT). The distribution and provision of different types of fertilisers can affect greatly the volume of agricultural crops and commodities with a high correlation of about 0.70 with agricultural production during 1979-1993. (see Figure 7.6) It is therefore, proposed as a potential explanatory variable in the DOMTI model.

7.4.2.2 Political characteristics

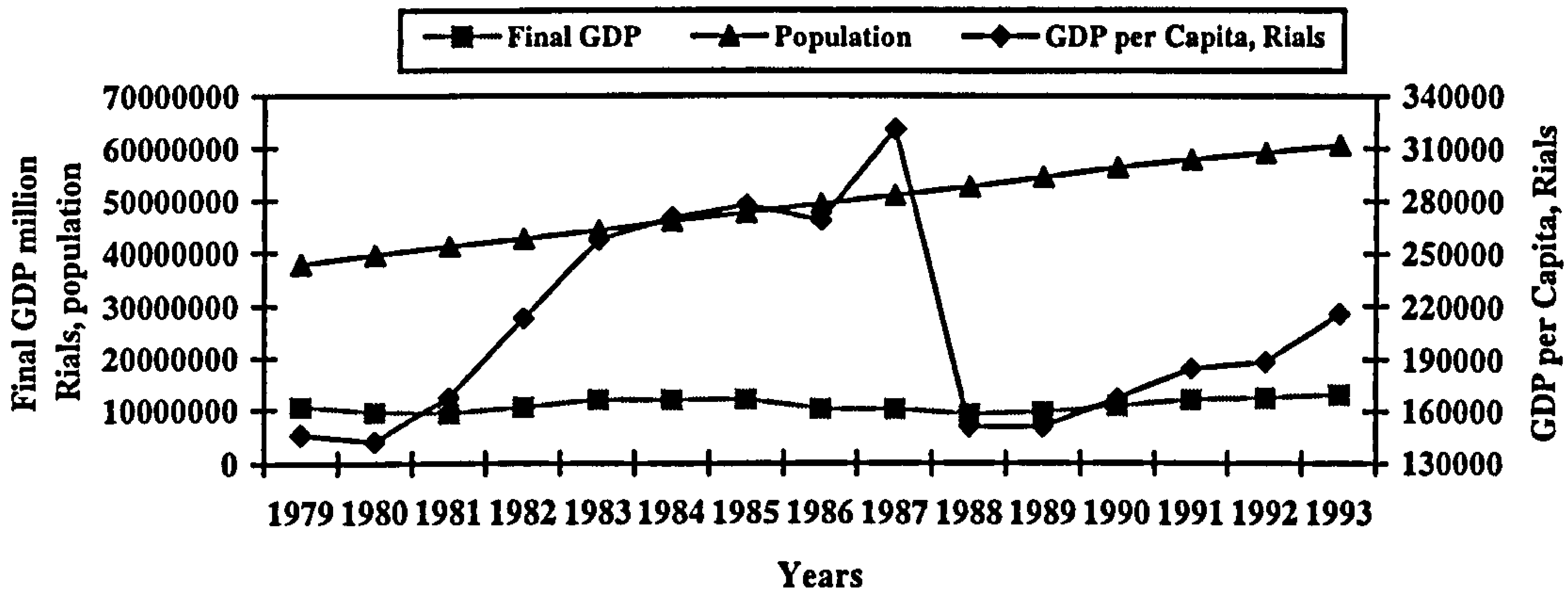
The political theme covers all those macroenvironment variables with a national or international flavour. Therefore, they are mainly composed of macroeconomic factors over which the government has a major influence.

1. GDP per capita

Real GDP per capita is a measure of real GDP to total population and relatively informative about the standard of living in a country (The Economic Review 1995). The variation in output of the four main GDP sectors (agriculture, industry and mines, oil, and services) affects GDP per capita. The extent of variation depends on the share of each sector in the total value of production and the population. Two major issues in Iran after the revolution have been, on the one hand, population growth (Figure 7.6) and on the other, falling output. During the 1979-1993 period, according to two official censuses, population doubled from about 30 to 60 million excluding roughly five million refugees from neighbouring countries. Real GDP, on the other hand, in 1993 compared with 1979 had only a 48 per cent growth which means a decline in GDP per capita (Amirahmadi 1996). Figure 7.7 shows the situation of real GDP and population patterns relative to GDP per capita. The sharp decline during 1987 is due to a significant decrease of oil revenues during the peak year of the war .

For CACFT the only available independent variable is GDP per capita and its correlation with the CACFT over time shows a strong negative relationship (-0.96) which is mainly due to the events after 1989 and in particular the collapse of the former USSR at the end of 1991. Therefore, GDP per capita, as it reflects both GDP and population variations, was

Figure 7.7 GDP per capita, population and final GDP in Iran (based on fixed prices 1982 Iranian Rials).



Source : Central Bank of Iran (Bank Markazi), (1991), National Accounts reports for 1974-1993. various pages.

chosen as the only available informative independent variable for the analysis. It is commonly used to explain the distribution of the resources among citizens. Appendix 2 shows the sum of the available CAC countries' GDP per capita during 1987-1993, all of which are measured in US $.

2. Rial exchange rates

Up to the Islamic revolution in 1979, Iran had a fixed exchange rate with very few changes as the national currency was subsidised heavily by oil revenues. More recently, the new government adopted a more flexible exchange rate system where fixed rates are applied to different trade purposes. Finally, at the end of 1993, a floating system was officially adopted. The fixed rates era corresponded to high oil prices, high production, and exports of crude oil, and also a relatively low population with moderate population growth. After 1979, national income declined due to the deliberate reduction in crude oil supply and export by the government. At the same time, the war had gradually absorbed the accumulated surpluses. Also, high demand for limited foreign currencies and the high population growth caused a great unofficial devaluation of the Iranian Rial. After the war, high levels of aggregate demand brought about by reconstruction required massive imports, which led to a very high trade deficit requiring a devaluation (to the extent of about 300%) in the Rial. It also led indirectly to the adoption of the single rate system as well as inflation at the beginning of 1994 (Central Bank 1994a, Sanate-Hamlo-Naghl 1995a). Devaluation occurred once again during 1995 as a result of temporarily high debts but, to some extent, was controlled by strict trade restrictions.

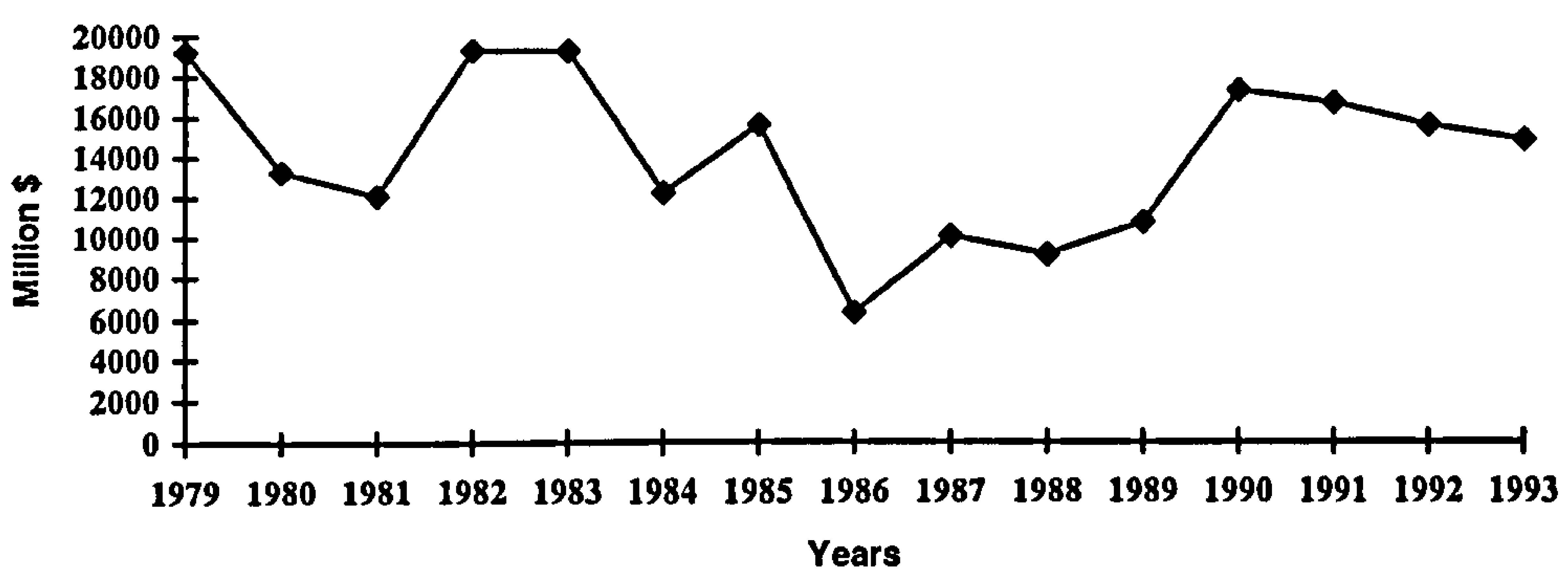
The devaluation of the currency of one country, while facilitating improvements and adjustment to the balance of trade, also puts pressure on domestic production. On the one hand, domestic producers in a free market economy engaging in foreign trade pay much higher equivalent national currency for their intermediate goods and materials. On the other hand, it may also lead to rise in the domestic production volume and value but, at the same time, transfer higher costs of imports to all economic sectors dependent on imports. Consequently, the higher cost of imports leads to higher wages, issues of liquidity, and cheaper export prices which may make domestic exports uncompetitive and reduce the volume of foreign trade. If the value of the national currency rises, while it makes imports cheaper, it also forces trade partners to pay higher prices for the exports of the country.

The Rial exchange rate can affect DOMTI in the ways described above. Both these cases were experienced in Iran, and in particular after the revolution in 1979 and the war in 1981, when policies to tighten control over the availability of currency were imposed. There was also the official introduction of the multi-rate Rial exchange rate for different types of imports and foreign payments after the Islamic revolution in 1979 (Central Bank 1992).

3. Iran's oil revenues

The oil revenues of Iran are a function of crude oil production, domestic consumption of crude oil and the international price of oil. A time series of oil revenues is shown in Figure 7.8. As a member of OPEC, Iran has the potential to sustain high volumes of oil production but, instead, has deliberately reduced its production since the beginning of the revolution. Since then, war has caused both supply and exporting facilities to be severely damaged and with a new era of sanctions made by the US government in 1995 any increase in the oil production becomes more difficult.

Figure 7.8 Oil revenues in Iran.



Source: Based on Central Bank, 1991, 1992, 1993, 1994a, and 1995b, various national accounts, pp. 191, 30, 13, 36, and 26 respectively.

The consumption of domestic oil (26.8% average of the annual production during the period 1979-1993) with the high growth in population led to restrictions in crude oil exports once the government was willing to export more (Central Bank 1994b). It would be expected that crude oil revenues have a strong positive relationship with GOPFT. A correlation coefficient of only 0.31, however, indicates a weak linear relationship with GOPFT.

Different sectors of Iran's economy are dependent on short and long term oil revenues as a major source of revenues or the necessary imports of capital and intermediary goods. In terms of both revenues and volume of production the oil industry is an important sector in DOMTI but shows a low positive correlation of only about 0.18 with DOMTI.

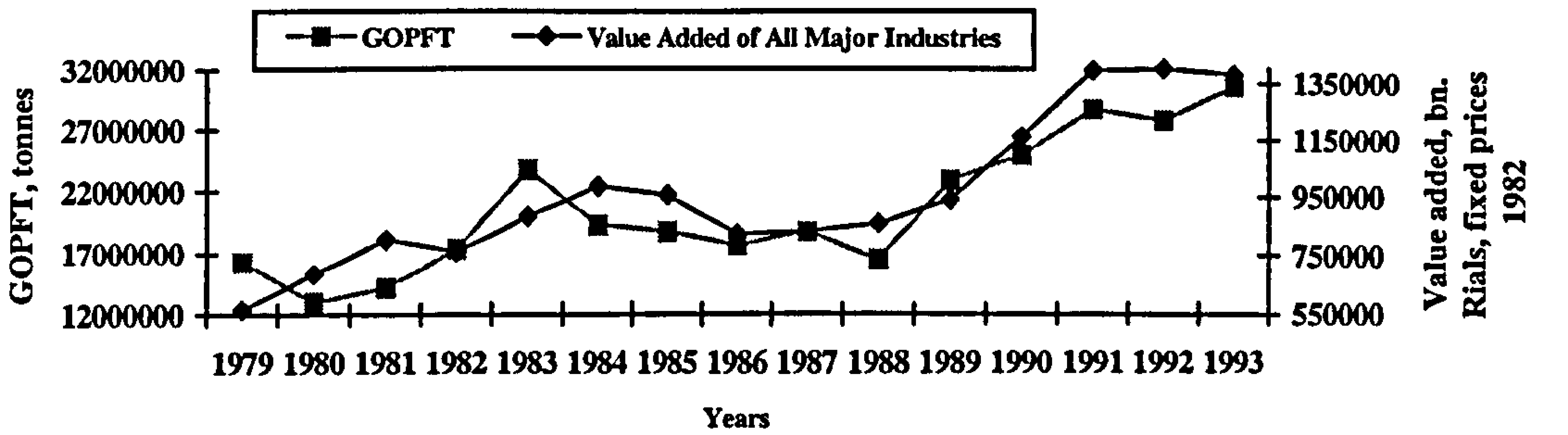
4. Value added of all major industries

Value added is the difference between production costs and the selling prices of goods and services. According to Riahi and Fekrat (1994, p. 3):

> "It is a measure of the total return generated in a firm through the utilisation of its productive capacity. i.e. labour and capital in the broad classical sense."

It may be a strong predictor of GOPFT as it represents the contributions of all major industries to GDP and is also an indicator of the costs and selling prices. It has a high correlation of about 0.91 with GOPFT over the period of study and is shown in Figure 7.9.

Figure7.9 Value added of all major industries and volume of GOPFT of Iran.



Source: GOPFT same as Table 7.2. Value added of all major industries is based on various Central Bank of Iran 1991, 1992, 1993, 1994a, and 1995b, annual reports of national accounts.

The value added of all major industries that are comprehensively covered by all seven classes of DOMTI might be a strong explanatory variable as it has the highest correlation of about 0.90 (with DOMTI) among all the explanatory variables.

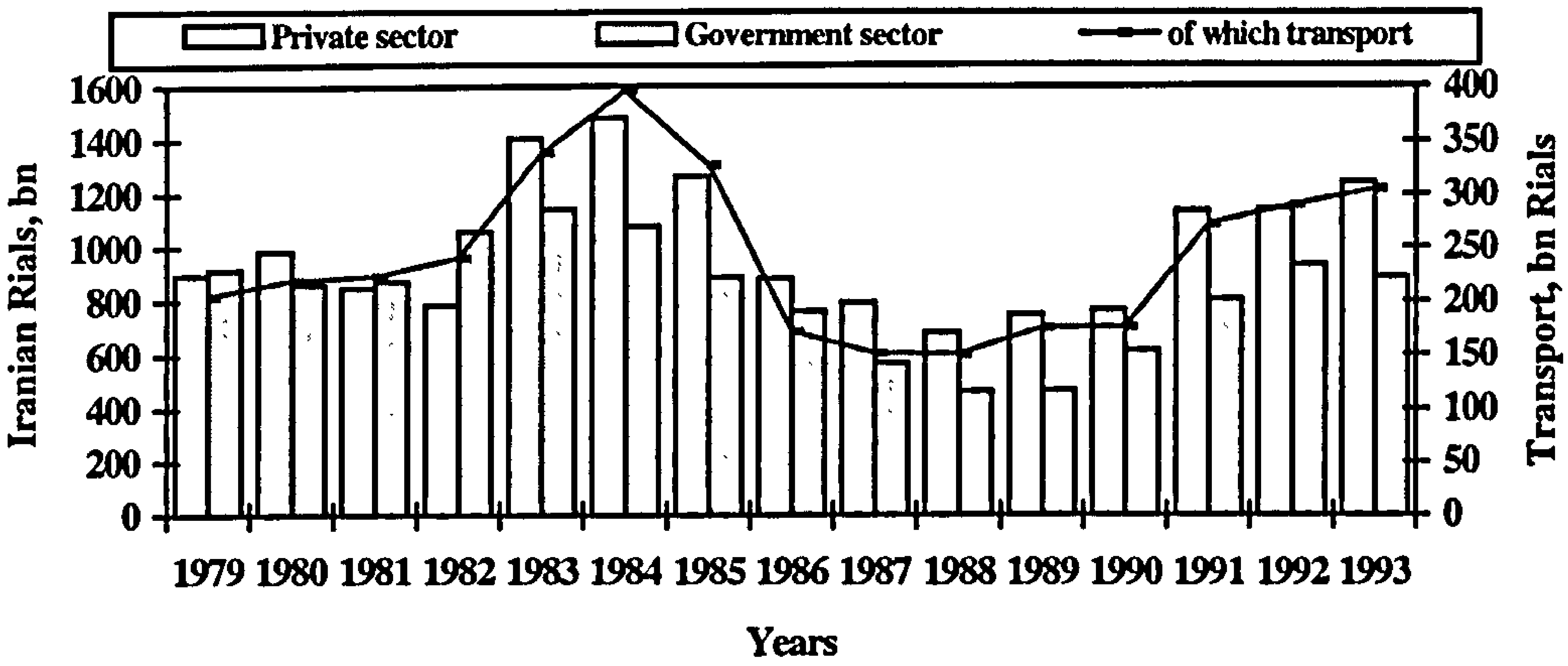
5. Fixed gross national investment

According to The Economic Review (1995, p. 17) investment:

> "Involves expanding the productive capacity of the economy, thus leading to economic growth, which is one of the fundamental objectives of economic policy for any government. This means that the choices that society makes about allocating resources to investment relative to present consumption are crucial for determining the future path of the economy. ... Thus we can think of investment as being concerned with extending the quantity or quality of the factors of production (capital, labour, entreprreneurship, land) or with improving the technology of production".

Fixed gross national investment occurs in terms of investment in machinery, construction and tools by both the public and private sectors involved in the four main sectors of agriculture, oil and gas, industry and mines, and services (Central Bank of Iran 1991). It has a relatively low correlation of about 0.24 with GOPFT. The future share of private and public investment is important (in particular the former) to both demand (increasing the volume and changing in the composition) and supply of ISLB (by the involvement of the private sector in renewing and owning the road fleet and rail rolling stock). Figure 7.10 shows the trend of fixed gross national investment in the past fifteen years emphasising the considerable share developed by the private sector. The share of transport varies but generally stands at 10.8% for all freight and passenger urban and inter-urban transport over the whole period.

Figure 7.10 Gross national investment of Iran: Private sector, government, and transport share at 1982 fixed prices.



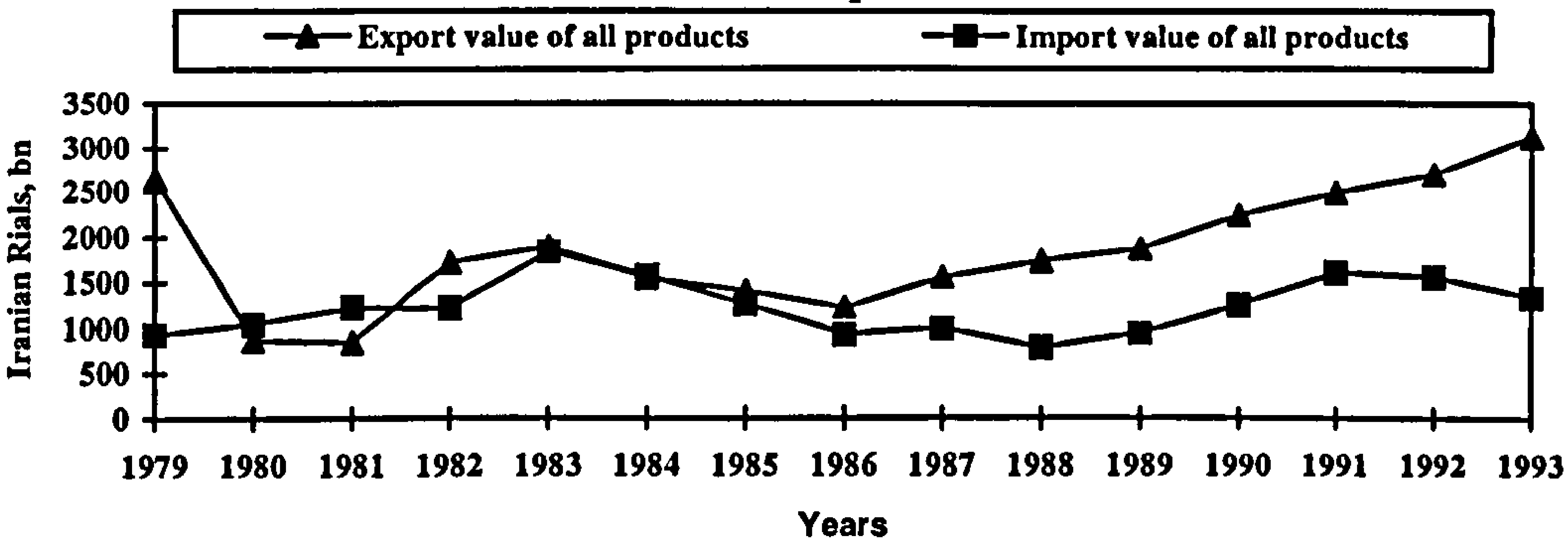
Source: Central Bank of Iran (1991, p. 295), (1992, p. 72), (1993, p. 31), (1994a, p. 55), (1994b, p. 45), various National Accounts.

New investment in annual and long term programmes varies at sectoral levels. This variable includes both investment in construction and machinery for all four sectors of the Iranian economy and has shown a weak correlation of about 0.36 with DOMTI.

6. The value of foreign trade goods

In general, import and export values are composed of two product categories in the national accounts of Iran (see Figure 7.11). The value of goods covers the trade in oil and gas, and all other material commercial trade. The trade in services includes transport, insurance, travelling, training and health. The net value of foreign trade in services is a much smaller contribution and includes transport exports (Central Bank of Iran, various annual national accounts). The values which are considered in this study are the total values of exports and imports and are broadly classified as the exports of crude oil, bulk cargoes, and general cargoes.

Figure 7.11 Goods and crude oil exports and imports of Iran at 1982 fixed prices.

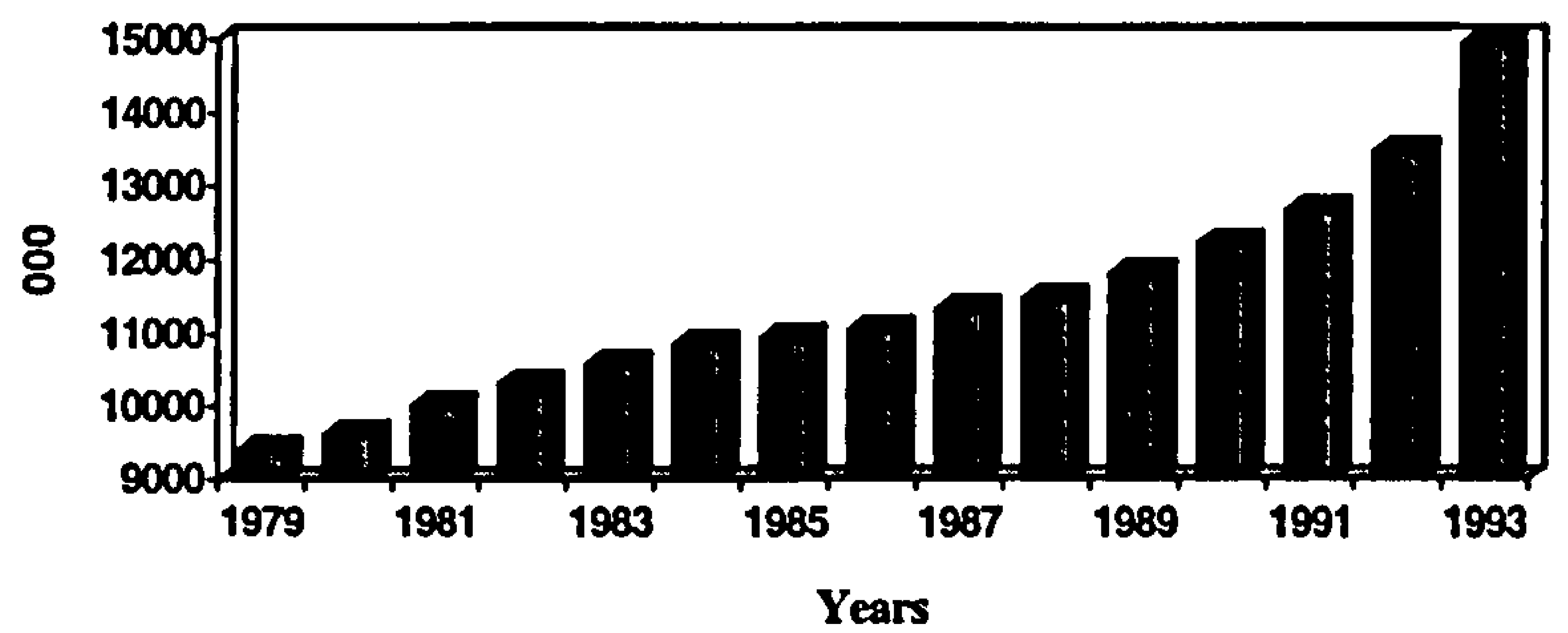


Source: Central Bank of Iran (1991, p. 210), (1992, p. 80), (1993, p. 34), (1994a, p. 58), (1994b, p. 48), various National Accounts,.

7. Employment

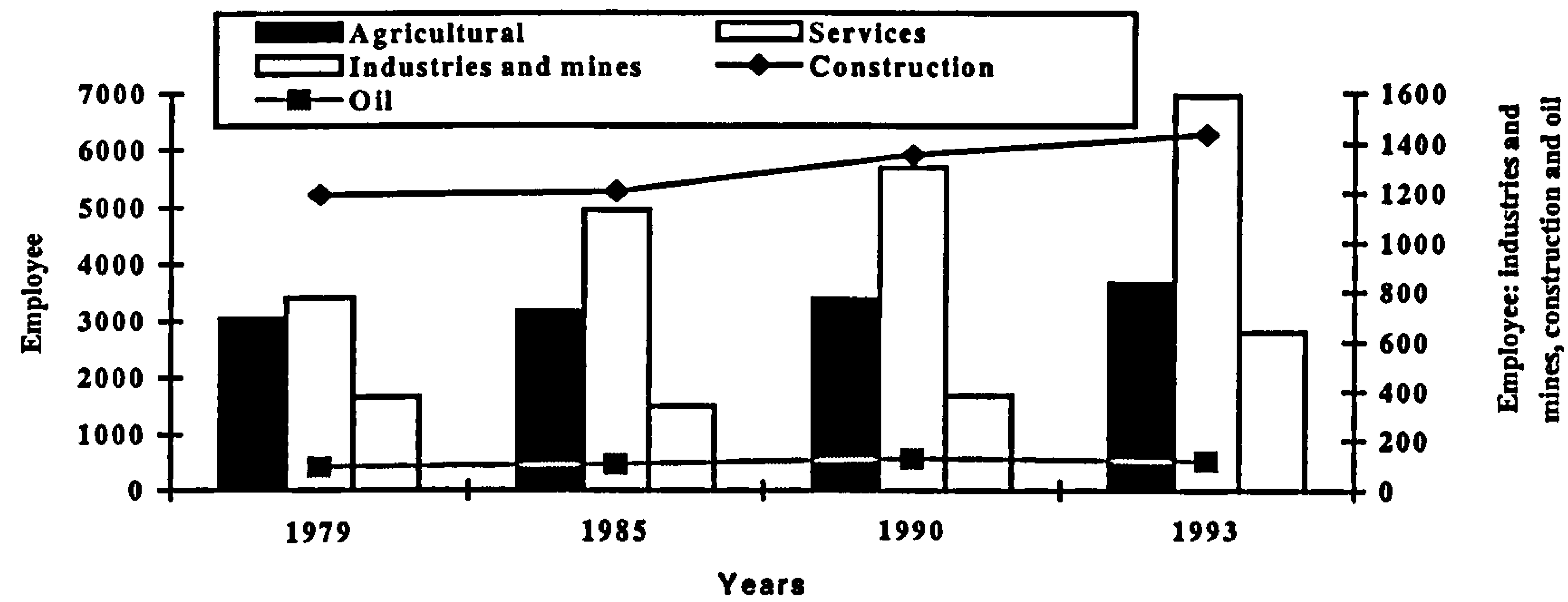
Employment is the third and second most highly correlated variable (0.88) with both GOPFT and DOMTI respectively. As shown in Figure 7.12 employment has followed an upward trend from 1979 to 1993. Figure 7.13 indicates the importance of employment in the service and agricultural sectors.

Figure 7.12 Employment in Iran.



Source: Central Bank of Iran (1991, p. 249), (1992, p. 57), (1993, p. 24), (1994a, p. 47), (1994b, p. 37), various National Accounts.

Figure 7.13 Sectoral contributions to employment in Iran.



Source: Central Bank of Iran, (1991, p. 249), (1992, p. 57), (1993, p. 24), (1994a, p. 47), 1994b p. 37).

8. Final GDP

According to The Economic Review (1995, p. 13):

> "We can monitor changes in the resources being available to a society by observing changes in real Gross Domestic Product (GDP)".

Final GDP is the third most highly correlated variable with DOMTI (0.87) and to a lesser extent with GOPFT (0.77).

9. Government expenditure

Government expenditure covers the cost incurred in the ministries, related organisations and municipalities and mainly concerns government purchasing. It has only a weak negative correlation of -0.29 with DOMTI.

10. Value of intermediate goods

The inclusion of this variable in the model was due to its contribution to the total DOMTI. It is strongly under the influence of imported goods and, therefore, indirectly could be a strong indicator of GOPFT.

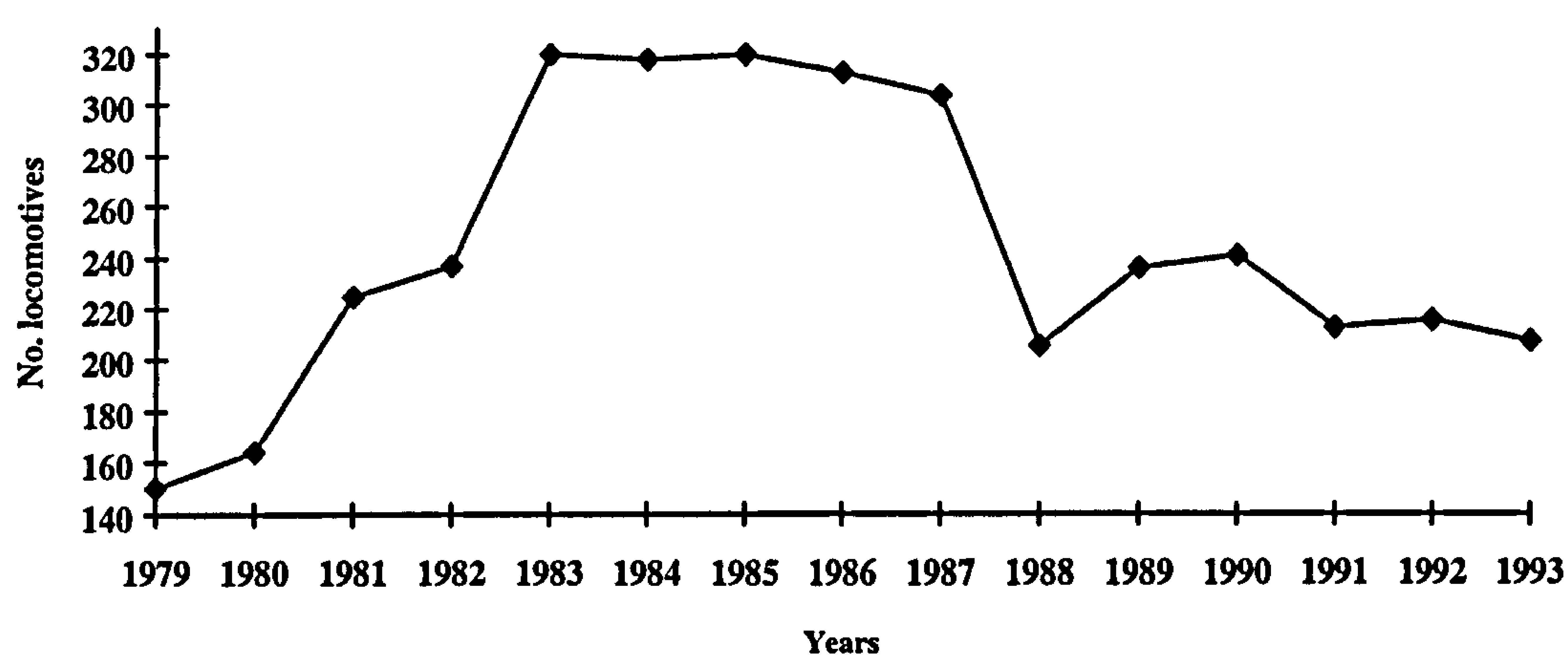
7.4.2.3 Technical characteristics

The foreign trade of Iran mainly takes place through six major ports, four on the Persian Gulf in the south and two in the north on the Caspian Sea. More than 85% of the foreign trade of Iran runs through the two southern ports of Abass and Imam which also account for about 80% of the total port infrastructure and superstructure. The following fourteen technical explanatory variables (five for GOPFT and twelve for DOMTI) presented in this section are those which directly affect the performance of the modes and interfaces in terms of capacity and services at planning and macro levels.

1. Number of locomotives

Diesel locomotives (variable for GOPFT) are the main motive power for rail transport in Iran. As a mountainous country, the availability of high power locomotives plays an important role in both freight and passenger movements.

Figure 7.14 Locomotive numbers in Iran.



Source: Based on PBO (1989-1993), The Preliminary Results of the First Social, Cultural and Economical Development Plan of the Islamic Republic of Iran, Transportation Sector, unpublished, IRIRC 1984-1993.

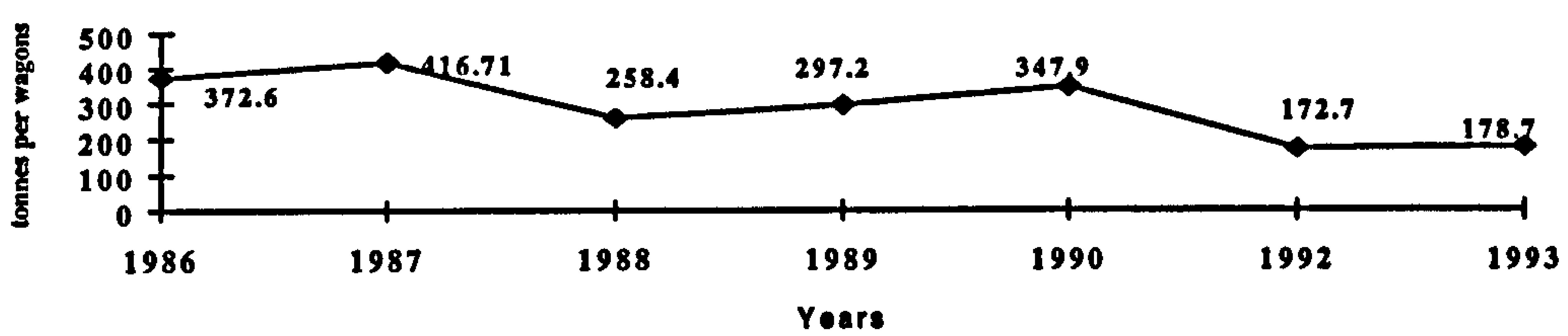
The variation in the number of locomotives during this period as shown in Figure 7.14 is mainly due either to war damages, locomotives under long term repair or a lack of spare parts.

The production capacity of the country in locomotive manufacturing is about 0.3 locomotives annually (IRIRC 1984-1993) which is an indication of the dependence of the rail industry on imports. Given the size of Iran, the railway plays a significant role in supplying cheap transport of iron ore to two giant irons melting plants and also in distributing the metal products of these plants to rail connected destinations. This includes exports to the southern Arabian States of the Persian Gulf through the ports of Imam and Abass. As such it may well be an important variable explaining DOMTI, GOPFT.

2. Number of wagons

The number of different wagons (variable for GOPFT) provided in a freight train is a key variable in the annual output of ports, cross border terminals and all types of domestic and foreign trade of Iran. Figure 7.15 shows the average annual performance and available wagons of the IRIRC for foreign trade. The role of IRIRC in the GOPFT and DOMTI is vital since every two wagons can carry a load equal to 47 trucks, and it reduces significantly the long distance road traffic and also costs of transport (Sanate-Hamlo-Naghl 1993a). Figure 7.16 shows the variation in the number of wagons in Iran during 1979-1993.

Figure 7.15 Train wagon utilization in Iran.



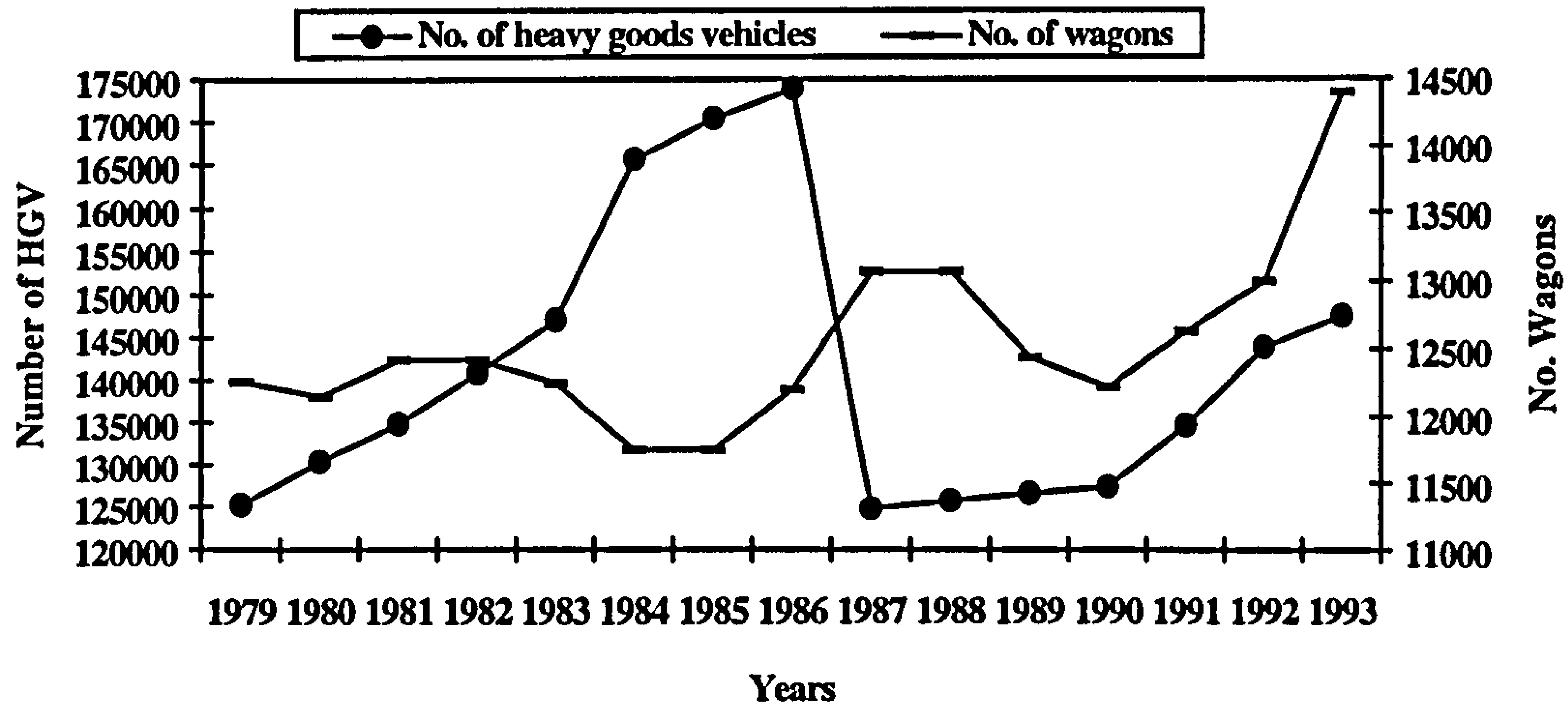
Source: Based on PBO (1989-1993), The Preliminary Results of the First Social, Cultural and Economical Development Plan of the Islamic Republic of Iran, Transportation Sector, unpublished, IRIRC 1984-1993.

3. Number of heavy goods vehicles

Up to the end of 1994, when the port of Abass like Imam, was connected to rail, heavy goods vehicles (HGVs) (variable with 0.05 correlation with GOPFT) were the only means of freight transport out of the ports. The traffic of HGVs into major ports is a function of the type and availability of goods, and the length and quality of roads. Based on Atrchian (1994), only those HGVs having a carrying capacity of between 13.5 and 22.5 tons are practically involved in the long distance carriage of freight between ports and border crossings to and from inland origin/destination points. Therefore, for this study the number of HGVs has been computed and deducted from the total road freight vehicles.

An analysis of the growth of HGVs as the backbone of Iran's foreign trade shows two distinct situations over the periods 1979-1986 and 1987-1993. There are two organisations involved and interested in HGVs: the traffic and registration department of the disciplinary forces and the Ministry of Roads and Transportation (MRT), which is mainly interested in the number of trucks for freight transport. Unfortunately, there are always differences in the published data of these two sources. As discussed in chapter two, every few years the registration and traffic department publishes the actual existing number of trucks and vehicles after the deduction of those that have been scrapped or banned. At the end of 1986, there was a census on all types of vehicles, the partial effect of which is shown in Figure 7.16. The sharp decline in the number of HGVs in 1986 is, on the one hand, the result of the significant role and consequent destruction of HGVs in war zones and, on the other hand, the result of the nation-wide vehicle census and the deduction of scrapped and obsolescent vehicles from the total registered.

Figure 7.16 Number of wagons and heavy goods vehicles of Iran.

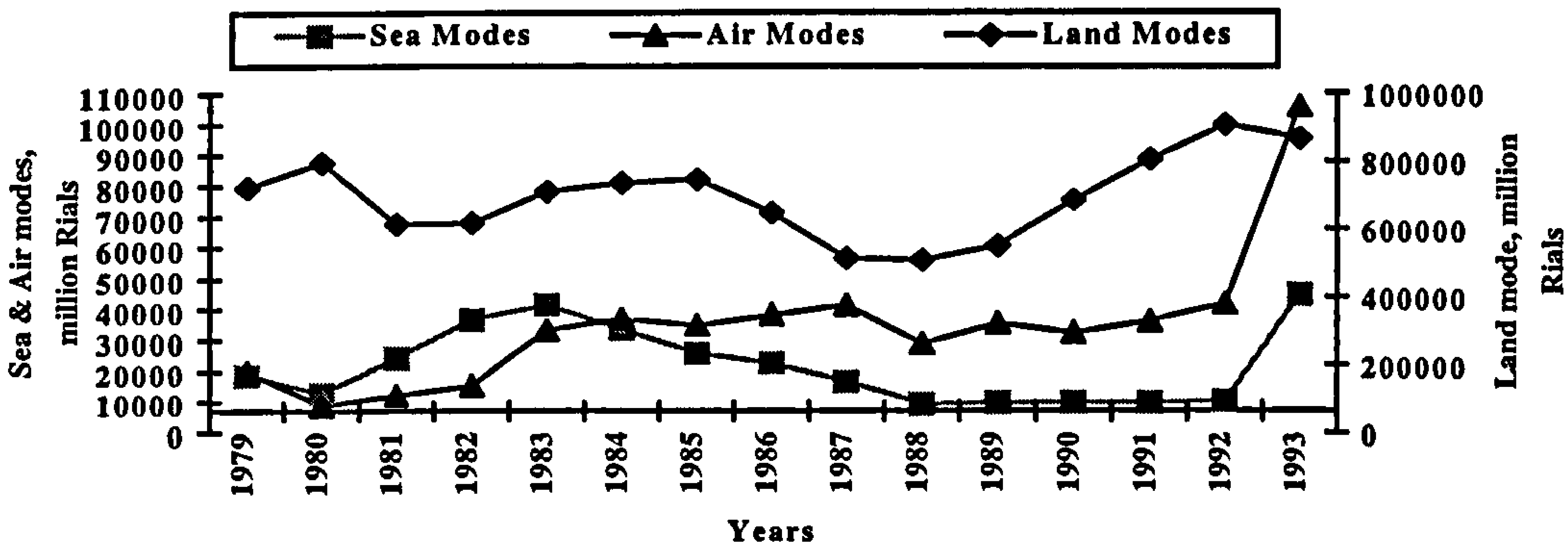


Sources: Based on IRIRC (1984-1993), Performance Report, and various SCI publications for 1979-1993.

4. Value added of transport sector

The definition of private road transport according to the Central Bank of Iran, covers road freight vehicles and buses as well as urban transport and contributes the main proportion of the value added of the transport sector (variable with correlation of 0.59 for GOPFT and 0.68 for DOMTI). In the public sector, the IRIRC is important. The second most important group of contributors to the value added of transport are the government-run air transport services with two national domestic and international airlines. In sea transport the function of the Ports and Shipping Organisation (PSO) as a government entity is important. The transport system in Iran largely depends on imports for a high proportion of the motive power of all modes and interfaces. Available domestic production is not sufficient to match the requirements of even domestic trade, including passenger movements. This means that the transport superstructure is mainly dependent on imports from abroad and is considered an intermediate good as it produces returns and has a medium and long-term life period. For instance, if Iran has more locomotives, wagons and HGVs of its own for international journeys it will be possible to take a much greater share in the national trade which is carried out by international road or rail systems via different border crossings. At the same time, by equipping ports with more container gantry cranes and other heavy lift equipment there has been a large reduction in the demurrage paid by government to ships during the recent years (PSO 1993). Consequently this variable can have a direct relationship with the GOPFT and also makes other associated resources more effective. Figure 7.17 shows a historical record of the variable with two main negative effects at the beginning of the revolution and during the critical years of the war.

Figure 7.17 Value added of three modes of transport in Iran.



Source: Based on Central Bank (1991, p. 214), (1992, p. 41), (1993, p. 17), (1994a, p. 40), (1994b p. 30) various national accounts.

The value added contribution of the transport sector is composed of land, air and marine activities with the former taking the most important proportion in both private and public sub-sectors. Transport service costs are a significant proportion of total commodity and product costs and have an effective role in the marketability of goods. Private road freight for urban and inter-urban purposes has a significant role (see figure 7.17) in the movement of GOPFT and DOMTI. Therefore, with a correlation of about 0.69 it may be a good explanatory factor in defining DOMTI.

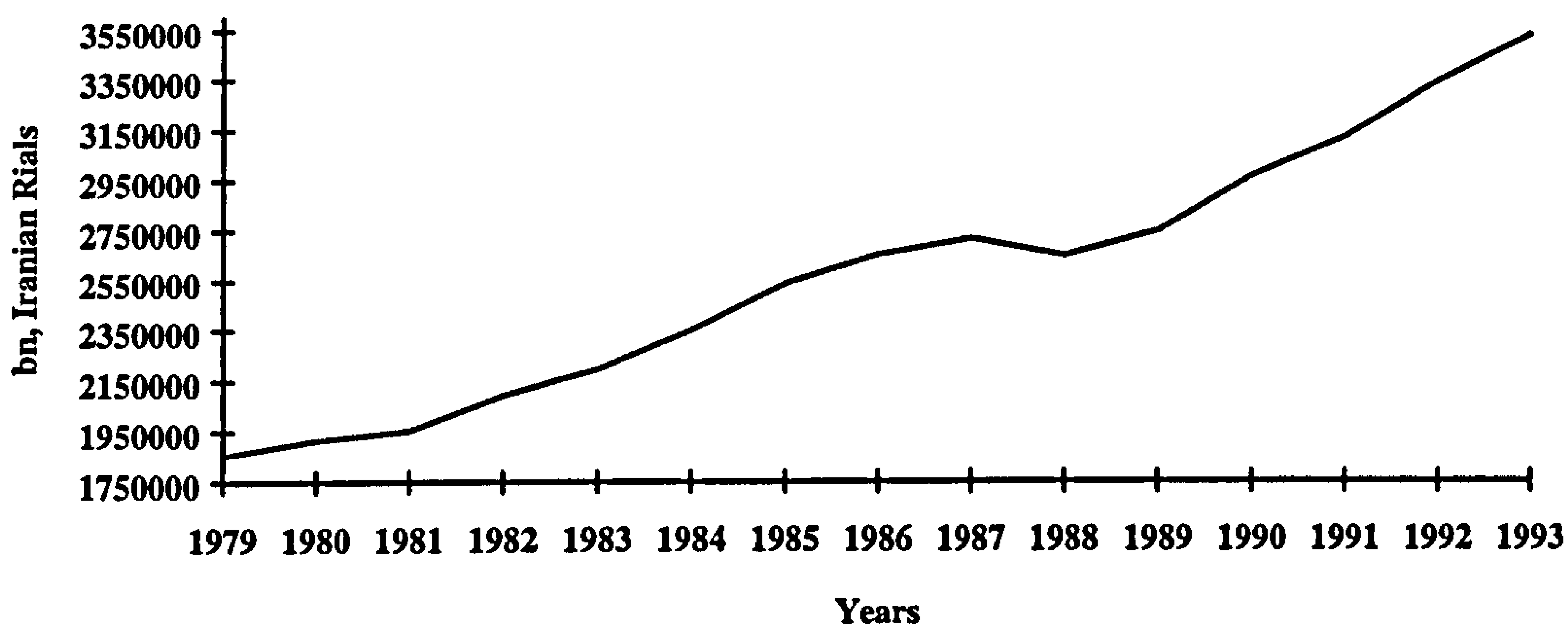
5. Transport investment

Transport investment (variable with correlation of 0.33 for GOPFT and 0.44 for DOMTI) covers all urban and inter-urban modes and interfaces in the forms of infrastructure, facilities, installations and vehicles. The development of the transport infrastructure is basically for the movement of freight and, particularly in the long term, causes the flows of commodities and materials to be possible or increased. e.g. the exploitation of new mines or establishment of major industries. The returns from the investment in transport can be seen as a long-term cause of increase in DOMTI (Gillen and Waters, 1996). Transport investment is a significant part of the investment in the total fixed gross investment and covers all urban and inter-urban modes and interfaces with, as was shown in Figure 10, an average share of 13.1% during 1979-1993 (Bamford 1995).

6. Value added of agricultural

Agricultural production is the most intensive employment sector and second in terms of output volume. The products and commodities in this class affect other classes like food and refrigerated goods and are generally significant for every individual in the form of daily consumption. The value added of the agricultural sector (see figure 7.18) (DOMTI variable) has shown the second highest correlation with DOMTI (0.88) and is expected to be a strong explanatory variable.

Figure 7.18 Value added of the agricultural sector in Iran.



Source: Central Bank of Iran (1991 p. 162), (1992, p. 18), (1993, p. 10), (1994a, p. 33), (1994b, p. 23), various National Accounts.

7. Fixed gross investment in agriculture

This has (DOMTI variable) a negative correlation (-0.32) with DOMTI which appears to contradict common theoretical assumptions. Iran has regular destructive earthquakes and frequent floods in different parts of the country, which may be a reason for the above contradiction. Also, the dependence of the country on unirrigated land means that the periods of drought influence harvests more effectively when there is a shortage of rainfall, and reduces the effects of new investment.

8. Investment in agricultural machinery

As a part of the fixed gross investment in agriculture, this (DOMTI variable) has a strong positive correlation of 0.77 with DOMTI. It functions as a direct input to the agricultural sector as it can increase the areas under cultivation, minimise the final costs and facilitate performance.

9. Value added of light industries

This (DOMTI variable) is composed of values for the six industries of textiles, wood, paper, chemicals, minerals, and miscellaneous industries with a high correlation of 0.86. This category is the third most important contributor with 18.35% of the total average DOMTI tonnage during 1979-1993. The most significant contribution is made by textiles.

10. Value added of basic metal, machinery & non-metal industries

This (DOMTI variable) is composed of the two strategic and labour intensive areas of heavy metal and non-metal industries and has the highest correlation among other variables with DOMTI (0.92) but had the smallest average share (1.78%) in the total volume of DOMTI during 1979-1993.

11. Value added of food industries

As one of the most important labour intensive industries with a direct impact on individuals, this (DOMTI variable) only has a moderate correlation of 0.55 with DOMTI.

12. Investment in oil and gas machinery

As only a minor part of the total investment in the sector, this (DOMTI variable) shows a weak correlation (0.24) with DOMTI. Indirectly, however, all industries are affected by the development of this sector in terms of the changes in fuel consumption patterns.

13. Value added of oil sector

This (DOMTI variable) includes crude oil export value added as well as oil products and has a moderate correlation of 0.49 with DOMTI.

14. Value added of crude oil sector

This (DOMTI variable) is the main part of the oil sector value added with a high correlation (0.85) to DOMTI. In fact, it is the difference between the costs of crude oil production and the selling price of domestic and international crude oil.

7.4.2.4 Organisational characteristics

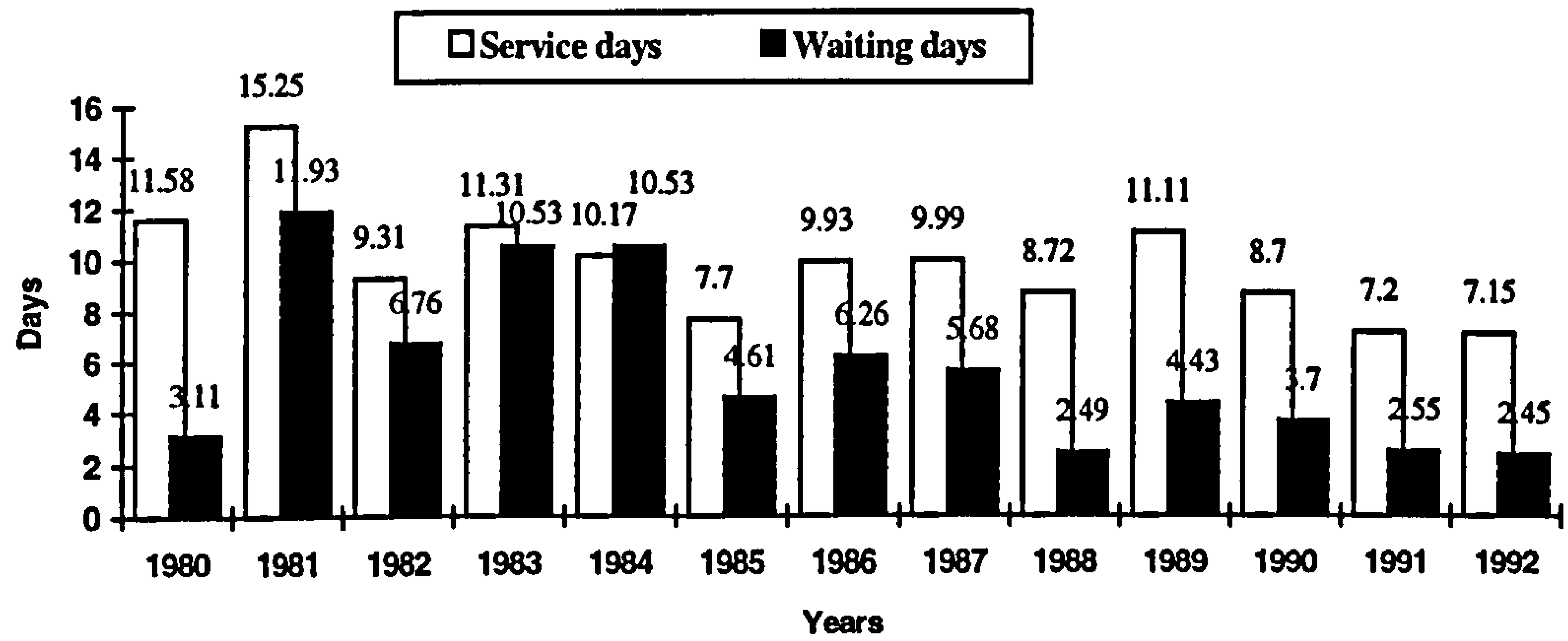
The organisational themes cover those independent variables where the major element of their output is human skill and decision making.

1. Ship service days in seaports

Total ship turnaround time covers the average days in port for a ship at each of the six major ports. It is also called port staying days (PSD). It is the ratio of the total period of days all ships spend in ports to the total number of ships visiting Iran, as shown in column 2 of Appendix 3. Each ship's PSD are composed of four elements: operating days (when the ship is berthed and working), service days (when the ship is alongside working but may also have some idle time), waiting days (when, after arriving at a port, a ship has to wait to come alongside), and idle times (a part of the service time when ships are alongside but, due to technical or other reasons, are not engaged in loading or discharging operations). Each of these factors is indicative of port operating efficiency and the data for Iran is shown in Figures 7.19 and 7.20.

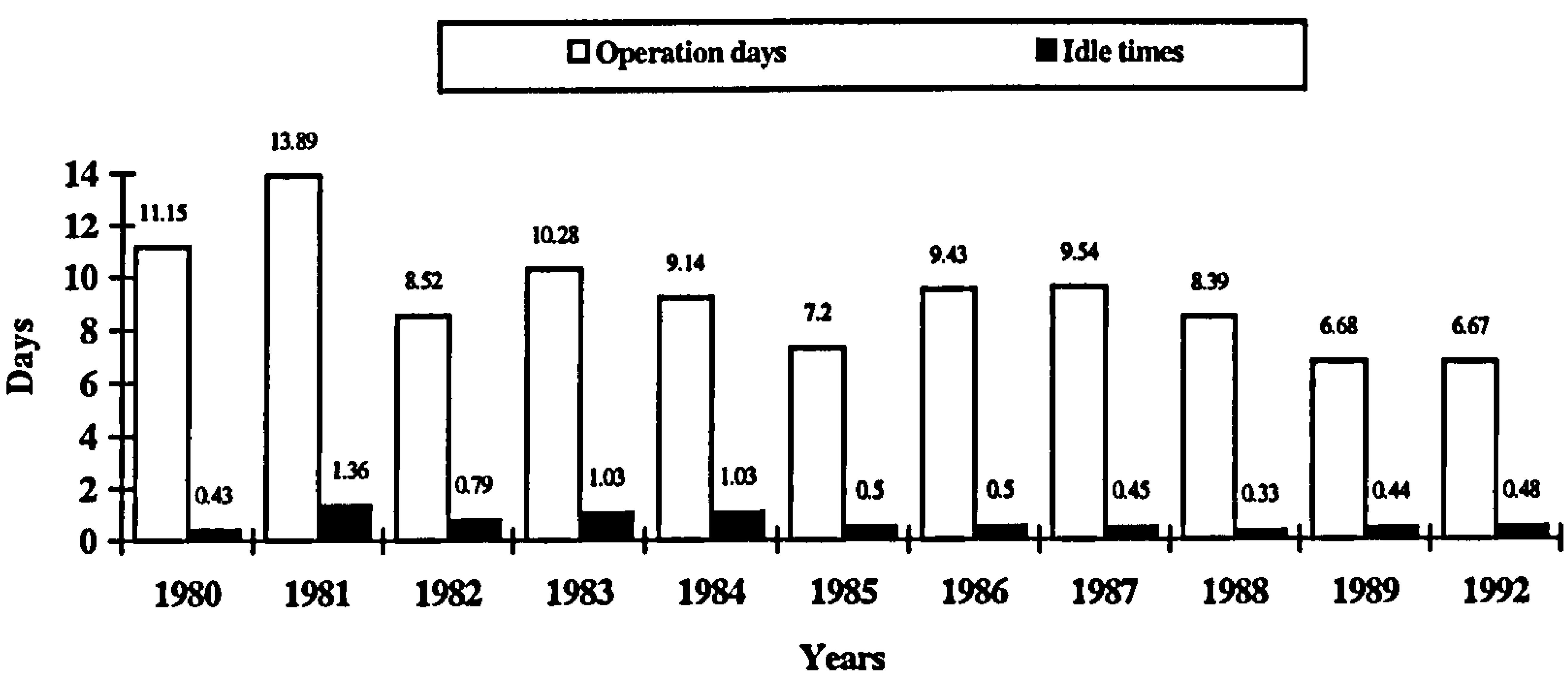
As shown in Figure 7.19 the data relating to these four main ship indicators reflect the capability of the major Iranian ports to serve ships and indicate that the average staying days of a ship during 1992 was equal to 9.6 (sum of service and waiting days) with the three major components being: operational days 69%; waiting time 26%; and idle days 5%.

Figure 7.19 Components of annual average staying days for six major ports of Iran.



Sources: Iran Statistic Yearbooks for 1981, and 1992 SCI (1982, p. 589) and SCI (1993, p. 392); PSO (undated probably 1991, p. 91), An Investigation in the Performance of the Iranian Ports for 1320-; PSO (1992, p.108), Operational Report of the Ports and Shipping Organisation of Iran for 1371.

Figure 7.20 Annual average service days components at berths for six major ports of Iran.



Sources: Iran Statistic Yearbooks for 1981, and 1992 SCI (1982, p. 589) and SCI (1993, p. 392); PSO (undated probably 1991, p. 91), An Investigation in the Performance of the Iranian Ports for 1320-; PSO (1992, p.108), Operational Report of the Ports and Shipping Organisation of Iran for 1371.

Total ship turnaround time is a very general indicator in the case of Iran as rates in southern ports differ considerably from Northern ports where much smaller coastal ships make for more rapid turnaround times.

2. Average berth productivity of Iran's general cargo and oil products (foreign trade)

The assessment of Iran's seaport productivity where there is centralised government control over cargo operation, equipment, land and sea traffic, and management, is a difficult task especially given the paucity of data. Low port productivity in Iran is due to both internal inefficiency (previous congestion, the key role of the ship's gear, the lack of a comprehensive training scheme for port workers) and also to inefficient road/rail transport modes. There is also evidence of both quantitative and qualitative shortages in skilled labour and personnel, port equipment and procedures, ships' cranes, etc. which impair port productivity. Iran's seaports basically must serve the non-oil cargo handling operation, but berths of some of the commercial ports serve oil products as well and complexity arises due to the mix of traffic data and utilisation of resources.

Port performance can be divided between ship, cargo and personnel indicators where the former five indicators have been explained already. One major measure of the productivity of a port is its output in general terms. It is the ratio of total port throughput to total working days in a year. According to Table 7.7, for example, for 1993 about 80,865 tonnes of GOPFT daily was handled by the six major ports of Iran (Column 1 for 1993 divided by 341 working days).

In other approaches (e.g. Sinclare 1979), some aggregate variables such as berth utilisation in terms of ship service days in ports are entered into the calculations. For example, for the same year in Table 7.7 the ratio of column 1 to 3 gives (see column 5) the average tonnage of each ship. When the average (column 5) is divided by 7.10 as the general measure of service days of each ship in major ports in 1993, 2021.8 tonnes will be the daily productivity of each ship. A more specific method lies in terms of the ratio of output to the number and length of berths as well as working days. The berth (ship) productivity of six major Iranian seaports was calculated and shown in column 6 of Table 7.7. This specific port productivity is based on total sea trade assuming 341 working days a year and a fixed number and length of berths for the period of 1988-1993 (77 berths with 14,592 metres of ocean going berths).

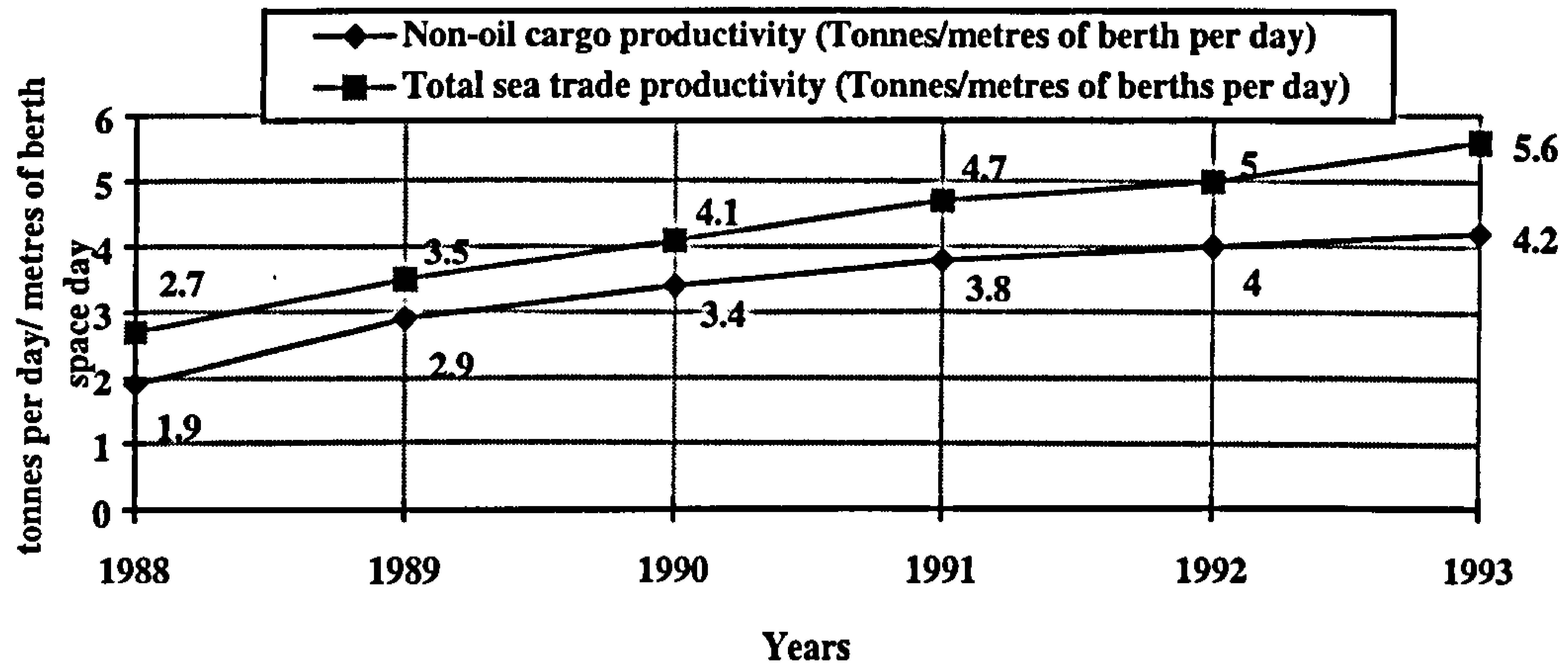
Table 7.7 General productivity of six major Iranian seaports.

Year	Total seatrade (000, tonnes)	PSO employees	No. ships	Ship Service days (X_{11})	Average shipment with oil products (tonne) (1/3)	Berth (ship) Productivity with oil products (tonnes) (5/4) (X_{12})	Productivity per PSO personnel tons/GOPFT (1/2) (X_{15})
	1	2	3	4	5	6	7
1979	11736	6813	1495	7.740	7850.20	1014.24	1722.59
1980	10460	6801	1395	11.58	7498.20	647.51	1538.00
1981	11357	7014	1194	15.25	9511.74	623.72	1619.19
1982	12276	6708	1326	9.31	9257.92	994.41	1830.05
1983	17090	6491	1652	11.31	10345.04	914.00	2632.87
1984	12855	6804	1291	10.17	9957.40	978.10	1889.33
1985	13107	7092	1345	7.70	9744.98	1265.58	1848.14
1986	13155	6774	1032	9.93	12747.09	1283.70	1941.98
1987	16602	6664	1231	9.99	13486.60	1350.01	2491.30
1988	13695	6457	1078	8.72	12704.08	1456.90	2120.95
1989	16341	6598	1314	11.11	12436.07	1119.36	2476.66
1990	18717	6837	1644	8.70	11385.04	1308.63	2737.60
1991	21756	6757	1897	7.20	11468.64	1592.87	3219.77
1992	25147	6145	1939	7.15	12969.06	1350.94	4092.27
1993	27575	5956	1921	7.10	14354.50	2021.76	4629.79

Source: Based on PSO (undated probably 1991, p. 51), An Investigation in the Performance of the Iranian Ports for 1320-1369; PSO (1992), Operational Report of the Ports and Shipping Organisation of Iran for 1371, various pages.

Productivity in ports according to the UN (1967) is calculated on the basis of tonnes/ man/hour output; but since such detailed data at shift and port operational levels are not available for the ISLB, an alternative method is to consider macro variables e.g. berth lengths and annual working days, average annual trade as shown in Figure 7.21 and Table 7.7 or using an important port employment sector such as the PSO productivity (Table 7.7 column 7).

Figure 7.21 Specific port productivity of the six Iranian major seaports.

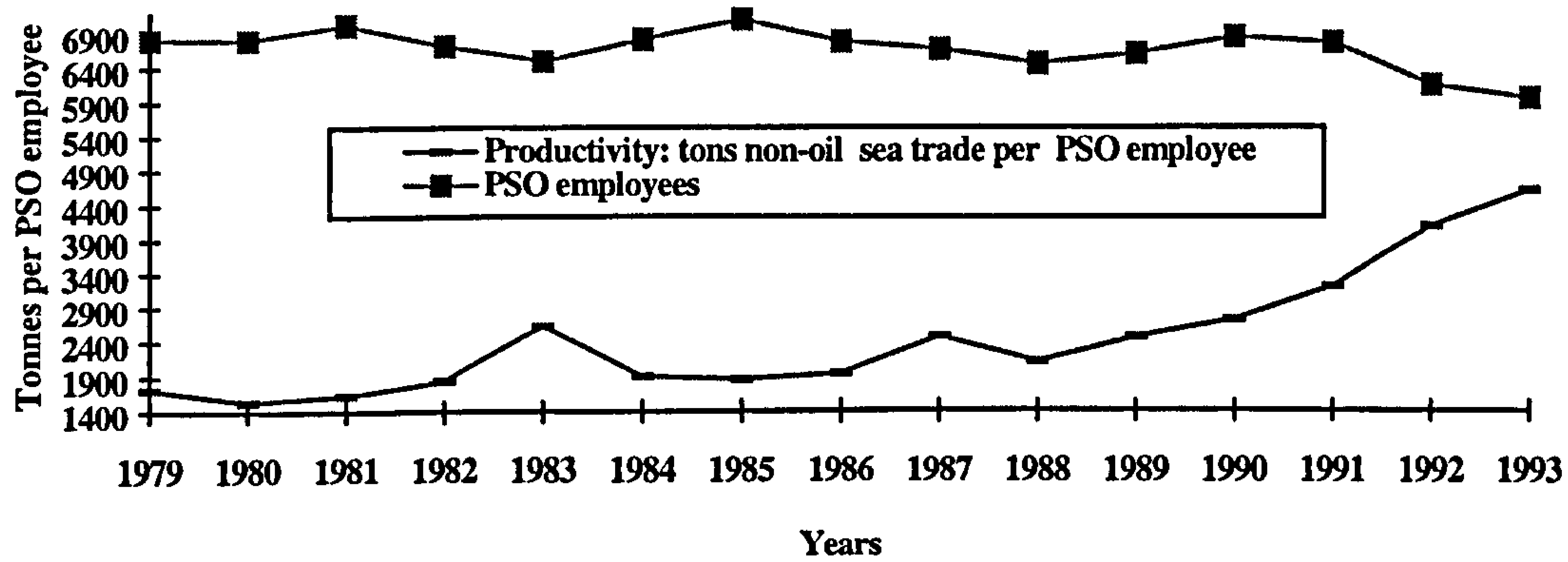


Sources: Based on the PSO (1992), Operational Report of the Ports and Shipping Organisation for 1371; PSO (undated probably 1991), An Investigation in the Performance of the Iranian Ports for 1320-1369 various pages; PSO (1993, p. 51).

3. Ports/employee productivity

The calculation of the productivity of ports according to personnel must broadly cover all port authorities, stevedoring, shipping, forwarders and shippers involved in direct port trade. Such data is not available. Cargo handling in all three stages of port operations -ship, quay, and storage - is directly under the practical administration of port authorities and then stevedoring companies. Port authorities are not involved in the ship (hold) operation in southern ports. Therefore, the role of PSO employees is important in the productivity of ports. After the war, there has been a tendency to reduce the number of employees at a national level. In the PSO, attempts were made to increase the productivity and reduce the number of staff as shown in Figure 7.22.

Figure 7.22 Productivity of six major ports of Iran in terms of tonnes for non-oil sea trade per PSO employee.



Source: same as Figure 7.21.

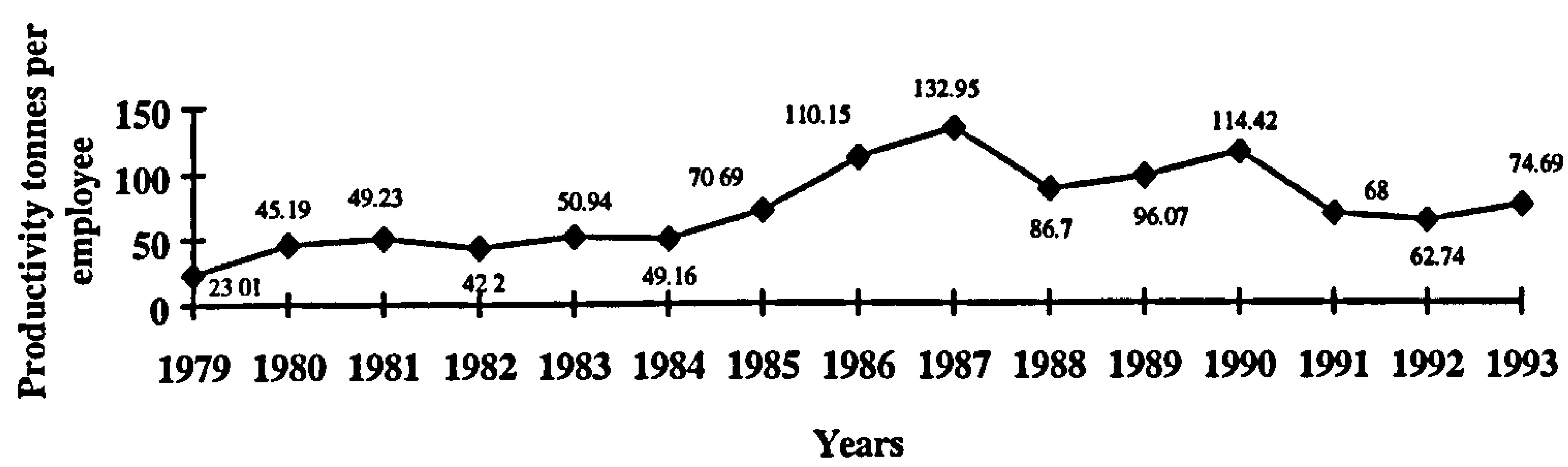
4. Rail / employee productivity

The Islamic Republic Iranian Railway Company (IRIRC) is a particularly labour-intensive entity with largely poorly educated employees. Since the last restructuring, the number of IRIRC employees has shown a declining trend as shown in Table 7.8. On the basis of permanent and on-contract temporary employees of IRIRC during 1986-1993, rail productivity for IRIRC is computed and shown in Figure 7.24 which generally reveals a decrease in the number of employees and an increase in the volume of traffic and resulting rail productivity. According to PBO (1993), during the second development programme the IRIRC must increase the number of highly skilled staff from 4% of the total in 1993 to 10% in 1998 and also improve the skills of the present personnel through IRIRC training centres and univesities.

	Table 7.8 Number of employees in IRIRC.							
	1986	1987	1988	1989	1990	1991	1992	1993
IRIRC Employees	41290	40790	38960	38480	37170	36940	35780	34450

Source: Based on IRIRC (1986-1993), Facts and Figures of the IRIRC for 1986-1990, and IRIRC (1984-1990), Performance Report of IRIRC for 1984-1990, various pages.

Figure 7.23 Freight tonnes/per employee in IRIRC.



Source: Based on IRIRC (1986-1993), Facts and Figures of the IRIRC for 1986-1990, and IRIRC (1984-1990), Performance Report of IRIRC for 1984-1990, various pages.

The organisational theme of DOMTI has three independent variables related to productivity as advocated by Hensher and Daniels (1995). These variables are the ratios of the total volume of production to total employment in the following sectors during 1979-1993. They have a high correlation with DOMTI of about 0.85, 0.58, and 0.87 respectively.

* Productivity of agricultural sector employees

* Productivity of industry, mine, and food sector employees

* Productivity of oil sector employees.

7.5 Conclusions

The ISLB scenario conceptual model developed in chapter six was operationalised in this chapter under four themes separately for general cargo and oil products foreign trade of Iran (GOPFT), domestic trade of Iran (DOMTI) and Central Asian and Caucasus foreign trade demand (CACFT). Sources of data and the related problems of collection and administration of this data were identified and introduced. Key issues and uncertainties identified in earlier chapters were expanded and described under the four headings: geographical, political, technical, and organisational. Independent variables were derived from these four areas to be used for estimation, scenario building and forecasting purposes in the next chapter.

8. Scenario analysis of the ISLB demand

8.1 Introduction

In the preceding chapter, data were prepared, identified and operationalised, and the framework for the ISLB scenario analysis in terms of events and trends was developed. The purpose of this chapter is to estimate three ISLB demand models, development of scenarios and interpret the relationships between dependent and independent variables under the three most probable scenario conditions.

The approach in this chapter is based on four main headings:

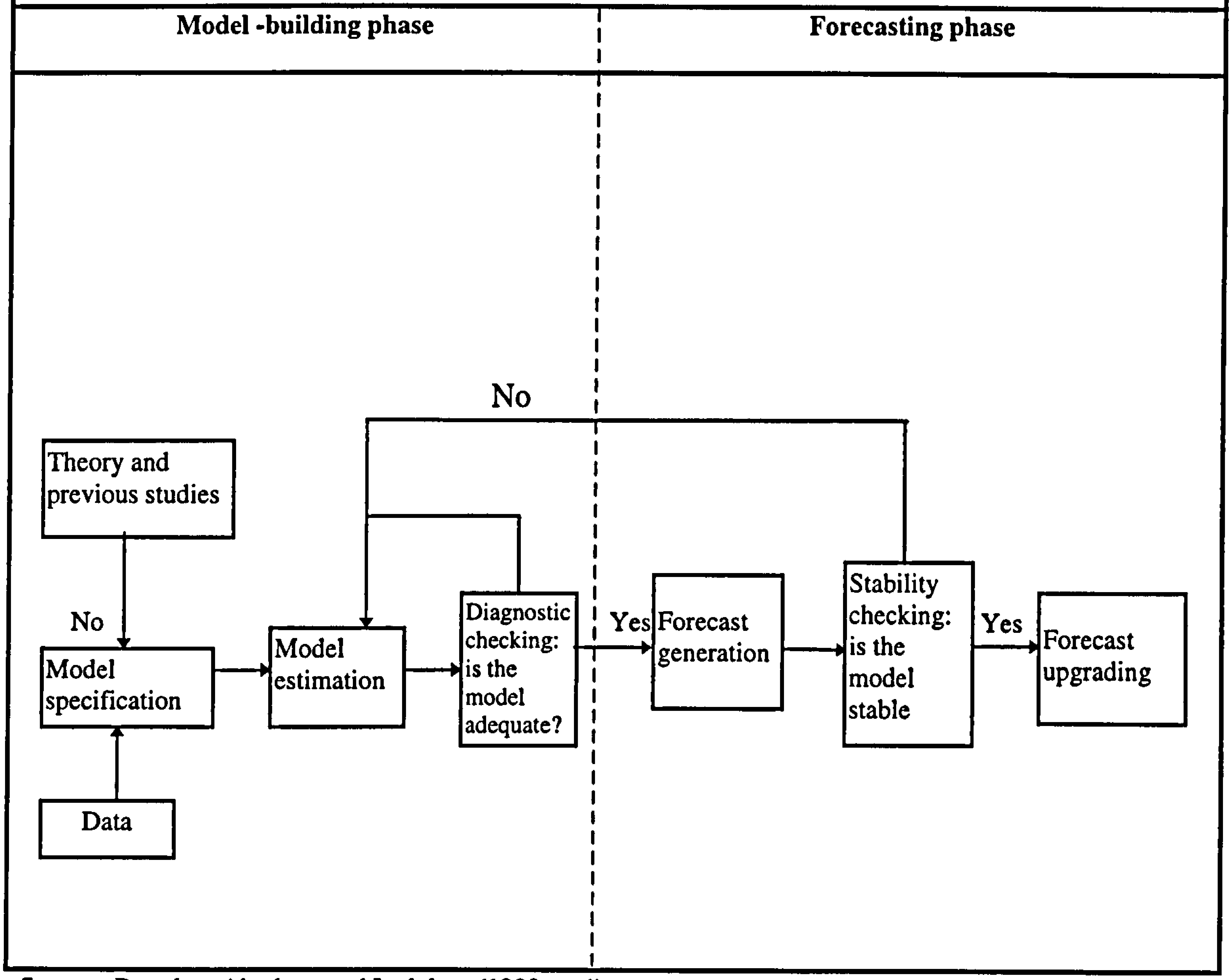
* Objectives and regression analysis
* Model estimation
* Interpretation of the results
* ISLB scenario development and model forecasts

8.2 Objectives and regression analysis

Many approaches to scenario analysis use some form of quantitative forecasting as the basis for further study (Cole and Chichilnisky 1978, Zenter 1982). Time series and causal models like regression are widely used techniques that facilitate a scenario analysis (Taylor 1992, Tongzon 1991, Picard and Nguyen 1987).

Regression analysis (RA) is used in many situations where one or more independent variables may explain the variation in a dependent variable and when "long range forecasts" are required (Kneafsey 1975). It also promotes better understanding of the relationships between different variables within the economic system. According to Abraham and Ledolter (1983), it is mainly based on two distinctive conceptual stages, that of model-building and forecasting. This process is illustrated in Figure 8.1.

Figure 8.1 Conceptual framework of a forecasting system.



Source : Based on Abraham and Ledolter (1983, p. 4)

RA is a mathematical procedure which explains the functional linear and curvilinear relationships of a dependent variable by one or more independent variables through the development of an equation indicating the relationship of dependent and independent variables to each other (Barron and Targett 1985 and Chatterjee & Price 1991). Regression analysis is often used to provide a series of forecasts based on an interpretation of historical data and forecast values can be varied through changes in the parameters of the model.

The degree of this variation can be measured by a value called the "coefficient of determination" of any independent variables to the dependent variable; it is the ratio of the explained variation to the total variation (Wheewright and Makridakis 1985) and is denoted by r^2. The effectiveness of the designed model is assessed using the r^2 statistic which explains the goodness of fit and explanatory power of the model and through various t-tests, the coefficients in the model are assessed.

The ISLB regression analysis (RA) study posed two questions: 1) to identify what are the effects and contributions made by the most powerful internal and external independent variables which affect the three dependent variables (volume of the three ISLB demands) and to assess their relative importance, 2) to forecast future values of these independent and then dependent variables (tonnage).

Since the main measure of the performance of all modes and interfaces is the tonnage handled or tonne/km travelled, any assessment must be based on some measure of the annual physical weight of the trade handled by each mode or interface which, in turn, may depend on some other independent variables like the number of road vehicles, rail rolling stock, or a ports average daily performance (MacNully, 1977). Specifically, the objective is, with the available data, to determine the relationships between the dependent and independent variables so that future volumes of the three types of demand can be identified and predicted. Macroeconomic data for 1979-1993 are employed to analyse the effects of socio-economic, political, technical and organisational factors on the total tonnage demand for the transport system of Iran. The use of available data from different parts of Iran's main national economic sectors provides a reasonable basis for such a study.

The aim is to measure the performance of Iran's transport system under uncertain internal and external conditions that will affect the future volume of trade. Therefore, RA provides both an estimated value of the trade and of the effects of the independent variables on the dependent variable given the scenario being tested.

The use of multiple regression analysis is limited by a number of inherent assumptions which must be met if analysis is to work as hoped. The four following main assumptions are based on Wheelwright and Makridakis (1985):

1. The linearity of the relationship between dependent and independent variables. If this condition is breached, the variables must be transformed into new variables e.g. through the application for example, of logarithmic, square root, or other transformations.

2. The homoscedascity (constant variance) of the regression errors or residuals (the difference between actual and forecast values) must be present over the entire set of observations.

3. A plot of the residuals indicates the independence of consecutive residuals (non-autocorrelation). If autocorrelation is present, however, then this indicates that one significant independent variable should be omitted so that a non-linear relationship between the variables exists.

4. Residuals must be normally distributed.

Model specification involves establishing the functional relationships between the dependent and independent variables of the three models (general cargo and oil products foreign trade of Iran (GOPFT), domestic trade of Iran (DOMTI), and Central Asian and Caucasus foreign trade (CACFT). This step is concerned with the determination of the variables in the equations and their functional form. According to Taneja (1978), there are three aspects in the specification of a model:

1. the selection of variables (see chapter 7, section 7.4 for ISLB)
2. the format of the variables (see chapter 7, section 7.4 for ISLB)
3. the functional form of the model (see section 8.4.1 for ISLB).

Scattergrams of each of the independent variables against the dependent variable give a rough guide to the nature of this relationship. The sample correlation coefficient (r) is a measure that indicates how closely the linear relationship exists between random dependent and independent variables and varies between -1 and +1. A value of -1 indicates a perfect inverse relationship whereby when x (the independent variable) increases, the dependent variable (y) decreases and vice versa. When r is equal to +1, alternatively, a perfect direct relationship exists. When it is zero, there is no relationship between x and y.

The linearity or any other probable functional form of the final model is determined by an assessment of the frequency of the residuals as well as their graphical relationship with the independent variables in the final model (Taneja 1978).

Two kinds of indicators are examined as an empirical basis for the ISLB model: factors related to the macroeconomic situation of Iran and the CAC countries and factors which concern transport performance.

Trade and in particular foreign trade forecasting is a common practice in scientific studies where volumes or values are regressed against some influential and explanatory socio-economic variables or time (Pollins 1982, Giannopoulos 1984, Tongzon 1991, and Dagenais and Martin 1987).

A country's health largely depends on the purchasing or selling of goods and services to other countries, and also is a function of population and market centres, geographical location, industrialisation, economic wealth, etc. The total volume of foreign trade is related directly and indirectly to GDP, income from foreign sources, population, industrialisation, geographical conditions, transport infrastructure and costs, etc. (Whiting 1986). In practice, it is affected by national tariffs and restrictions and also by a variety of other minor factors. It is necessary to assume that these variables are exogenous to the model being developed. In principle, many such independent variables might be simultaneously determined in such a general model along with the tonnage of foreign trade (Giannopoulos 1984).

The ISLB model is investigated using regression analysis where it is assumed that the dependent variable Y (e.g. foreign trade tonnage) is dependent on several independent variables X .

8.3 ISLB model estimation

According to Chatterjee and Hadi (1988) three factors which determine the regression equations are mainly "variables, the observations, and the model assumptions." According to Mendenhall and Sincich (1989, p. 80):

> "To decide quantitatively how well a straight line fits a set of data is to determine the extent to which the data points deviate from the line."

To estimate the GOPFT and DOMTI models an elimination (backward regression) and then stepwise processes was investigated where only those variables significant at 0.05% probability or lower are included in the preliminary or final estimated models.

ISLB Model estimations were carried out for three demands (GOPFT, DOMTI, and CACFT). These were introduced in sections 7.4.1.1, 7.4.1.2, and 7.4.1.3 respectively.

8.3.1 General cargo and oil products foreign trade of Iran

A correlation analysis was performed as a preliminary assessment of the selected twenty independent variables with GOPFT as the dependent variable. The variables were ranked according to their correlation coefficients with GOPFT as shown in Appendix 4. Using the results of a correlation analysis the first seven significant variables, all of which have positive correlation coefficients of higher than 0.70, were found to be: the value of foreign trade goods (X_6), port productivity/employee (X_{15}), value added of all major industries (X_4), employment (X_7), value of the intermediate goods (X_{18}), population (X_{20}), and final GDP (X_{20}).

To specify the GOPFT model, 20 independent variables were tested in 32 runs and in five phases. Three of these runs specifically were only applied for the assessment of each variable of the second and third GOPFT estimated models. The results of each phase and run are presented in Appendix 6 consecutively. To estimate the GOPFT model an elimination process was investigated where only those variables significant at 0.05% probability or lower are included in the preliminary and final estimated models It means that at each run the independent variable with highest *p-value* was eliminated from the subsequent run.

The independent variables were regressed against the GOPFT using the backward elimination procedure and resulted in equation (1) where the *p-values* are (for X_5, X_6 and X_{14}) less than 0.05 on all coefficients in the model and there is a high r^2 of 0.93. The empirical results of the final estimated model are presented in Appendix 5 (Abraham and Ledolter 1983).

$$Y_{GOPFT} = -7365.866588 - 0.0048 X_5 + 0.0041 X_6 + 0.0023 X_{14} \qquad \textbf{(EQ.1)}$$
$$(-1.276) \qquad (-2.93) \qquad (4.3) \qquad (2.52)$$

where X_5 is fixed gross national investment, X_6 foreign trade goods value, and X_{14} final GDP.

From the empirical results of the regression analysis it can be seen that X_6 has had a strong individual correlation with its share in the r^2 of 0.93 as high as 13.5%. It was found, however, that as a strong predictor there are not significant grounds for it to be used as a suitable independent variable for forecasting GOPFT. Also as independent variable it is (X_6) in fact the GOPFT but in terms of value; it produces a very direct logical correlation with its volume (i.e. it says the same) and consequently was excluded from further runs (Miller and Wichern 1977). Removing X_6 resulted in the r^2 (or explanatory power of the independent variables) of the first model dropping to about 0.80. The second estimated model that resulted is shown in equation (2).

$$Y_{GOPFT} = -24277.46 - 0.008 X_5 + 0.0054 X_{14} \qquad \textbf{(EQ.2)}$$

where X_5 is fixed gross national investment, and X_{14} final GDP.

High multi-collinearity among independent variables of a model can give a false indication for the value of the B coefficient and one or more variables with such behaviour should normally be dropped from the analysis.

To increase the explanatory power of the estimated GOPFT model in the second step of the GOPFT estimation procedure, the following five independent variables, as well as repeating the employment variable (X_7)[1], were included in the model with X_5 and X_{14} one at a time (stepwise regression) through runs 14 and up to run 20 as shown in Appendix 6 (Miller and Wichern 1977, Chatterjee and Price 1991).

1. Port productivity/employee (X_{15})
2. Rail productivity/employee (X_{16})
3. Government expenditure (X_{17})
4. Value of intermediate goods (X_{18})
5. Transport Investment (X_{19})
6. Employment (X_7)
7. Population (X_{20})

The result of each of these inclusions was evaluated by *p-values* as shown from run 13 to 20 in Appendix 6. While all of them influenced the explanatory power of the second estimated model found in run 13 to be higher than 0.80, they also increased the probability of a higher error than that adopted by the 0.05% level of significance (high *p-values*).

In assessing the final two remaining independent variables (X_5 and X_{14}), the sign of the correlation analysis of X_5 with GOPFT changes when assessed alone (-) and together with X_{14} (+) which is not logical.

To find out the importance of these two independent variables in the total r^2, each was regressed against GOPFT. It was found that X_5 had a positive correlation of about r = 0.23

[1] These variables in the first run were excluded purposely due to a perfect model with $r^2 = 1$ as the number of the variables equalled the number of observations (Abraham and Ledolter et al. (1983, P. 42).

but could only explain GOPFT with an $r^2 = 0.056$ which is a weak explanatory variable and not significant, providing another reason for its deletion in addition to its incorrect sign. Thus, X_{14} with population (X_{20}), which was the only variable among the new set of independent variables which gave a *p-value* of lower than 0.05 (0.029), were regressed against GOPFT to give the final model shown in equation (3).

The empirical results corresponding to this final GOPFT model are given in Appendix 7.

$Y_{GOPFT} = -24552.8 + 0.00213\,X_{14} + 0.00044\,X_{20}$	**(EQ. 3)**
where X_{14} is final GDP and X_{20} population.	

The results of the GOPFT final model show a high value of r^2 (0.87), with reasonably high *t-statistics* corresponding to very low *p-values* for both independent variables of the GOPFT model. They still do not indicate a good fit which can be assured by analysis of the residuals. Chatterjee and Price (1991, p. 8) pointed out that the:

> "Results are valid and have meaning only insofar as the assumptions concerning the residual terms in the model are satisfied."

An examination of Appendix 7 shows that the estimated parameters of all independent variables have the expected signs, with statistically significant impacts on GOPFT. The estimated form of the final model (equation 3) resulted in an r^2 of about 0.87 which indicates a strong predictive ability. There exists moderate collinearity of about 0.49 between the two independent variables (final GDP and population) which according to Wheelwright and Makridakis (1985, pp. 176-77) "is a frequent problem in economic and business data because of the high correlation between the different factors". This is acceptable given the long range aims of the project.

Consequently, the analysis results in the fact that changes in the GOPFT are related to changes in real GDP and population. In practice, to a great extent, there are cause and effect relationships between them. The assumption is not unrealistic since GDP is a measure of the output of the economy of Iran whose efficiency is largely dependent upon the import of mainly intermediate goods. Also the growth of the population requires more employment and economic centres, which again calls for more foreign trade and greater aggregate demand for imports.

8.3.2 Domestic trade of Iran

There is not a comprehensive published data source about the geography of inter-provincial freight transport in Iran, nor for any of the foreign trade of CAC traffic through Iranian ports. The basic reason for the former is mainly the lack of research and comprehensive scientific studies in this particular field and also as there is no statutory reason to do so.

To further the analysis, at first the interrelationships of available data must be analysed and processed. As a second stage, since the nature of transport services and networks vary, the process of data identification for links will be carried out separately for road and rail modes. To specify the DOMTI model, 25 independent variables were tested in 48 runs and in four phases. Four of these runs specifically were only applied for the assessment of each variable of the second and third estimated models. The results of each phase and run are presented in Appendix 9.

The results of the correlation analysis (see Appendix 8) carried out between all variables involved in the DOMTI study, show that most of the independent variables have a high positive correlation with DOMTI, a preliminary indication of the linearity of the model. For a properly understanding, the results of the "net" correlation with DOMTI were categorised between 0.70 and over (high), 0.50-0.70 (moderate), and lower than 0.50 (low). On this basis, 12 ranked high, 4 moderate, and 8 achieved a low score, two of which were negative (Salvatore 1982).

To assess and describe the future situation of DOMTI the actual data for 1979-1993 will be used and therefore the mathematical model must be established.

The regression results, parameters, and residuals of the first estimated model of DOMTI used the backward elimination method as shown in Appendix 10 (Chatterjee and Price 1991). Two independent variables have a high explanatory power of about 0.96 with expected positive signs, significant low *p-values* and high t-statistics as shown in (EQ.4).

$$Y_{DOMTI} = -37740.6476 + 0.038466755\,X_5 + 0.004440867\,X_9 \qquad \textbf{(EQ.4)}$$
$$(-2.392) \qquad (7.21) \qquad (15.083)$$

where X_5 is fixed gross national investment, and X_9 value added of the agricultural sector.

One of the variables (X_9) is among those with a very high Pearson correlation coefficient, while the other (X_5) was weak. They were 0.88 and 0.36 respectively.

Therefore, in the second phase, the estimated model with X_5 and X_9 was run (runs 14-23) and started with X_2, which was intentionally dropped from the first phase due to a perfect model situation and presented a *p-value* higher than 0.05% level of confidence (0.06). Then, from the model, ten other explanatory variables (X_{15} to X_{25}) were tested with a view to modifying the model. One explanatory variable (X_{23}) was added to the first DOMTI estimated model in run 23 and the results are shown in (EQ. 5) and Appendices 9 and 11. The results of the second estimated DOMTI model indicate an increased r^2 0.98, a *t-statistic* for X_{23} which is higher than 2 and acceptable (2.85), but a very low *p-value* close to 0.016.

$$Y_{DOMTI} = -54345.3444 + 0.034965907\,X_5 + 0.053414667\,X_9 + 42364.205387\,X_{23} \qquad \textbf{(EQ. 5)}$$
$$(-3.944) \qquad (7.95) \qquad (9.032) \qquad (2.853)$$

where X_5 is fixed gross national investment, X_9 value added of agricultural sector, and X_{23} productivity of agricultural sector/employee.

To forecast the future volumes of the aggregate DOMTI, the final parameters of the model must be estimated to provide the most reliable basis for obtaining demand predictions of all ISLB modes. The second estimated model includes three variables of which only one can be considered a macroeconomic variable (X_5) which has a weak correlation. Therefore, a search for a stronger model was continued with first and second estimated models up to run 27 with X_{24} and X_{25}. Then since some of the explanatory variables have shown a correlation of higher than 0.70 with DOMTI, they were added for the second time to the second estimated model up to run 36. In runs 37 and 38, attempts were made to assess the individual contribution of the independent variables of the first estimated model (X_5 and X_9). It was found that X_5 with $r^2 = 0.13$ had contributed much less than X_9 to the explanatory power of the first model and, therefore, it was dropped. The model with two variables X_9 and X_{23} was run again with most correlated independent variables higher than 0.70. In run 42, the third DOMTI estimated model had 0.98% explanatory power (r^2) and the inclusion of X_{14} was obtained. The estimated parameters and other regression results of this phase are shown in Appendix 12 and seem to be appropriate with a common explanatory variable like GDP in the final model (EQ.6).

$$Y_{DOMTI} = \underset{(-5.886)}{-95088.6714} + \underset{(5.856)}{0.032627984}\, X_9 + \underset{(2.245)}{0.01559261}\, X_{14} + \underset{(8.301)}{3311.95902}\, X_{23} \qquad \textbf{(EQ.6)}$$

where X_9 is value added of agricultural sector, X_{14} final GDP, and X_{23} productivity of agricultural sector/employee.

8.3.3 Central Asian and Caucasus foreign trade

The objective of this part of the study is to specify and estimate an aggregate model for forecasting the freight of the CAC countries through Iran. The CACFT volume shows an expected, relatively high positive correlation of 0.79 with GDP per capita (Appendix 13) which indicates the possible linear functional relationship (but negative against time) and also is supported by the scattergram of CACFT against GDP per capita.

In order to specify the parameters of the CAC foreign trade model, the simple regression technique was used to estimate the relationship between the total CAC Asian foreign trade through Iran and GDP per capita of all these eight countries. The number of observations is limited to only seven due to the non-availability of data which may undermine confidence in the results (Fischer et al. 1996). The regression model for CACFT is shown in EQ. 7 and results in Appendix 14.

$$Y_{CAC} = -1274653.287 + 125.6\,X \qquad \textbf{(EQ. 7)}$$
$$(-0.913) \qquad (2.862)$$

where X is GDP per capita of CAC countries.

8.4 Interpretation of the results

8.4.1 General cargo and oil products foreign trade of Iran

To examine the adequacy of the model there are several questions to be answered about the value of the regression coefficient, confidence interval, and confidence attached to the forecast values (Wheelwright and Makridakis, 1985). The slopes of both explanatory variables will be hypothesised as null i.e. ($B = 0$) which means those variables (X_{14} and X_{20}) in the regression analysis with *t-ratios* higher than 2 will be deemed significantly different from zero. The regression analysis found that the coefficients for X_{14} and X_{20} are not close to zero but are approximately four to five times higher than the related standard error of the explanatory variables (Wheelwright and Makridakis 1985). Therefore, the null hypothesis is rejected and both independent variables are considered to have an impact on GOPFT (see table 8.1). In obtaining the value of the regression coefficients of the general cargo and oil products foreign trade of Iran (GOPFT) independent variables, a 95% level of significance was applied and *p-values* of 0.0007 and 0.00011 obtained, lower than the 0.05 level of confidence, which assured the true values of the regression coefficients.

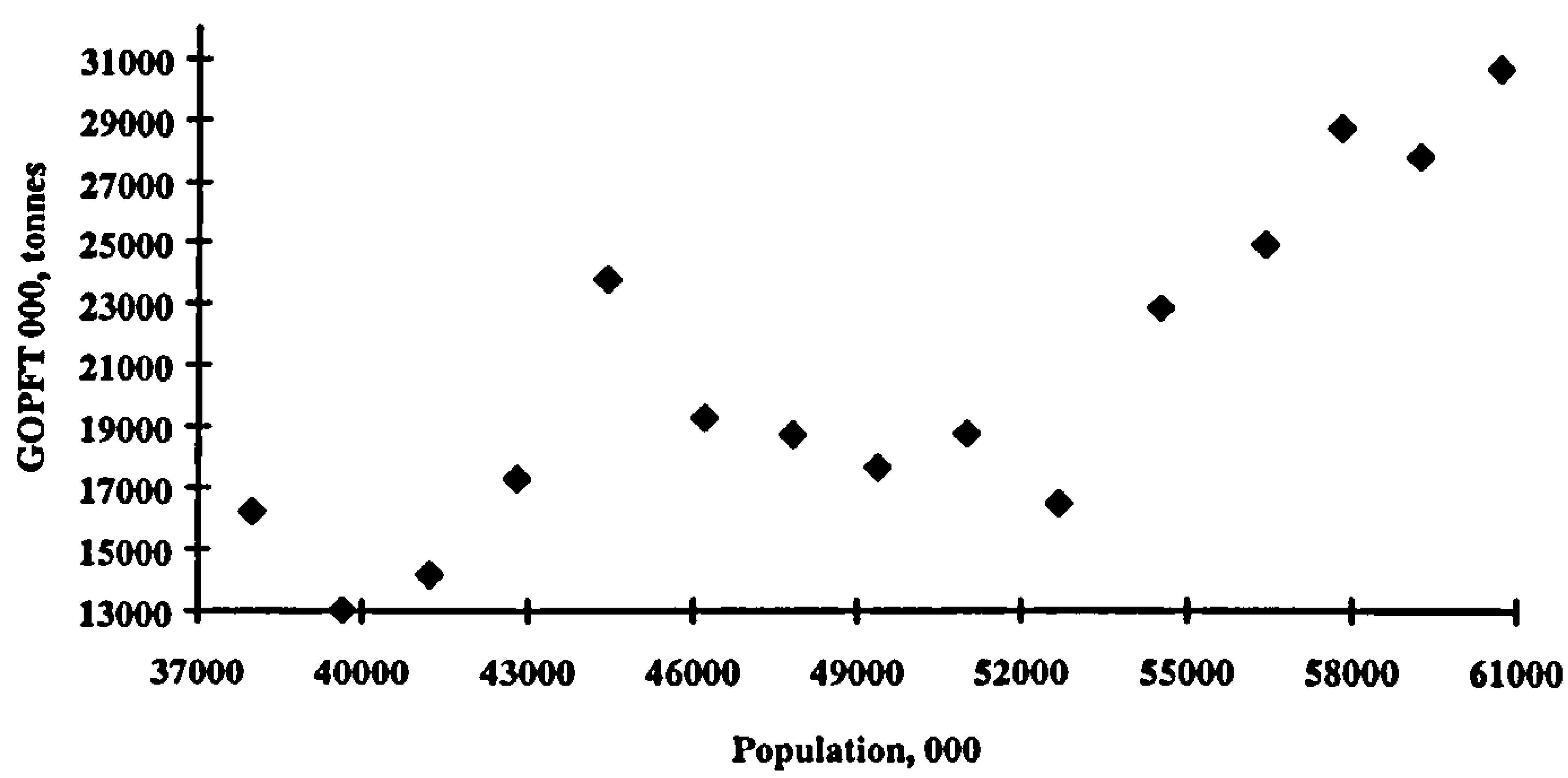
The results of the final GOPFT regression analysis are presented in Appendix 7 with an explanatory power of about 0.87, which indicates most of the future variations of the GOPFT forecasts are explained by the two selected independent variables of final GDP and population. Both of these two variables have positive signs as expected. The *t-ratios* produced in the final GOPFT model are about twice as great as the absolute and required value of 2, confirming that the regression coefficients of this model are not zero. The stability of the model as shown in Appendix 6 was tested for final GDP and population in runs 21 and 30 by regressing each against GOPFT which showed relatively high r^2 (0.6 and 0.7 respectively).

Table 8.1 Impacts of *B* coefficient on final GOPFT model.

	Change in dependent variables	*B* Coefficient (000 tonnes)	Impact on GOPFT tonnes
X_{14}	Every one million Rials increase in GDP	0.002127379	0.002173 x 1000 = 2.173 tonnes increase in GOPFT
X_{20}	Every one person increase in population	0.000442677	0.000442677 x 1000 = 0.4426 tonnes increase in GOPFT

1. Population has a high correlation of 0.83 with GOPFT. A scattergram of this relationship, shown in Figure 8.2, also shows this tight linear relationship. The regression coefficient for population indicates that there is an increase of 0.443 tonnes of GOPFT for every one person increase in population. When population was tested individually against GOPFT the result is higher at about 0.617 tons. Population has a two-edged effect on GOPFT. On one hand, it causes a greater demand for consumable goods which accounts for 19.5% of the total 30.5 million tonnes of Iranian foreign trade in 1993. On the other hand, the increased population can cause increased GDP requiring an expansion of the economy through more investment and, consequently, more capital and intermediate goods being imported.

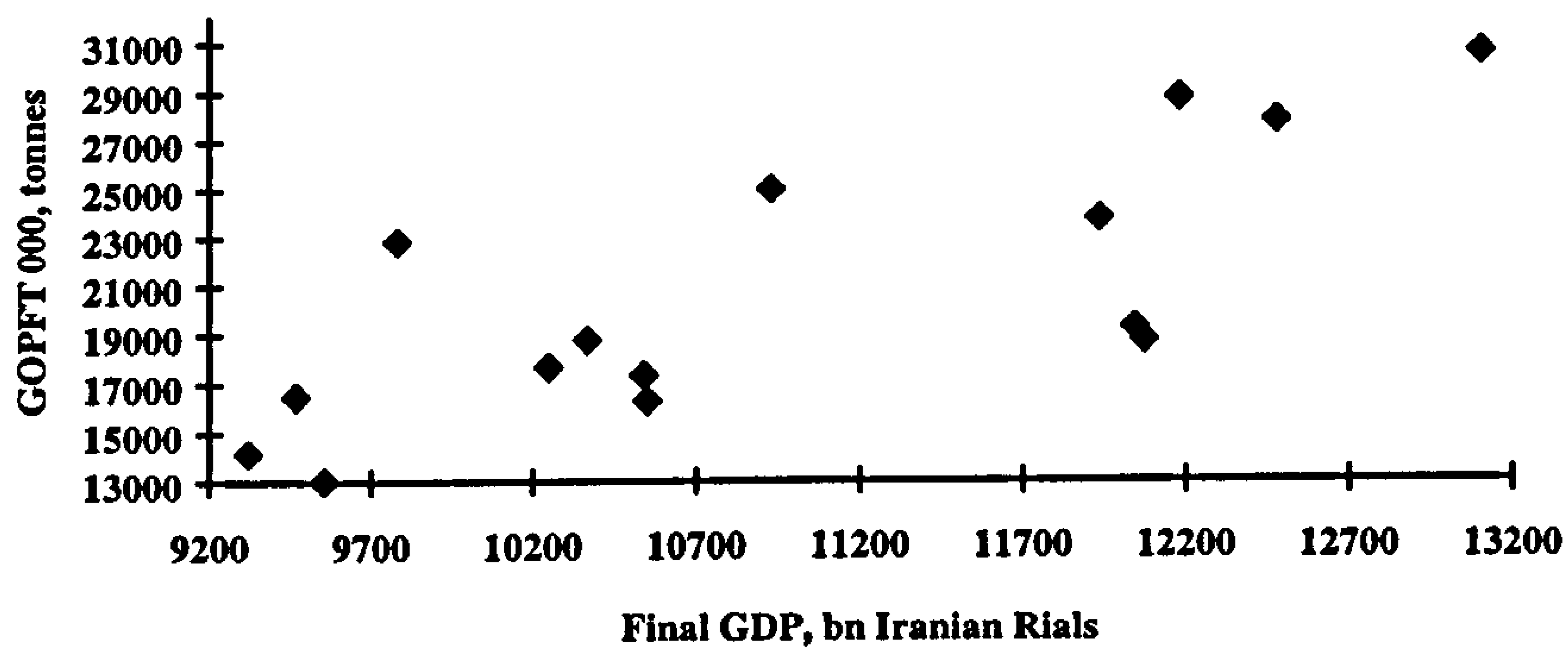
Figure 8.2 Scattergram of the GOPFT of Iran by population during 1979-1993.



Source : Central Bank (Bank Markazi) of Iran, 1991, 1992, 1993, 1994a, 1994b, various national accounts reports, various pages.

2. Real GDP also has a relatively high correlation of about 0.77 with GOPFT as shown in Figure 8.3. The regression coefficient indicates (Table 8.1) that there is an increase of 2.13 tonnes of GOPFT (based on seven sectors) for every one million Iranian Rials increase in the real GDP composed of four sectors (agriculture, industry and mine, oil and gas, and the main service sectors). One aspect of the effect of the GDP on GOPFT is that, through the needs of different sectors to import capital and intermediate goods, there are qualitative and quantitative improvements in the output of the GDP sectors. The other impact is that better and higher volumes of domestic production can lead to increased exports.

Figure 8.3 Scattergram of the GOPFT of Iran by final GDP 1979-1993.



Source: Central Bank (Bank Markazi) of Iran, 1991, 1992, 1993, 1994a, 1994b, various national accounts reports, various pages.

When using the GOPFT model for forecasting, the structure of the relationships between variables is subject to change over time. Time could result in inaccurate forecasts due to the over- or under-prediction and divergence from the mean (Saunders, et al. 1987). According to Barron and Targett (1985, p. 45):

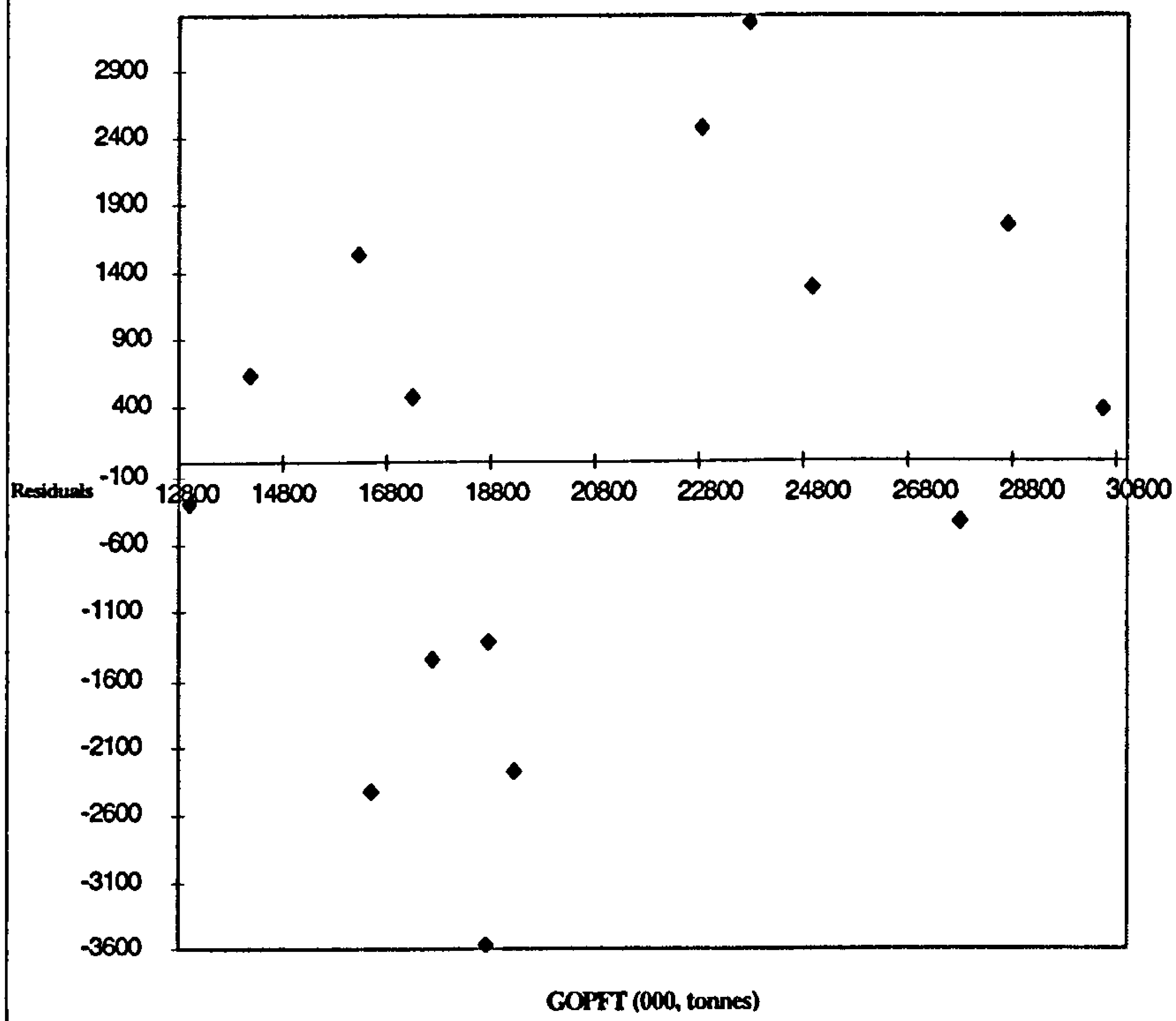
> "The residuals determine the accuracy of the forecast. ..... The size of the residuals is therefore an indication of forecasting accuracy. An overall measure of the size of residuals is their standard error."

The other method is to plot the frequency of the residual histogram where the band of the residuals is presented against the frequency of the repetition of the band.

The analysis of residuals provides a basis for assessing the accuracy of the GOPFT model. It involves plotting the difference between predicted and actual GOPFT against each of the independent variables in the final model. The residuals for the GOPFT model are shown in Figure 8.4.

The scatter plot of residuals shows the dispersion of the 15 points. The outliers or extreme predicted values of GOPFT by the final model lie outside the range +2900 to -3600 (Chatterjee and Price, 1991). The scattergram presentations in Figures 8.2 and 8.3 for the GDP and population versus GOPFT show that the functional pattern of the model is appropriate. The plot of the estimated residuals against GOPFT tonnage indicates that residuals are randomly distributed about zero and lie between -3569 and 3247. Ten high value residuals are nearly balanced by 7 points (47%) located in the negative band which indicate that the predicted values of GOPFT by the final model are lower than the relative observed ones. Eight points lie in the positive bands, indicating that the predicted values by the model are higher than actual volumes and can reasonably be acceptable as the systematic distribution of the residuals. The almost counterbalancing residuals (+8 and -7) suggest that there might be over forecasting by the model, which can be accepted since GOPFT involves long range prediction. According to Barron and Targett (1985, p. 43) "residuals should be random; .... without any pattern or order". There are few and in particular two extreme residuals with different signs (belonging to data in 1983 and 1985) and may indicate the existence of some inadequacy in the assumptions or in the GOPFT model specification (Chatterjee and Price 1991).

Figure 8.4 Plot of the predicted residuals against actual tonnage of the General Cargo and Oil Product Foreign Trade of Iran during 1979-93.



Therefore, according to this residual analysis a first order regression model must be applied for forecasting the GOPFT of Iran during the forecast period of 1993-2005. The summary of each run up to the first estimated model is shown in Appendix 6.

8.4.2 Domestic trade of Iran

The results of the domestic trade of Iran (DOMTI) regression analysis are presented in Appendix 14. The explanatory power of the final model, with an r^2 of 0.98, is higher than for GOPFT (0.87). This indicates that the proportion of DOMTI which is not explained by fluctuations in the three variables in the model is only 2%. All *t-ratios* (b/standard error) are greater than the absolute value of 2, which indicates that the constant term and regression coefficients of all three independent variables are significantly different from 0. The accuracy of the final model as shown in Appendix 15, was expressed by residuals as percentages of the observed values. Since the largest residual is only -6.5%, it can be seen that the final DOMTI regression equation is quite accurate.

The final estimated model (in run 42) resulted in three independent variables upon which the volume of the DOMTI will be assessed and then forecast. These were value added in agriculture (X_9), final GDP (X_{14}) and productivity of the agricultural sector (X_{23}), all of which have the expected positive signs. Their impact on DOMTI is shown in Table 8.2 .

Table 8.2 Impacts of *B* coefficient on final DOMTI model.

	Change in dependent variables	*B* Coefficient (000 tonnes)	Impact on DOMTI tonnes
X_9	Every one million Rials increase in the value added in agricultural	0.03263	0.03263 x 1000 = 32.63 tonnes increase in DOMTI
X_{14}	Every one million Rials increase in GDP	0.01559	0.01559 x 1000 = 15.59 tonnes increase in DOMTI
X_{23}	Every one man/tonne increase in agricultural productivity	3311.96	3311.96= 3311.960 tonnes increase in DOMTI

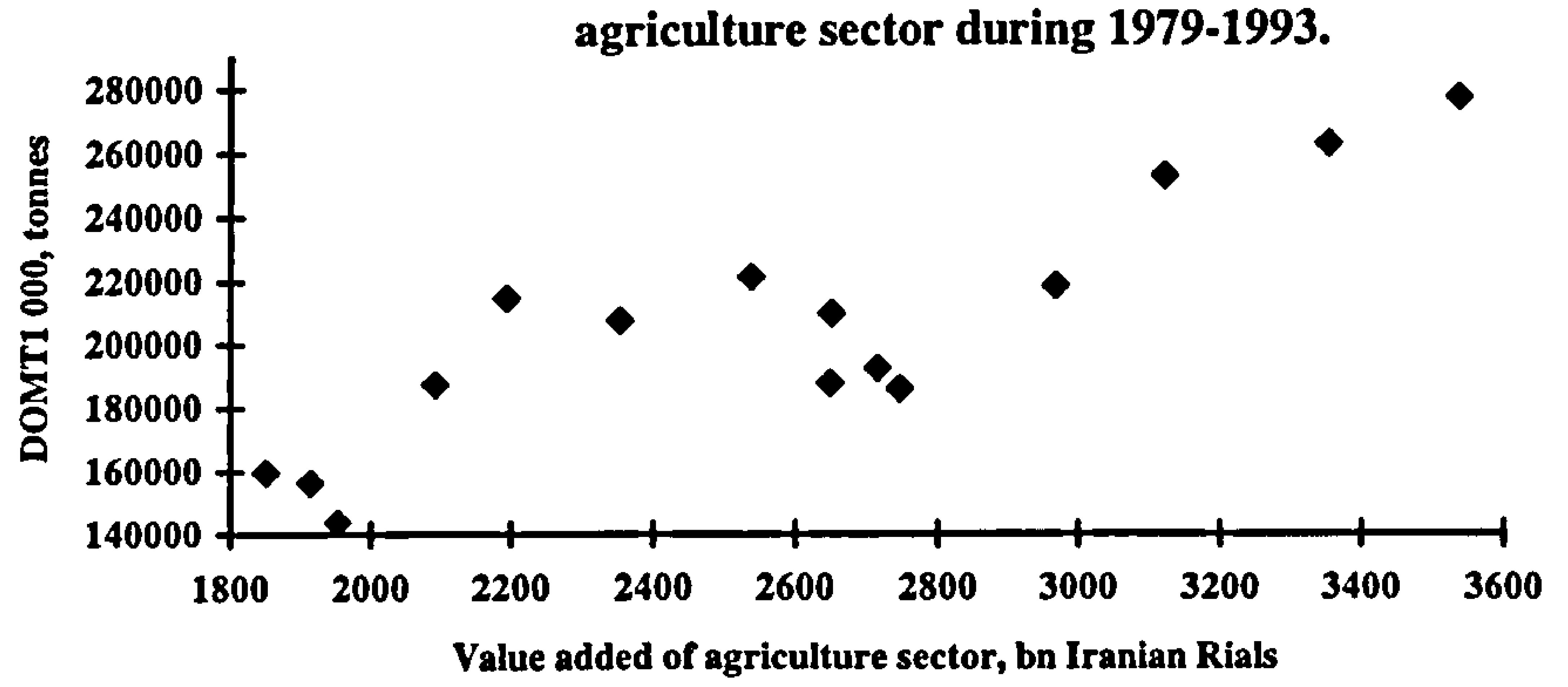
The coefficient of determination (r^2) ranges from 0.96 in the first estimated equation to 0.97 and 0.98 in the second and third estimated models respectively. All three explanatory variables of the final model (X_9, X_{14}, and X_{23}) are highly correlated with DOMTI (Jin 1993).

The stability of the model was tested by the omission of the variable X_{23} from the third model and it was found that both remaining variables (X_9 and X_{14}) still have very low *p-values* of about 1.93×10^{-06} and 2.32746×10^{-06} respectively (both with positive signs). Let us consider each of the three variables in relation to DOMTI.

1. Value added in agriculture (X_9)

This may be an indication of the impact of the sector activities on the total economic operation of the country. It accounts for a 0.88 correlation with DOMTI (Figure 8.5). Agriculture in Iran is an important sector. The bulk of Iran's exports are through this sector while imports of wheat, barley, and maize are significant items.

Figure 8.5 Scattergram of the DOMTI of Iran by value added of agriculture sector during 1979-1993.

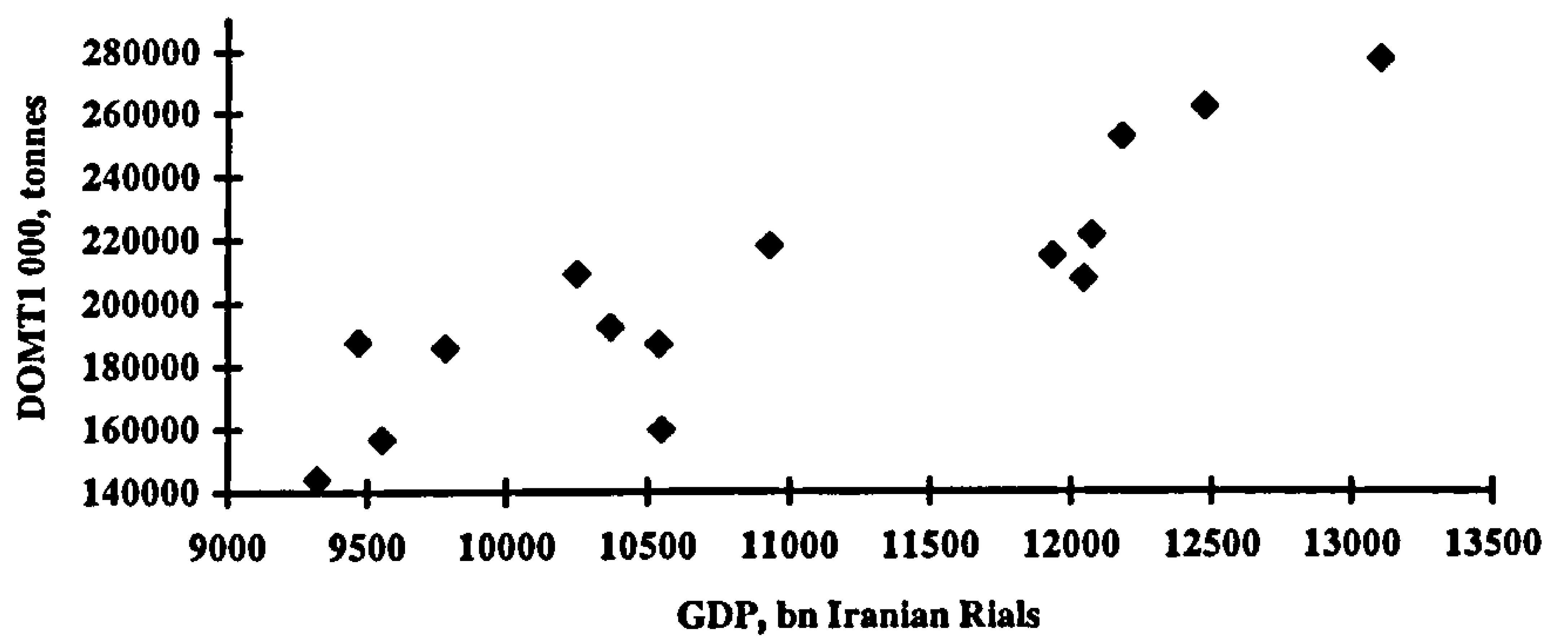


Source: Central Bank (Bank Markazi) of Iran, 1991, 1992, 1993, 1994a, 1994b, various national accounts reports, various pages.

2. GDP (X_{14})

DOMTI also has 0.87 correlation with final GDP excluding services (Figure 8.6).

Figure 8.6 Scattergram of the DOMTI of Iran by GDP during 1979-1993.



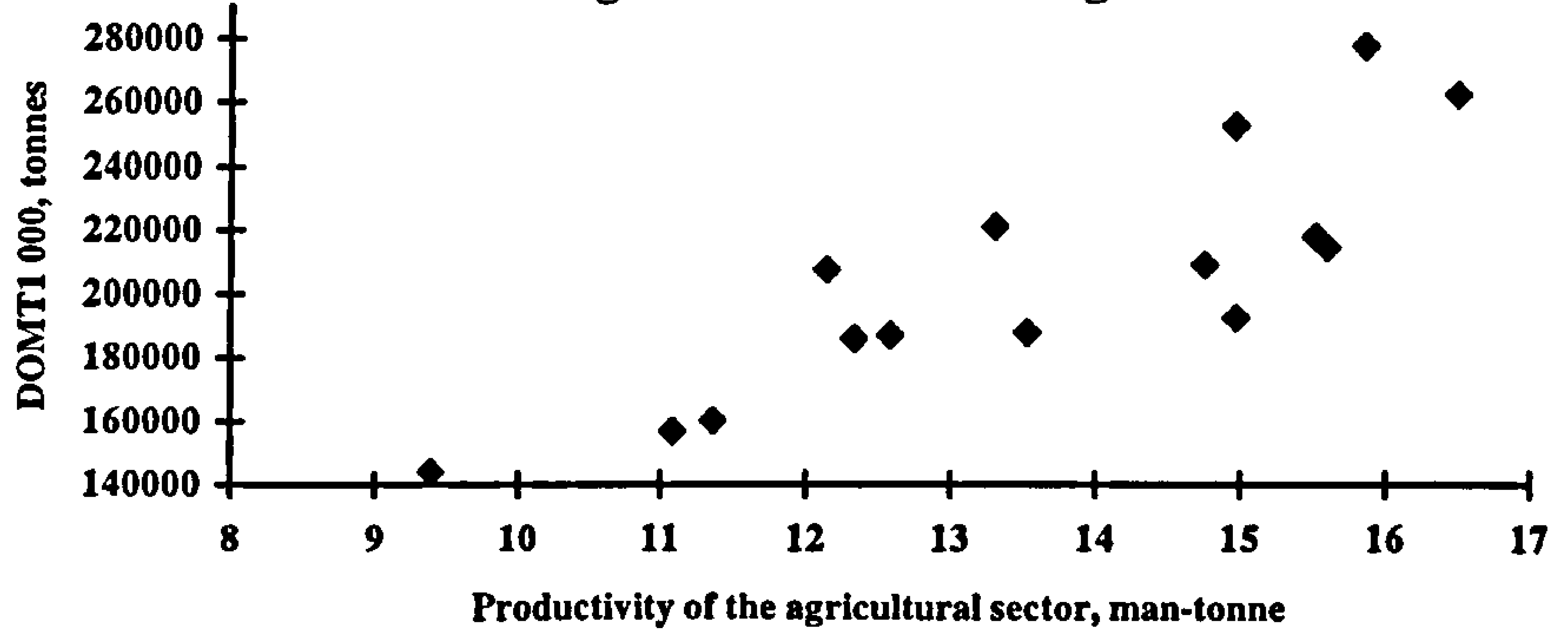
Source: Central Bank (Bank Markazi) of Iran, 1991, 1992, 1993, 1994a, 1994b, various national accounts reports, various pages.

3. **Productivity of the Agricultural Sector (X_{23})**

This has a 0.85 correlation with DOMTI (Figure 8.7). Since this is a derived variable (given by the ratio of agricultural volume/employees) its high correlation can be explained directly by the impact of the human skills and technology on production volumes.

The linearity of the single variable models can be determined by assessing the magnitudes of the r^2 close to + or - 1 (which in the three estimated models of the DOMTI were very high and varied between 0.96 and 0.98).

Figure 8.7 Scattergram of the DOMTI of Iran by the productivity of the agricultural sector during 1979-1993.

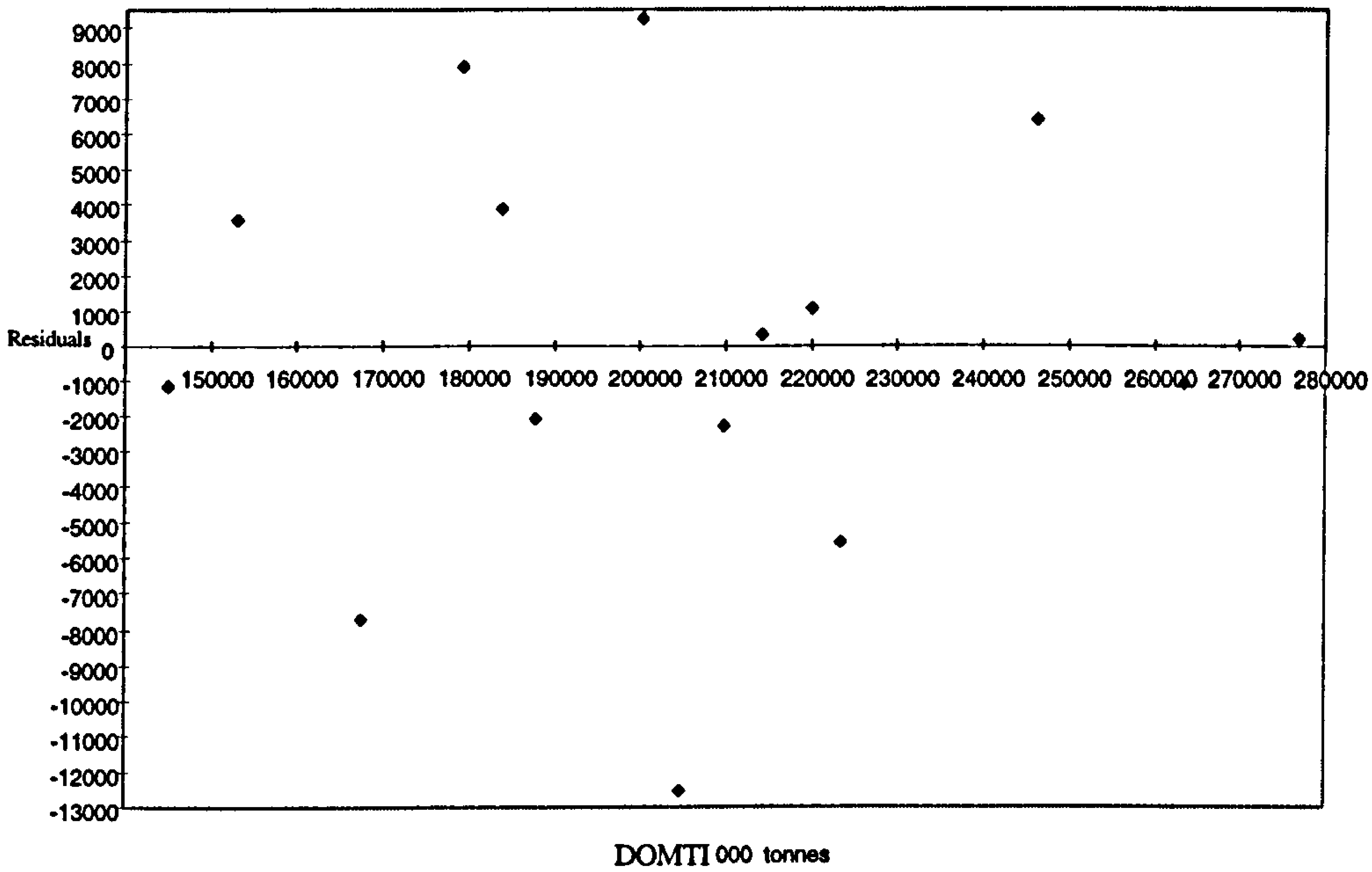


Source: Central Bank (Bank Markazi) of Iran, 1991, 1992, 1993, 1994a, 1994b, various national accounts reports, various pages.

The DOMTI linearity can be confirmed by plotting independent variables against the dependent variable and inspecting the relationship. In the case of two or more independent variables, however, analysis of a plot against actual values of the dependent variable is more appropriate. In fact, this accounts for considering them as the dependent and independent variables in a simple regression (Taneja 1978). The plot of the residuals against predicted DOMTI in Figure 8.8 shows two high residuals with different signs respectively. One is equal to 6.5% of the total observed data and the other to 4.2% in 1987 and 1982. The dispersion of the residuals shows a +8 and -7 distribution which suggest they are about normally distributed as shown in Figure 8.8 and can be accepted as a reasonable model for DOMTI.

The Final DOMTI regression can now be used to prepare a forecast. This requires that values of X_9, X_{14}, and X_{23} be estimated and then be substituted into the regression equation to compute a prediction for DOMTI in the year 2005.

Figure 8.8 Plot of the predicted residuals against actual tonnage of the DOMTI of Iran during 1979-1993.



8.4.3 Central Asian and Caucasus foreign trade

The results of the Central Asian and Caucasus foreign trade (CACFT) ordinary least squares regression model are presented in Appendix 14. Equation 7 indicates that GDP per capita affects CACFT positively.

It also shows that about 38% of the future value of the CACFT cannot be expressed by the GDP per capita and is shown in terms of a high negative value intercept. The results in Appendix 14 indicate that with an increase of one US $ in the GDP per capita of the whole CAC region, the CACFT increases by about 125.6 tonnes. Another result of the coefficient in the model is the moderate explanatory power of the model (r^2 of 0.62) which is probably acceptable for CAC countries in their current transitional situation. The *t-ratio* of the GDP per capita is above 2 which confirms that the regression coefficient is not zero and acceptable. With a *p-value* of about 0.035, the future forecasts can be further verified.

8.5 ISLB scenario characteristics and descriptions

8.5.1 Justification and choice of ISLB scenarios

The application of just one scenario with any measure of probability is not sufficient as an assessment of different futures, while the use of many scenarios is not possible or practical. According to Schnaars (1987), in seven sample studies (Becker 1983, Dekluyer 1980, Zentner 1975, Linneman and Klein 1977, MacNully 1977, Wilson 1978, and Vanston 1977) all have used three to six scenarios. Consequently, the development of three scenarios seems reasonable to investigate the potential of Iran as a landbridge country for CAC countries.

According to Schnaars (1987), six out of seven studies used the base year scenarios as the most probable anticipated scenario. This approach is also adopted in the ISLB study. The other two scenarios are labelled as optimistic and pessimistic views (Mandel 1983).

The contents of these three scenarios are based on research and literature. Starr (1996) has proposed three possibilities for the future of the Central Asian countries:

* they could come under the hegemony of one or more outside powers, Russia being the most likely candidate.

* they could lapse into chaos. Tadjikistan and Afghanistan have already done so, threatening the security of adjoining regions.

* they could achieve equilibrium and coherence from within, through the emergence of an anchor state or states.

On these bases the description of the three ISLB scenarios as shown in Table 8.3 were developed (Porter 1985).

The other aspect of the ISLB scenarios is to attempt to identify the effects of a changing demand on the Iranian transport supply system. All the inputs of the ISLB scenarios will examine the future effects of the independent variables on volumes of demand and then

Table 8.3 Description of the three alternative ISLB scenarios of demand and supply to 2005 in Iran and CAC countries.

Scenario No.	Description of scenarios
I	**Most probable scenario:** It basically incorporates the most recent and available economic information on Iran (1979-1993) and CAC countries (1985-1993) but assumes that there will be no radical deviation from expected policies of Iran, CAC republics, CIS and in the international environment. This scenario is used as the basis of comparison of the other two probable alternatives. An increase in the real GDP of Iran and GDP per capita of the CAC countries (on the basis of past historical data for these countries) is assumed to affect the total flow of the foreign and domestic trade through the Iranian network and interface system. The response will be greater investment and utilisation of existing transport capacities and services and also some other macroeconomic and political factors.
II	**Optimistic:** A significant increase in oil prices and consequently oil revenues of Iran and most CAC countries as oil producing countries. This event results in much greater investment in transport infrastructure and superstructure for Iran and also higher transport demand by both Iran and CAC republics. This optimistic situation is associated with significant changes in the foreign policies of Iran in particular USA.
III	**Pessimistic:** This scenario assumes a radical change and decay in the environment of the CAC and CIS countries and Iran. Re-emergence of the former USSR leads to greater interaction of the CAC countries with CIS and Russian economic and political forces which generally will result in changes in the direction of CAC trade and consequently a reduction of its flow through Iran. The objective of this scenario is to determine its effects on the internal and external environment of the transport system of Iran in terms of policies and strategies.

will evaluate their impact on the transport supply system (Ducot and Lubben 1980, Nijkamp and Blass 1994). Therefore, on the one hand, the ISLB scenarios are exploratory scenarios with certain independent variables as causes with probable future situations as effects. On the other, the ISLB scenarios are descriptive as potential future events are selected and applied (Jungermann, 1985 and Neuman 1994). ISLB can also be an explanatory research as it is partially quantitative and has identified relationships between GOPFT, DOMTI and CACFT and the six independent variables.

8.5.2 ISLB Scenario descriptions

For these scenarios a detailed Table 8.4 is developed showing the specific quantifiable events or trends for each of the key issues presented in chapter six (see Table 6.3). These are in turn classified according to the four broad areas (geographical, political, technical, and organisational) used throughout this dissertation and first introduced in chapter four. The figures given in Table 8.4 are justified in more detail during the model forecasting undertaken for the three scenarios in section 8.6.

Table 8.4 Most probable, optimistic and pessimistic scenarios for ISLB development.

	Themes		Events and trends		
	Geographical	Key issues	Most probable scenario	Optimistic scenario	Pessimistic scenario
1.1		Volume of trade from CAC countries and Iran	1. Growth of the independent variables of the three models during 1979-1993 for Iran and 1987-1993 for the CAC countries was considered as base for forecasting period (1994-2005) for all three scenarios. (see Tables 8.4-8.15 except for 8.6 and 8.8). The volume of the CAC countries trade with Iran in 1993 (see Table 3. 39) was considered as a base for the Asian trade of these countries through ISLB. Therefore, it is assumed that they will have a low growth. Consequently, the GDP per Capita of these countries is based on the sum of the growth of the related independent variable (-2 in 1994, see Table 8.9) grows in such a way that will have only 174,000 tonnes increase in 2005 (over the 1652000 tonnes trade with Iran in 1993) and from 1994, this growth (0.6%) will be allied to the GDP per capita of the CAC countries onward as shown in Table 8.9. 2. Volume of GOPFT oil products drops from 24.1% of total in 1993 to 13.3% in 2005 (see section 9.2.4 for further detail). 3. The volumes of the GOPFT and DOMTI increase (see sections 2.5 and 4.2 of this Table and sections 8.6.1.1 and 8.6.1.1 for further details).	1. High growth in the trade of CAC countries (about 6 times the most probable scenario) and 26% for GOPFT, 51.6% for DOMTI all of which are based on the sum of the growth of the related independent variables for different demand models between 1994-2005 (see section 8.6.2 and Tables 8.10, 8.11, 8.12 for further details). 2. Volume of oil products drops same as the most probable scenario. 3. The volumes of the GOPFT and DOMTI increase (see 2.5 and 4.2 of this Table and sections 8.6.2.1 and 8.6.2. for further detail).	1. Volume of CAC and Iranian trade decline as independent variables in models decline except population. This is due to the failure of the CIS and CAC economic policies (see section 8.6.3.3 and Table 8.15 for further detail). 2. Volume of GOPFT oil products drops same as the probable scenario. 3. The volumes of the GOPFT and DOMTI decrease (see 2.5, 2.6 and 4.2 of this Table and section 8.6.3.1 and 8.6.3.2 and Tables 8.13 and 8.14 for further details).
1.2		Population growth	Iran, based on 1979-1993 data and a linear model compared with base year 1993, will have approximately 33% increase in 2005 (see section 8.6.1.1 for further detail).	Same as most probable scenario	Population grows as most probable scenario.
1.3		Land enrichment and significant agricultural-based developments	Grow according to the second developmental programme and continued with same rate to 2005.	New dams on Karun river will be completed with increased land under irrigation and also agricultural crops.	Delay in the completion of new dams on Karun river. Occasional droughts and decline in irrigation and agricultural crops.
1.4		Major economic projects in Iran and CAC countries	Iran will complete its national projects (second and third development programmes) particularly around desert areas with regard to exploitation of new mines, power stations, petro-chemical plants, Bojnoord metal projects.	1. Iran will succeed in completing its major national projects according to the third development programmes. 2. CAC countries will succeed in accomplishing the industrial renewal.	1. Iran will not succeed in completing its major national projects according to the third development programme. 2. CAC countries will not succeed in accomplishing the industrial renewal process.

Table 8.4 continued.

			Events and trends		
2	Political	Key Issues	Most probable scenario	Optimistic scenario	Pessimistic scenario
2.1		Iran domestic politics and foreign relations	1. Present situation will be continued with USA. 2. Re-election of the President Rafsanjani or one with similar policies.	1. New full relations with USA. 2. Election of a new President for Iran. 3. Iran joins World Trade Organisation (formerly GATT).	1. Iran's relations with USA are similar to optimistic scenario. 2. New elections in Iran lead to the election of a President with similar policies. 3. Iran join WTO.
2.2		CIS, CAC countries and Russia future political environment	Russian reforms move forward with economic problems but present political party faces stronger competition from nationalist and Communist parties; meanwhile no radical change happens in both political and territorial areas.	Russian reforms become more successful economically and no radical change happens both politically and territorially.	1. Russian economic reforms fail leading to radical changes in both politics and territory. Communist parties win parliamentary elections and enforce certain restrictions over market economy policies of Russia and other CIS and CAC countries.
2.3		Iran's foreign revenues	1. Stable revenues; oil prices increase at expected and low levels within $14 and 16.5 per barrel for 1993-1998 and with the same rate ($ 0.5 annually) to $20 in 2005. 2. Increase in supply of crude oil at the rate of 6.16 barrels per employee in oil sector for 1994-1998. 3 Iran supply and share in the OPEC exports will increase but not significantly. Crude oil exports grow with 2.545 million barrels a day in 1993 to 2.912 million in 1998 and continues to increase at the same annual rate (73,400 barrel annual increase per day for each year) and 3.428 million barrel a day in 2005. 4. Iran domestic consumption of gasoline decreases replaced by pipeline gas.	A boost in oil prices similar to 1978 with 75.3% increase making revenues double in 2005 compared with 1993.	1. Sharp decrease in oil prices due to over-supply by former Soviet Union republics and OPEC countries. Iran restricted to situation of 1986.
2.4		Iran's gross national investment	Sectoral investment is assumed to grow from 1993 to 1998 with annual rate of 255.7 bn. Rials and continues with the same amount to 4938.6 bn. Rials in 2005.	Sectoral investment increases on the basis of the 1976 sectoral investment (highest before and after revolution at 1982 fixed prices) with 5.6% for agricultural, 18.6% for oil, 20.5% for industries and mines, and 55.3% for services as the total gross national investment.	1. Sectoral investment falls compared with most probable scenario (except in transport) in 2005; this is to keep CAC countries encouraged to trade through ISLB; all sectoral investment drops to the level of 1986 (agriculture 6.4%, oil and gas 3.4%, industry and mining 14.4% and services to 75.9% of which transport holds an annual high share of 11.1% during 1994-2005.
2.5		Iran's national growth	1. The real GDP based in 1994 was considered for 1.9 as the average growth of 1979-1993. A target GDP growth of about 8.5% was considered for the year 2005 as the average growth of Iran during 1989-1993 and a relatively stable condition after the war (annual rate 0.6%) (see section 8.6.1.1 for further detail). 2. Value added of agriculture for DOMTI grows moderately and based on 1989-1993 average growth from 1994 (4.8%) with annual rate of 0.5% and ends with 10.3% for 2005 (see section 8.6.1.2 for further detail).	1. High growth in real GDP based on 1983 as the highest after the revolution. It grows from 1994 (1.4%) at 1.05% annually, ending with 13.45% in 2005 (see section 8.6.2.1 and column 4 of Table 8.10). 2. Value added of agriculture for DOMTI grows significantly, similar to highest amount of the period of study in 1983 to about 13.49% in 2005 (see section 8.6.2.1 and column 3 of Table 8.10).	Decline in the real GDP with 1.9% in 1994 to - 15.7% in 2005.

Table 8.4 continued.

2.6		CAC countries national growth	Negative GDP per capita growth based on 1985-1993 average. But it assumes to grow from -8.2% in 1993 to -2% in 1994 and then with 0.6% annual growth to 4.6% in 2005 (see section 8.6.1.3 for further detail).	A high growth for CAC countries is expected in GDP per capita to be about 4.6 times higher than most probable scenario. This is based on the 8 million tonnes estimated transit rail freight of Iran due to the completion of port Abass rail connection at the end of 1994.	1. Reforms fail to satisfy all former USSR republics and disruption causes decay in the GDP per capita for all CAC countries ranging between -2% and -8.6% (see section 8.6.3.3 and Table 8.15). 2. Value added of the agricultural sector drops to -2.9% in 2005.
2.7		Development of privatisation in Iran	1. Privatisation programmes at different sectoral levels of the industries and economy continue. 2. Licensing and operating of domestic private rail freight companies.	1. New presidential policy makes foreign investment more secured and permitted. 2. Long term port terminal operations permitted.	1. Foreign investments are secured and permitted. 2. Long term port terminal operations permitted.
2.8		Development of privatisation in CAC countries	Privatisation moves ahead according to the present market economy policies.	All Communist restrictions on privatisation and ownership are removed.	New Communist restrictions on privatisation and ownership will be enforced.
3	**Technical**	**Key Issues**	**Most probable scenario**	**Optimistic scenario**	**Pessimistic scenario**
3.1		CAC origin-destination travel distance	1. Central Asian rail access to ISLB ports decreases by 921 km for Bafgh-Mashad link . 2. Caucasus access to ISLB ports by rail decreases by 200 km.	1. The capacities of ports will be increased by the modernisation of all berths. 2. Port Cha Bahar as the second important effective port for Central Asia becomes operational.	Central Asian rail access to port of Abass decreases by 921 km due to completion of Mashad-Bafgh link.
3.2		Transport capacities	1. Ports handle 87.97% of total GOPFT & CACFT and border crossing points handle 12.03% (see section 9.2.3 and Table 9.2 for further detail). 2. Ports' capacities increased by the average growth of 1979-1993 period (12.45 to 35.49 million tonnes). With an annual growth of about 1.54 million tonnes there will be 53.92 million tonnes in 2005. Improvement in the ports will be made through equipment and technology renewal and also by an increase in manpower productivity (see section 9.3.1.2 for further detail). 3. Increase of ports containerisation by an annual rate of about 24000 TEU from 1993 to 1998 as expected by PBO and with same rate up to 2005 for a total of 368,000 TEU. 4. Presentation of heavy train concept with 8000 tonnes in 2005. 5. Rail freight will expand by 2.5 million tonnes annually during 1993-1998 (20 to 32.5 million tonnes total freight) and continue to about 50 million tonnes in 2005. 6. Share of pipelines in transport of total GOPFT oil products will grow from 59.8% in 1993 to 64.12% in 2005; while for DOMTI it will range between 10.3% in 1993 and 14.62% in 2005 with a rate of 0.36%.	1. Central Asian road access to port Abass decreases by 100 km. 2. Caucasus access to port Imam by road decreases by 100 km.	Increase of capacities similar to most probable scenario.

Table 8.4 continued.

3.3		Transport technology	1. Rail freight wagons grow from 1993 to 1998 to 3700 new wagons and continued with a rate of 1000 per year and 100 annual increase (1100, 1200, so on). In 2005 there will be in total 13500 new wagons; If all present wagons stay in service in 2005 there will be 27965 wagons in total. 2. Rail locomotives growth as planned for 1994-1998 and continued. There will be 168 new rail locomotives and in total 541. 3. Heavy road freight vehicles will be renewed at a rate of 2000 annually. There will be 22000 new heavy trucks which makes a total of 326047.	1. Double rail line projects are completed and capacity of freight by rail to CAC doubled (16 million tonnes). 2. Iran will invest on the expansion of the domestic rolling stock manufacturing to cope with domestic and CAC freight demand.	1. Iran invests in domestic rolling stock manufacturing to cope with domestic and CAC demand more efficiently. 2. Iran reduces the rail freight rates for the CAC countries by 20% .
3.4		Iran's transport investment	Transport investment grows from 1993 to 1998 at rate of about 40.04 bn. Rials annually which continues to 2005 with a total share of about 762.78 bn. Rials.	1. Transport investment grows from 1994 with an annual share of about 15.5% of the total investment as highest for 1984 during 1974-1993. 2. Rail projects receive much higher priorities to create double lines and rolling stock investment. 3. Port of Anzali will be connected to Iranian rail network. 4. Iranian and Armenian rail trades are linked at Megri (Noor Dooz) border crossing.	1. To compensate the negative effects of the changes in CAC and CIS on ISLB operations, transport investment grows from 1994 with a rate of 11.1% annually. This priority is due to obligation within ECO and international aid to Iran. 2. Rail projects receive much higher priorities and investment to complete Bafgh-Mashad link and domestic manufacturing of the rolling stock. 3. ECO investors will be permitted to have a share in construction of the infrastructure and superstructure of the ports in Iran.
4	**Organisational**	**Key Issues**	**Most probable scenario**	**Optimistic scenario**	**Pessimistic scenario**
4 .1		Institutional elements and developments of ECO	1. Regional and ECO co-operation facilitates more frequent journeys between Iranian ports and CAC inland points by the extension of coverage to ISLB port operations and to land (road and rail) transport services where CAC terminal operators can have joint ventures with Iranian companies. 2. ECO will succeed in to establishing a free trade system among member states by the elimination of the Customs tariff in year 2005. 3. Introduction of the block train and the heavy 8000 tonnes train as one of the future alternatives have been considered by IRIRC to increase the freight performances. 4. IRISL establishes rail and road transport services.	1. Introduction of non-tariff trade among ECO countries increases the volume of the CAC trade through Iranian ports to twofold. 2. Reinforcing of rail trades and introduction of heavy train with 16000 tonnes as the highest alternative which IRIRC is seeking for improvement of the performance by train weight. 3. ECO shipping company expanded greatly in particular through Iran and other ECO oil based member states, into CAC countries. 4. ECO coverage of ISLB port operations and land (road and rail) transport services extends to the long lease of terminals at border crossings, ports, and rail and road terminals, rolling stock and haulage companies. 5. International rail operators, NVOCC, and foreign shipping companies are permitted to work within ISLB corridors. 6. All border restrictions for trade, transport and employment will be removed among ECO members.	1. Introduction of non-tariff trade among ECO members. 2. Introduction of block heavy train of 8000 tonnes. 3. ECO shipping company expanded greatly in particular through Iran to keep ISLB operating and competitive. 4. ECO coverage of ISLB port operations and land (road and rail) transport services expanded in long leasing of the terminals in border crossings, ports, and rail and road terminals, rolling stock and haulage companies. 5. International rail operators, NVOCC, and foreign shipping companies are permitted to work within ISLB corridors. 6. Iran reduce ports and dues of ships carrying cargoes to/from CAC countries.

4.2		Improvement of know how in Iranian transport	1. Skills and know how will be improved and developed as an obligation imposed by PBO for second developmental programme in: 1.1 Increase of the PSO expert personnel ratio to total personnel with a annual rate of 3% during 1993-1998 but extending up to 2005 at 1%. 1.2 Increase of the IRIRC expert personnel ratio to total personnel with a annual rate of 2% during 1993-1998 but extending up to 2005 at 1%. 2. Improvement in the productivity of the agricultural sector (variable for DOMTI) based on average growth of 1989-1993 from 1994 with 4.2% and ends in 2005 to 8.6% with annual rate of 0.4% (see section 8.6.1.2 and column 7 of Table 8.7 for further detail).	1. A transport university is established in Iran and supported by ECO. 2. Extensive use of international and UN transport courses by Iran. 3. Improvement in the productivity of the agricultural sector based on 1989-1993 from 1994 from 4.2% with annual rate of 2% ending in 26.2% (see section 8.6.2.2 and Table 8.13).	1. While Iran does not have infrastructure limitations, attempts made to improve productivity of the ISLB services by training similar to most probable scenario policies. 2. Productivity of the agricultural sector falls from 4.2% to -22.2% during 1994-2005 as in 1984 (see section 8.6.3.2 for further details).

Sources for most probable scenario:
1.1 (2) Based on the average of oil products handled by ports ranging from a minimum of 13.3% to a maximum 24.1% of the total GOPFT during 1979-1993 for all three scenario. **1.3 (1)** PBO (1993), pp 1-4, 1-9 1.4 (1) Sanate-Hamlo-Naghl (1996c), p. 12. **2.1 (1)** Roberts (1996, pp. 15-16). **2.3 (1, 2 & 3)** PBO (1993) pp. 0-18 and 3-3. **2.3** (4) OPEC Bulletin (1996), January, p. 29. **2.4 (1)** PBO (1993), p. 0-24. **2.6** UNCTAD/UN (1994), Economic Bulletin for Europe (1994), p. 69 and 85. Fischer et al. (1996), p. 47. **2.7 (1)** Ehteshami (1995, pp. 112-4), Amirahmadi (1996, p. 127). **3.1 (1)** Afshar (1995) p. 59. **3.1 (2)** Sanate-Hamlo-Naghl (1996c), p. 9 and Afshar (1996) p. 19 and PBO (1993), p. 6-25. **3.2 (2 & 3)** PBO (1993) p. 6-8. **3.2 (4)** PBO (1989-1993), the Preliminary results of the first developmental programme, transport sub-sector, Unpublished and undated, p. 1-5. **3.2 (5)** PBO (1993) p. 6-24. **3.2** (6) PBO (1993) p. 3-7). **3.3 (1, 2 & 3)** PBO (1993) p. 6-24. **4.1 (2 & 3)** PBO (1989-1993). **4.2** (1) PBO (1993, pp. 6-7, 6-8).

Sources for optimistic scenario:
2.1 (1) the Economist (1997), January 18. p. 17. **2.1 (2)** Sbirley (1995) p. 36. **2.1 (3)** Shahbazi (1996), pp. 34-44. Ehteshami (1995, p. 112) **2.3 (1)** Central Bank of Iran (1991) p. 191. **2.4 (1)** Central Bank of Iran (1991) p. 297. **2.6** Sanate-Hamlo-Naghl (1996c). **3.2 (2)** PBO (1993) pp. 6-4, 6-5. **3.3 (1)** Afshar (1995) p. 58. **3.4 (1)** Central Bank of Iran (1991) p. 297. **4.1 (2)** PBO (1989-1993), the preliminary results of first developmental programme, Unpublished and undated Transport sub-sector p. 1-5. **4.2 (1)** Central Bank of Iran (1991).

Sources for pessimistic scenario:
1.1 (2) Based on the average of oil products handled by ports ranging from a minimum of 13.3% to a maximum 24.1% of the total GOPFT during 1979-1993 for all three scenario. **2.1 (1)** the Economist (1997), January 18. p. 17. **2.1 (2)** Sbirley (1995) p. 36. **2.1 (3)** Shahbazi (1996), pp. 34-44. Ehteshami (1995, p. 112). **2.3 (1)** Central Bank of Iran (1991) p. 191. **2.5** and **2.6 (2)** Central Bank of Iran (1991). **3.1** Afshar (1995) p. 59. **3.2** PBO (1993) pp. 6-8, 6-24 and 3-7. **4.2 (1)** Central Bank of Iran (1991).

8.5.2.1 ISLB most probable scenario

This scenario represents the most likely situation for the environment of the ISLB. The trends in this scenario are based on the independent variables used to forecast the three volumes of demand for GOPFT, DOMTI, and CACFT. The future growth for Iran is based on 1989-1993 as a stable period.

It is assumed there will be no significant changes in the domestic politics of Iran and the CAC countries. Iran moves toward international economy and according to Amirahmadi (1996, p. 127):

> "The Iranian government believed that the break-up of the Soviet Union had resulted in a less ideological global order, which is more than ever centred on economic issues and co-operation. With such considerations in mind ... Iran embarked on bringing its economic policies in line with current trends in the international economy. Seeking loans and investments from abroad and approaching the IMF and the World Bank were initiatives taken in this light. As a prerequisite for IMF assistance, the government was compelled to accept the organisation's guidelines for economic liberalisation and stabilisation".

Therefore, the political issues in this scenario assume the continuation of the present situation, with both Iran and the CAC countries attempting to pass the previous critical period and to overcome present economic instabilities at national and international levels. This probable situation can be supported as Barylski (1994, p. 413) according to Kozyrev (1993) has noticed that:

> "The ideal international system for Central Asia as a club of friends of regional stability consisting of Russia, Iran, Afghanistan, Pakistan and the five former Soviet republics."

During this period Iran would have the ability to cope with development programmes and to improve the ISLB, mainly by simplification of the transit trade and the transport regulations relating to its corridors for the CAC countries. The moderate scenario assumes that internal opposition forces in Iran have sufficient power to contain a significant adverse foreign relations development with USA, given that external forces are not effective against present Iranian policies (Roberts (1996). It is assumed there will be no official relations with USA but also no serious measures taken against Iran. There are no internal or external threats in terms of revolutions or war with other countries for both Iran and any of CAC countries. Therefore, the Iranian economy operates under present conditions with central planning and low economic growth. Further specific assumptions for this scenario are shown in Table 8.4.

8.5.2.2 ISLB optimistic scenario

This scenario argues that Iran, in response to the improved internal political reforms, settles its conflicts and improves relations with the USA and other countries. Oil price increases provide significant currency sources for development projects and completion of transport projects. This is a period of credit and high stable growth for Iran. Further specific assumptions for this scenario are shown in Table 8.4.

8.5.2.3 ISLB pessimistic scenario

This refers mainly to political changes in CIS and CAC countries, which causes ISLB competitors to attract the Asian foreign trade of the CAC countries. These will still be opportunities for neighbouring and other countries to have trade with each of the former USSR republics but in a more tightly controlled way, which will create a more competitive situation for the ISLB. Further specific assumptions for this scenario are shown in Table 8.4.

8.6 Model forecasts

Under stated assumptions made in Table 8.4 for the three ISLB scenarios, the three final forms of the model will be used to forecast the total tonnage of the three ISLB scenarios for the year 2005. These aggregate tonnage of the ISLB policy scenarios will then be distributed over the ports and border crossings as well as onto the rail and road modes which together form the transport system of Iran under each scenario. The translation of these forecasts as the transport supply of Iran will provide the new level of service requirements which may require expansion of the physical transport capacities when compared with base year facilities and infrastructure (Zwam and Valk 1984). Each of these steps must be carried out by multiplying the future input values of each of the significant independent variables by their respective estimated parameters and then summing. Accordingly, future values of the independent variables under most probable, optimistic and pessimistic must be forecast. Model forecasts will take place for each of the three areas of study under three scenarios.

8.6.1 Most probable scenario

8.6.1.1 GOPFT

Three attempts were made to forecast the future values of GDP (for the year 2005) by developing a model of its growth against time, by linear, exponential, and polynomial techniques, all of which exhibited a low coefficient of determination of 0.24, 0.23, and 0.29 respectively.

Forecasting GDP is an uncertain excerise (Bell et al. 1983). GDP is the main political and macroeconomic indicator of GOPFT. Its composition can be reflected by other different variables like investment, value added, etc. The average annual growth of GDP during the turbulent years of the revolution and the war was equal to 1.9%. The 1.9% average growth in GDP is a reflection of the past behaviour of the Iranian economy during 1979-1993 and will be considered as the basis for the growth which will underpin the real GDP forecasting of future values of the most probable scenario for GOPFT. While in the most probable scenario it is assumed that there will be no war and no unusual incidents for Iran, its low value (1.9% base growth) may, to a great extent, reflect the instability of the economic system during the period over which data was collected (column 4 in Table 8.5 for 1979-1993). The coefficient of the GDP growth between 1993-2005 must be at such a value that keeps future GDP values firstly within a logical boundary and then, secondly, between, the optimistic and pessimistic GDP scenarios. During 1979-1993 the highest positive growth in real GDP was 13.2 % in 1983 (column 4 in Table 8.5). It will be assumed that by 2005, the most probable GDP with a base growth of 1.9% (in 1994) will expand to 8.5% (annually by an addition of 0.6% per annum from 1994). This was derived from the average values of the GDP growth during 1989-1993 as the more stable period after the war with Iraq. Under such assumptions, the values of real GDP for 1994-2005 are calculated and summarised in Table 8.5 column 3.

Forecasts of population are based on a linear time series projection with a coefficient of determination (r^2) of about 0.9996 which indicates an almost perfect historical relationship given by the mathematical model in equation (8) with the forecasts derived shown in column 2 of Table 8.5.

Table 8.5 Actual and forecast independent and dependent variables of the most probable GOPFT scenario by growth factor and time series projection.

	1	2	3	4
Year	GOPFT actual & forecast	Actual and forecast values of the population in Iran (X_{20})	Actual and forecast GDP of Iran (X_{14})	GDP growth rate (0.6 over 1.9 from 1993)
1979	16247	37991000	10551300	
1980	13027	39646000	9555500	-9.44
1981	14166	41221000	9320700	-2.46
1982	17289	42800000	10539800	13.10
1983	23756	44438000	11934700	13.20
1984	19250	46201000	12043800	0.91
1985	18723	47807000	12072300	0.24
1986	17660	49363000	10248900	-15.10
1987	18747	50995000	10368100	1.20
1988	16489	52672000	9468000	- 8.70
1989	22850	54504000	9781500	3.30
1990	24956	56401000	10930200	11.70
1991	28700	57799000	12181200	11.40
1992	27773	59229000	12477800	2.40
1993	30555	60708000	13101000	5.00
	Most	**probable scenario**	**forecasts**	Forecast values 26.75 /14 =1.9
1994	31426.30	62599400	13349919	1.90
1995	32860.20	64242800	13683667	2.50
1996	34486.80	65886200	14107860.7	3.10
1997	36321.80	67529600	14629851.6	3.70
1998	38384.80	69173000	15258935.2	4.30
1999	39977.40	70816400	16006623	4.90
2000	43298.80	72459800	16886987.3	5.50
2001	46216.00	74103200	17917093.5	6.10
2002	49496.10	75746600	19117538.8	6.70
2003	53191.70	77390000	20513119.1	7.30
2004	57366.60	79033400	22133655.5	7.90
2005	62097.00	80676800	24015016.2	8.50

$Y_{pop} = 36305 + 1643.4\,X$ **(EQ.8)**

where X is given values of 16, 17, 18, ... 27 as future time periods move from 1994 to 2005 and Y stands for population and forecast values as shown in column 2 of Table 8.7.

Using the future values of GDP and population and the estimated final model shown in equation 5, and on the basis of the final model parameter estimations, the best estimate future values of the GOPFT of Iran was predicted up to the year 2005 as shown in Table 8.5 column 1.

Table 8.6 Comparison between regression GOPFT forecast and three time series models (000 tonnes).

	Models			
	1	**2**	**3**	**4**
EQ.	$Y_{TSTP} = 12737+1101.2t$ (9)	$Y = 13701e^{0.0474x}$ (10)	$Y = 16082+77.417\,X^2-225.27\,X$ (11)	
	Linear trend	**Exponential**	**Polynomial**	**Regression**
	$r^2 = 0.24$	$r^2 = 0.23$	$r^2 = 0.29$	$r^2 = 0.87$
1994	30356.20	29053.28	32296.43	31426.30
1995	31457.40	30463.56	34625.92	32860.20
1996	32558.60	31942.31	37110.25	34486.80
1997	33659.80	33492.83	39749.41	36321.80
1998	34761.00	35118.62	42543.40	38384.80
1999	35862.20	36823.32	45492.23	39977.40
2000	36963.40	38610.77	48595.89	43298.80
2001	38064.60	40484.99	51854.38	46216.00
2002	39165.80	42450.19	55267.71	49496.10
2003	40267.00	44510.78	58835.88	53191.70
2004	41368.20	46671.39	62558.87	57366.60
2005	43469.40	48936.88	66436.70	62097.00

Time series models rely heavily on historical data and stable conditions. They attempt to find the trend, seasonal, and cyclical variations that exist in the data series. There should be a long historical period of data with which to test the model.

Forecasting is a practice that should be grounded on more than just a good fit between simulated and historical values. Therefore, as an additional procedure for forecasting the GOPFT, ex-post forecasts of the GOPFT were derived from models based on trend, exponential, and polynomial time series techniques and then compared with the main regression model in Table 8.6 (Doganis 1985).

The coefficient of determination (r^2) in Table 8.6 indicates that all three time series models have low explanatory powers compared to the regression model.

According to the latest data available, a comparison shows that the GOPFT forecast for 1995 is only 6.6% over-estimated when compared with actual foreign trade in the same year (PSO 1994).

8.6.1.2 DOMTI

The aims of the DOMTI analysis were to assess the impact of different variables on DOMTI and also to derive a model capable of predicting the domestic trade of Iran in the long run between 1993 and 2005 by the application of multiple regression analysis. Obviously, the accuracy of any forecasting model will be conditional upon the accuracy with which the independent variables are predicted.

The future values of DOMTI GDP are based on the most probable scenario GOPFT assumption as shown in column 4 of Table 8.7. The future values of the value added of agriculture (X_9) was considered to be 4.8% and productivity of the agricultural sector (X_{23}) for 4.2% in 1994 and then were upgraded with the average growth rate of these two variables during 1989-1993 (0.5 and 0.4 respectively). The future values of these three independent variables are shown in column 2 and 3, and 6 and 7 of Table 8.7. By inserting the future values of these three independent variables into the final DOMTI model (EQ.5), future values of DOMTI for 1994-2005 were estimated and shown in column 1 of Table 8.7.

An assessment was made between multiple regression and four other different time series techniques (EQs. 12, 13, 14, and 15), for estimating DOMTI forecasts, all of which estimated in an r^2 lower than the DOMTI derived by multiple regression (see Table 8.8).

$Y_{DOMTI} = 261.25X^2 - 1030652.77X + 1016654072$ where x is 1994, 1995, 1996 ....and 2005.	(EQ. 12)
$Y_{DOMTI} = 153277\ e^{0.0343x}$ where x is 16, 17, 18, ...27 equivalent to 1994, 1995, 1996, ... 2005.	(EQ. 13)
$Y_{DOMTI} = 7033.51X - 13763527.26$ where x is 1994, 1995, 1996 ....and 2005.	(EQ. 14)
$Y_{DOMTI} = 13966578.09\ Ln\ (X) - 105855434.19$ where x is 1994, 1995, 1996 ....and 2005.	(EQ. 15)

There were significant differences between predicted and actual values shown in Table 8.8. Among other techniques the polynomial has the highest r^2 while the results of the log and exponential models are very close.

Table 8.7 Actual and forecast of the DOMTI independent and dependent variables by growth factor and time series projection (000 tonnes).

		VAA		GDP		PAS	
		X_9		X_{14}		X_{23}	
	Actual Y	Values	Growth	Values	Growth	Values	Growth
	1	2	3	4	5	6	7
1979	159713.50	1851200		10551300		11.36	
1980	156657.59	1914900	3.40	9555500	-9.44	11.08	-2.50
1981	143905.97	1952700	2.00	9320700	-2.46	9.39	-15.30
1982	187046.21	2091400	7.10	10539800	13.10	12.58	34.00
1983	214483.34	2193000	4.90	11934700	13.20	15.59	24.00
1984	207417.78	2353700	7.30	12043800	0.91	12.14	-22.10
1985	221041.09	2537600	7.80	12072300	0.24	13.3	9.60
1986	209298.56	2650500	4.50	10248900	-15.10	14.75	10.90
1987	192223.03	2715800	2.50	10368100	1.20	14.97	1.50
1988	187630.97	2648000	-2.50	9468000	-8.70	13.53	-9.60
1989	185742.17	2746000	3.70	9781500	3.30	12.33	-8.90
1990	217939.21	2967500	8.10	10930200	11.70	15.51	25.80
1991	252590.10	3120200	5.20	12181200	11.40	14.96	-3.60
1992	262396.35	3351600	7.40	12477800	2.40	16.49	10.20
1993	277223.84	3535700	5.50	13101000	5.00	15.85	-3.90
Forecasts values							
1994	288618.90	3705413.60	4.80	13349919.00	1.9	16.5	4.2
1995	309172.90	3901800.50	5.30	13683667.00	2.5	17.3	4.6
1996	319859.10	4128105.00	5.80	14107860.70	3.1	18.2	5.0
1997	339795.80	4388175.60	6.30	14629851.60	3.7	19.2	5.4
1998	362984.10	4686571.50	6.80	15258935.20	4.3	20.3	5.8
1999	389779.50	5028691.20	7.30	16006623.00	4.9	21.5	6.2
2000	420941.40	5420929.10	7.80	16886987.30	5.5	22.9	6.6
2001	456983.10	5870866.20	8.30	17917093.50	6.1	24.5	7.0
2002	498519.50	6387502.40	8.80	19117538.80	6.7	26.3	7.4
2003	546617.60	6981540.10	9.30	20513119.10	7.3	28.4	7.8
2004	600688.30	7630823.30	9.80	22133655.50	7.9	30.7	8.2
2005	664279.50	8416798.10	10.30	24015016.20	8.5	33.3	8.6
$Y_{DOMTI} = -95088.6714 + 0.032627984\ X_9 + 0.01559261 X_{14} + 3311.95902\ X_{23}$ (6)							
VAA: Value added of the agricultural sector. PAS: Productivity of the agricultural/employee sector.							

Figure 8.9 DOMTI forecasts for Iran 1993-2005

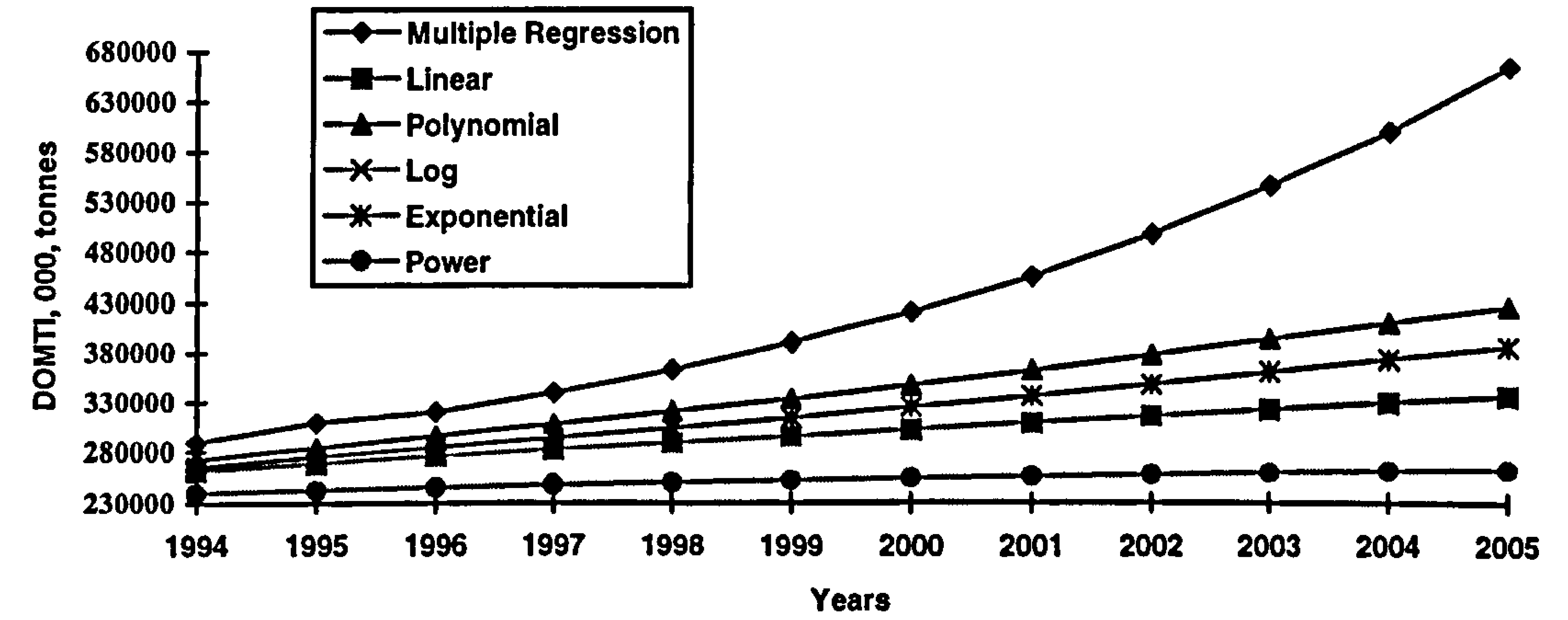


Table 8.8 Comparison between regression of most probable DOMTI forecast and three time series models for 1994-2005 (000 tonnes).					
	Models				
	Linear trend (14)	Exponential (13)	Polynomial (12)	Log (15)	Regression
r^2	0.67	0.67	0.69	0.67	
1994	261291.68	265349.20	271854	261201.60	288618.90
1995	268325.19	274608.60	283327	268198.80	309172.90
1996	275358.70	284191.10	295324	275196.10	319859.10
1997	282392.21	294107.90	307842	282193.40	339795.80
1998	289425.72	304370.80	320883	289190.60	362984.10
1999	296459.23	314991.80	334446	296173.90	389779.50
2000	303492.74	325983.50	348532	303157.20	420941.40
2001	310526.25	337358.70	363141	310140.50	456983.10
2002	317559.76	349130.80	378272	317123.80	498519.50
2003	324593.27	361313.80	393925	324093.10	546617.60
2004	331626.78	373921.80	410101	331062.40	600688.30
2005	338660.29	386969.80	426800	338031.70	664279.50

8.6.1.3 CACFT

The future values of the GDP per capita are required for forecasting CACFT during the period 1994-2005. The latest available data concerning the foreign trade of most CAC countries shows a high negative value for exports while imports are in a better situation. At the same time the "discrepancy between the initial trade data and the adjusted trade values is in some cases quite substantial" (UNCTAD/UN 1994, p. 69). It is assumed that they have had a negative growth in GDP per capita of about -2% in 1994 (Michalak 1994). Then, it will grow by 0.6% per annum to produce about 1.85 million tonnes of trade and close to that which these countries had with Iran in 1993 (see Table 3.39. On the basis of this assumption, by calculating the growth rate the future values of GDP per capita of CAC countries is inserted in the final CACFT model (EQ. 7). The CACFT values for the period 1994-2005 were estimated and are shown in Table 8.9 where comparisons of the CACFT forecast volume for 1995 with actual transit trade through Iran (about 1.35 million tonnes in 1995) shows about a 4 % under-estimation (PSO 1994).

Table 8.9 CACFT independent and dependent variables by growth factor and time series projection (tonnes).

	CAC Asian foreign trade	GDP per capita	
	Y_{CACFT}	X	
	Volumes	Values	GDP per capita
1985	-	31800	
1986	-	31700	-0.30
1987	3630570.60	32700	3.20
1988	3780642.90	35400	8.30
1989	3509606.90	36800	4.00
1990	2728208.40	36100	-1.90
1991	1896981.90	33400	-7.50
1992	1647787.90	23100	-30.80
1993	1351898.30	21200	-8.20
	Most probable scenario forecast values (growth rate 0.6)		
1994	1334812.60	20776.00	-2.00
1995	1298275.30	20485.10	-1.40
1996	1277689.40	20321.20	-0.80
1997	1272590.10	20280.60	-.020
1998	1282776.20	20361.70	0.40
1999	1308348.40	20565.30	1.00
2000	1349670.80	20894.30	1.60
2001	1407409.10	21354.00	2.20
2002	1482505.30	21951.90	2.80
2003	1576253.20	22698.30	3.40
2004	1690285.40	23606.20	4.00
2005	1826674.50	24692.10	4.60

8.6.2 Optimistic scenario

8.6.2.1 GOPFT

It is assumed that the population growth in the optimistic scenario is at the same rate as the most probable scenario and only the future real GDP will be forecast for the period of study. A maximum value of 13.45% for the GDP of Iran in 2005 is considered to be similar to what was experienced in 1983 as the highest value in the last two decades. Therefore, the optimistic scenario GDP varies between 1.9% and 13.45 % during 1994-

2005 with an increase in the growth rate of 1.05% annually. On this basis, future values of both independent variables are shown in Table 8.10.

Table 8.10 GOPFT independent and dependent variables by growth factor and time series projection for the optimistic scenario (000 tonnes).

	1	2	3	4
Year	GOPFT actual & forecast	Actual and forecast values of the population in Iran (X_{20}) (000)	Actual and forecast GDP of Iran (X_{14})	GDP growth
1979	16247	37991	10551300	
1980	13027	39646	9555500	-9.44
1981	14166	41221	9320700	-2.46
1982	17289	42800	10539800	13.10
1983	23756	44438	11934700	13.20
1984	19250	46201	12043800	0.91
1985	18723	47807	12072300	0.24
1986	17660	49363	10248900	-15.10
1987	18747	50995	10368100	1.20
1988	16489	52672	9468000	- 8.70
1989	22850	54504	9781500	3.30
1990	24956	56401	10930200	11.70
1991	28700	57799	12181200	11.40
1992	27773	59229	12477800	2.40
1993	30555	60708	13101000	5.00
		Optimistic scenario forecast values		
1994	31426.26	62599.40	13349919.00	1.90
1995	32988.20	64242.80	13743741.60	2.95
1996	34882.27	65886.20	14293491.30	4.00
1997	37142.84	67529.60	15015312.60	5.05
1998	39816.88	69173.00	15931246.70	6.10
1999	42966.22	70816.40	17070330.80	7.15
2000	46670.82	72459.80	18470097.90	8.20
2001	51032.99	74103.20	20178582.00	9.25
2002	56183.06	75746.60	22256975.90	10.30
2003	62286.89	77390.00	24783142.70	11.35
2004	69555.70	79033.40	27856252.40	12.40
2005	78259.21	80676.80	31602918.30	13.45

8.6.2.2 DOMTI

The future values of the optimistic scenario GDP are based on the most probable GOPFT assumptions, where the growth of 1994 (1.9%) goes to 13.45% in 2005 with a rate of about 1.05% annually as shown in Table 8.11.

The maximum rate of growth in the productivity of the agricultural sector is assumed to be 26.2% in the year 2005. This was actually experienced in 1990 as the best past situation during the period of study. A minimum value of 1.9% is similar to that for the most probable DOMTI. The optimistic scenario value added of the agricultural sector ranges between a minimum of the most probable scenario DOMTI and a maximum value of 13.49%, similar to the optimistic scenario GDP (13.45%) in 1983.

	Table 8.11 DOMTI independent and dependent variables by growth factor and time series projection for the optimistic scenario (000 tonnes).						
		X_9		X_{14}		X_{23}	
	Actual Y	Values	Growth	Values	Growth	Values	Growth
1979	159713.50	1851200		10551300		11.36	
1980	156657.59	1914900	3.40	9555500	-9.44	11.08	-2.50
1981	143905.97	1952700	2.00	9320700	-2.46	9.39	-15.30
1982	187046.21	2091400	7.10	10539800	13.10	12.58	34.00
1983	214483.34	2193000	4.90	11934700	13.20	15.59	24.00
1984	207417.78	2353700	7.30	12043800	0.91	12.14	-22.10
1985	221041.09	2537600	7.80	12072300	0.24	13.3	9.60
1986	209298.56	2650500	4.50	10248900	-15.10	14.75	10.90
1987	192223.03	2715800	2.50	10368100	1.20	14.97	1.50
1988	187630.97	2648000	-2.50	9468000	-8.70	13.53	-9.60
1989	185742.17	2746000	3.70	9781500	3.30	12.33	-8.90
1990	217939.21	2967500	8.10	10930200	11.70	15.51	25.80
1991	252590.10	3120200	5.20	12181200	11.40	14.96	-3.60
1992	262396.35	3351600	7.40	12477800	2.40	16.49	10.20
1993	277223.84	3535700	5.50	13101000	5.00	15.85	-3.90
Forecasts values							
1994	288618.90	3705413.60	4.80	13349919.00	1.90	16.50	4.20
1995	304906.09	3912546.22	5.59	13743741.60	2.95	17.52	6.20
1996	326381.64	4162166.67	6.38	14293491.30	4.00	18.96	8.20
1997	353778.82	4460594.02	7.17	15015312.60	5.05	20.89	10.20
1998	388087.95	4815657.30	7.96	15931246.70	6.10	23.44	12.20
1999	430778.11	5237027.31	8.75	17070330.80	7.15	26.82	14.40
2000	483294.66	5736639.72	9.54	18470097.90	8.20	31.16	16.20
2001	548054.02	6329234.60	10.33	20178582.00	9.25	36.84	18.20
2002	628068.68	7033045.49	11.12	22256975.90	10.30	44.28	20.20
2003	727342.42	7870681.21	11.91	24783142.70	11.35	54.11	22.20
2004	851239.03	8870257.72	12.70	27856252.40	12.40	67.20	24.20
2005	1007011.94	10066855.48	13.49	31602918.30	13.45	84.80	26.20

8.6.2.3 CACFT

It is assumed that IRIRC under the optimistic scenario will have about 8 million tonnes of demand for rail from the CAC countries (Sanate-Hamlo-Naghl 1996c). To accomplish such an optimistic demand, it is assumed that the CAC countries with a negative growth per capita GDP of about -2% in 1994, should have a considerable growth rate of about 32.48% annually attaining to \$ 95004 GDP per capita in 2005. On this basis, the total optimistic scenario GDP per capita values of CAC countries were computed and inserted in equation 7 to produce the optimistic CACFT volumes shown in Table 8.12.

	Table 8.12 CACFT independent and dependent variables by growth factor and time series projection for the optimistic scenario (000 tonnes).		
	CAC Asian foreign trade	**GDP per capita (X)**	
	Volumes (Y_{CACFT})	**Values**	**Growth**
1987	3630570.60	32700	3.20
1988	3780642.90	35400	8.30
1989	3509606.90	36800	4.00
1990	2728208.40	36100	-1.90
1991	1896981.90	33400	-7.50
1992	1647787.90	23100	-30.80
1993	1351898.30	21200	-8.20
	Optimistic forecasts values		
1994	1334812.60	20776	
1995	2182361.11	27524	32.48
1996	3029909.91	34272	32.48
1997	3877458.71	41020	32.48
1998	4725007.51	47768	32.48
1999	5572556.31	54516	32.48
2000	6420105.11	61264	32.48
2001	7267653.91	68012	32.48
2002	8115202.71	74760	32.48
2003	8962751.52	81508	32.48
2004	9810300.32	88256	32.48
2005	10657849.12	95004	32.48

8.6.3 Pessimistic scenario

8.6.3.1 GOPFT

The pessimistic forecasting scenario of GOPFT keeps population growth as specified for the most probable scenario. However, the growth of the real GDP (X_{14}) drops from 1.9% in 1994 by an annual rate of 1.6% to -15.7% in 2005 which is close to the value of real GDP in 1986 as shown in Table 8.13. In fact, the independent variables of the pessimistic scenario for GOPFT move in different directions for the forecast period. The downward pressure on the growth rate of the real GDP of Iran arises from the effects of the U.S embargo policy and the external political environment of Iran. In the pessimistic scenario, it is expected that the GOPFT compared with the base year (1993) drops by about 26.5% to 22.46 million tonnes in 2005.

Table 8.13 GOPFT independent and dependent variables by growth factor and time series projection for the pessimistic scenario ((000 tonnes).

	1	2	3	4
Year	GOPFT actual & forecast	Actual and forecast values of the population in Iran (X_{20}) (000)	Actual and forecast GDP of Iran (X_{14})	Growth
1979	16247	37991	10551300	
1980	13027	39646	9555500	-9.44
1981	14166	41221	9320700	-2.46
1982	17289	42800	10539800	13.10
1983	23756	44438	11934700	13.20
1984	19250	46201	12043800	0.91
1985	18723	47807	12072300	0.24
1986	17660	49363	10248900	-15.10
1987	18747	50995	10368100	1.20
1988	16489	52672	9468000	-8.70
1989	22850	54504	9781500	3.30
1990	24956	56401	10930200	11.70
1991	28700	57799	12181200	11.40
1992	27773	59229	12477800	2.40
1993	30555	60708	13101000	5.00
		Forecast values		
1994	31426.26	62599.40	13349919.00	1.90
1995	32064.05	64242.80	13309869.30	0.30
1996	32418.63	65886.20	13136841.00	-1.30
1997	32330.22	67529.60	12755872.60	-2.90
1998	31830.68	69173.00	12181858.30	-4.50
1999	30970.99	70816.40	11438765.00	-6.10
2000	29818.01	72459.80	10557980.10	-7.70
2001	28449.68	74103.20	9576088.00	-9.30
2002	26949.49	75746.60	8532294.40	-10.90
2003	25400.86	77390.00	7465757.60	-12.50
2004	23881.77	79033.40	6413085.80	-14.10
2005	22460.27	80676.80	5406231.30	-15.70

8.6.3.2 DOMTI

The pessimistic scenario for DOMTI assumes that both the DOMTI variables will have a downward growth. Value added of agriculture sector moves downward with a rate of 0.7% to about -2.9% in 2005 which closely corresponds to the situation experienced in 1988. Productivity of the agricultural sector will decline by -22.2% per annum a rate of growth of -2.4% in 2005, nearly matching the 1984 situation. The future values of these independent variables and their effects on volumes of the pessimistic scenario for DOMTI are shown in Table 8.14.

Table 8.14 DOMTI independent and dependent variables by growth factor and time series projection for the pessimistic scenario (000 tonnes).

	Actual Y	Values (X_9)	Growth	Values (X_{14})	Growth	Values (X_{23})	Growth
1979	159713.50	1851200		10551300		11.36	
1980	156657.59	1914900	3.40	9555500	-9.44	11.08	-2.50
1981	143905.97	1952700	2.00	9320700	-2.46	9.39	-15.30
1982	187046.21	2091400	7.10	10539800	13.10	12.58	34.00
1983	214483.34	2193000	4.90	11934700	13.20	15.59	24.00
1984	207417.78	2353700	7.30	12043800	0.91	12.14	-22.10
1985	221041.09	2537600	7.80	12072300	0.24	13.30	9.60
1986	209298.56	2650500	4.50	10248900	-15.10	14.75	10.90
1987	192223.03	2715800	2.50	10368100	1.20	14.97	1.50
1988	187630.97	2648000	-2.50	9468000	-8.70	13.53	-9.60
1989	185742.17	2746000	3.70	9781500	3.30	12.33	-8.90
1990	217939.21	2967500	8.10	10930200	11.70	15.51	25.80
1991	252590.1	3120200	5.20	12181200	11.40	14.96	-3.60
1992	262396.35	3351600	7.40	12477800	2.40	16.49	10.20
1993	277223.84	3535700	5.50	13101000	5.00	15.85	-3.90
Forecast values							
1994	288618.90	3705413.60	4.80	13349919.00	1.90	16.50	4.20
1995	282043.90	3553491.60	4.10	13309869.30	0.30	16.20	1.80
1996	275072.70	3432672.90	3.40	13136841.00	-1.30	16.10	-0.60
1997	264452.40	3339990.70	2.70	12755872.60	-2.90	15.60	-3.00
1998	250341.70	3273190.90	2.00	12181858.30	-4.50	14.70	-5.40
1999	233723.40	3230639.40	1.30	11438765.00	-6.10	13.60	-7.80
2000	214720.50	3211255.60	0.60	10557980.10	-7.70	12.20	-10.20
2001	194337.50	3208044.40	- 0.10	9576088.00	-9.30	10.70	-12.60
2002	171925.50	3182380.10	- 0.80	8532294.40	-10.90	9.10	-15.00
2003	165068.90	3134644.40	- 1.50	7465757.60	-12.50	7.50	-17.40
2004	124806.90	3065682.20	-2.20	6413085.80	-14.10	6.00	-19.80
2005	101901.00	2976777.40	-2.90	5406231.30	-15.70	4.70	- 22.20

8.6.3.3 CACFT

The pessimistic scenario for CACFT assumes that all political and economic events at domestic and international levels affect directly and indirectly the volume of foreign trade of the CAC countries. In the worst situation it is assumed that the present internal situation of CIS countries becomes worse and GDP per capita of all the CAC countries declines dramatically to -8.6% in 2005 (with a rate of reduction of -0.6%) which closely corresponds to the situation experienced in 1993). This is as shown in table 8.15 .

	Table 8.15 CACFT independent and dependent variables by growth factor and time series projection for the pessimistic scenario (tonnes).		
	CAC Asian foreign trade	GDP per capita	
	Volumes (Y_{CACFT})	Values (X)	Growth
1987	3630570.60	32700	3.20
1988	3780642.90	35400	8.30
1989	3509606.90	36800	4.00
1990	2728208.40	36100	-1.90
1991	1896981.90	33400	-7.50
1992	1647787.90	23100	-30.80
1993	1351898.30	21200	-8.20
	Pessimistic scenario forecast values		
1994	1334812.60	20776.00	-2.00
1995	1266966.21	20235.82	-2.60
1996	1185634.38	19588.28	-3.20
1997	1092143.45	18843.92	-3.80
1998	988004.40	18014.79	-4.40
1999	874871.51	17114.05	-5.00
2000	754498.13	16155.66	-5.60
2001	628690.74	15154.01	-6.20
2002	499263.35	14123.54	-6.80
2003	367993.52	13078.40	7.40
2004	236581.77	12032.13	-8.00
2005	106615.56	10997.36	-8.60

8.7 Conclusions

The purpose of this chapter of the study is to develop the three scenarios for the general cargo and oil products foreign and domestic trade of Iran, the Central Asian and Caucasus foreign trade. Three types of scenario (most probable, optimistic, and pessimistic) with a time span of up to the year 2005 were developed using different trends and events to show the future of the ISLB under three distinct future environments. Forecasts were developed using selected independent variables for each of the demand models. These three models provide an aggregate volume of flows along the ISLB modes and foreign trade and domestic interfaces within the ISLB network. The framework has now been provided to assess the potential of the Iranian transport system by undertaking the scenario distribution and assignment.

9. ISLB Scenarios: modal split and distribution

9. 1 Introduction

The objective of the modal split and the distribution modelling and analysis is, for each ISLB scenario, to assign all three types of forecast demand onto the Iranian rail and road modes. It also models interchanges (ports and border crossings) in order to emphasise the importance of modal choice and distribution for the CAC countries. It then assesses the impacts on the landbridge supply system of Iran with an emphasis on capacities.

According to Nijkamp and Blaas (1994, pp. 35-36):

> "Rational and consistent policy analysis presupposes a reliable assessment and balanced evaluation of all foreseeable consequences and choice possibilities in relation to policy initiatives. The aim of generating and judging alternative frameworks of policy measures is a far from easy task for mainly two reasons ...... of generating meaningful choice options and the assessment of expected impacts of policy measures".

Each of these three types of demand has some special features, all of which call for some kind of additional consideration of each type of demand in later stages. General cargo and oil products foreign trade of Iran (GOPFT) uses the capacities and services of all six major ports and the three modes of road, rail, and pipelines. In terms of vehicle capacity only certain types are used. In terms of the direction of trade, it mainly starts from or ends at southern ports and north-west border crossings towards the central provinces of the country around Tehran. The Central Asian and Caucasus foreign trade (CACFT) is similar to the GOPFT but is expected to be much smaller in volume and in priority and through the two ports in the south and the ten border crossings on both sides of Iran in the north. Domestic trade of Iran (DOMTI) constitutes the major part of the demand for Iranian transport supply and employs not only all modes but all types of vehicles.

The objective of the optimistic scenario is to show a possible long-term future for Iranian transport demand and supply. It is based on data from 1979-1993 for Iran and 1987-1993 for the CAC countries and also upon the present situation of these countries and the world political and economic environment. Its purpose is to examine transport supply by analysing the maximum probable annual freight movements resulting from Iran and CAC trade and to assess the implications for infrastructure capacities and investment. In the short term, freight transport demand and supply are unlikely to have very significant variations. Forecasting and assessment of the maximum probable volume and output for demand and supply of a transport system is necessary, even if there is not full capacity utilisation (Matthews 1995).

9.2 ISLB demand scenario distribution and modal split

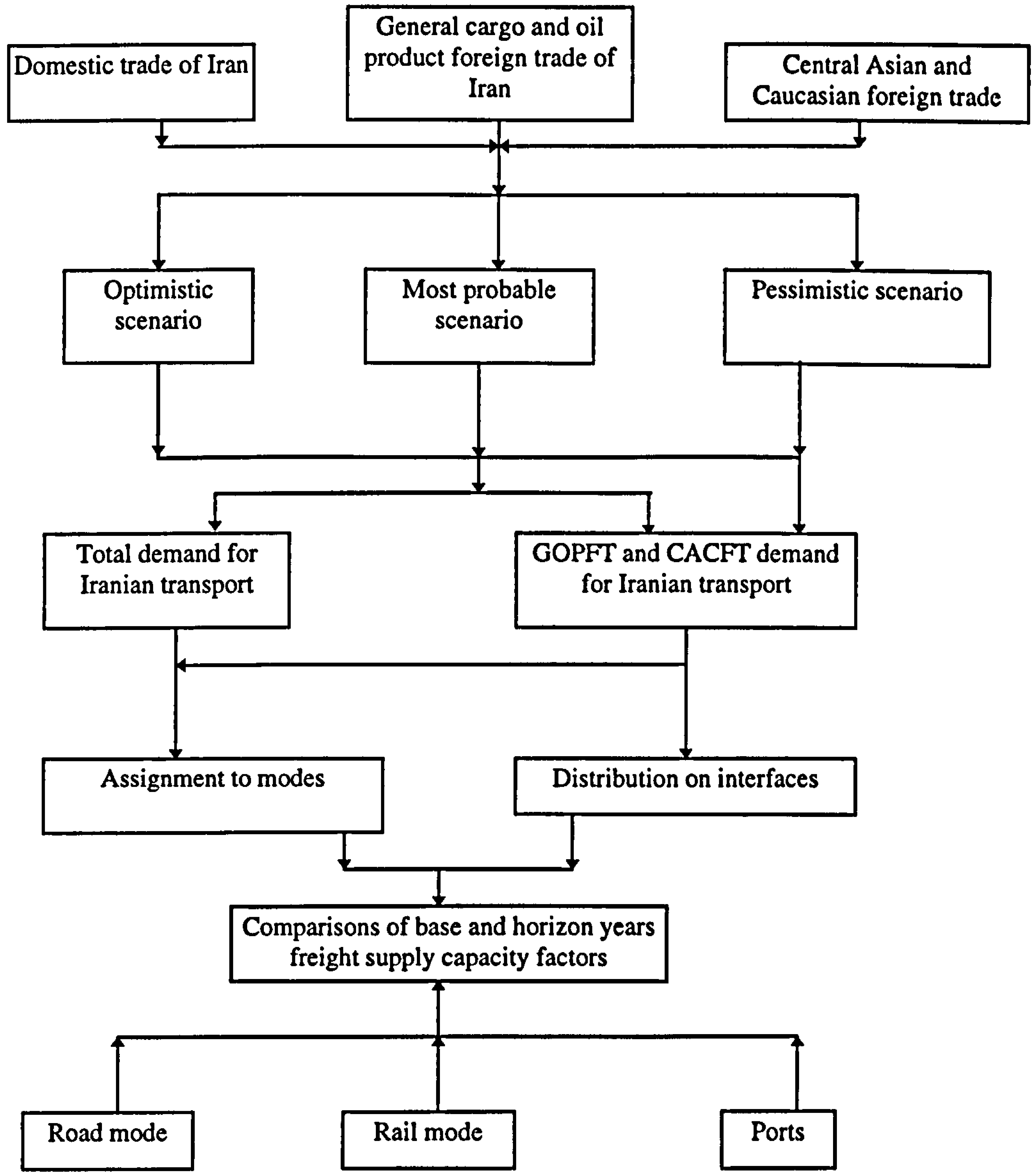
According to Quinet, Reyaud, and Marche (1983, p. 161):

> "The influence of distance on the rail/road modal split certainly reflects the influence of transport cost".

To assess the potential of the Iranian transport system as the supplier of future landbridge services for CAC countries, a model must be developed to distribute the forecast volume of the three scenarios of GOPFT and CACFT to interfaces and then, together with DOMTI to assign them among road and rail modes. This model is composed of the sequential steps shown in Figure 9.1.

In chapter eight, three forecasts under most probable, optimistic, and pessimistic scenarios were developed for GOPFT, DOMTI, and CACFT to serve as a basis for future estimates of the ISLB transport demand. It is now necessary to assign and distribute these forecasts to Iranian modes and interfaces (Williams 1980). It is necessary to evaluate Iran's present and future macroeconomic policies which will affect transport supply and demand. Thus, where possible, the impacts of the distribution arising from these three scenarios were compared with the national policies of the second development programme of Iran for 1994-1999 provided by the programming and budgeting organisation (PBO).

Figure 9.1 ISLB model of distribution and assignment.



The ISLB network system is composed of rail, road and ports. Detailed assessment of the border crossings were excluded due to the lack of information concerning their infrastructure and facilities. Ports, road and rail modes each have a sub-system with special features and involvement in the total process of the Iranian landbridge supply, all of which refer back in one way or another to the total transport demand.

According to the assumptions made earlier in chapters two and five, six ports were considered as the major ports of Iran. Due to their infrastructure and geographical proximity, the two largest ports of Abass and Imam were included in the ISLB supply model for CACFT distribution. For these two ports the three modes of rail, road, and pipeline, were considered as the supplier of services for combined GOPFT and CACFT. Due to its nature, DOMTI only utilises three modes. For other ports, only road was considered.

Port capacities, which are calculated by extrapolation between base and horizon years, are those required to match the level of demand for each scenario for each port. They are consistent with the level of throughput in terms of length of berth, and number and areas of facilities. In the case of transport modes, those factors which primarily have an immediate impact on carrying capacity, such as the number of wagons, locomotive, train weight and trucks, were considered to be significant in describing the physical capacity (Shneerson 1981).

9.2.1 Individual and regional shares of CAC countries in CACFT

The impact of CACFT on Iranian transport supply under the most probable scenario is not significant. It totals about 1.8 million tonnes, equivalent to 3% of the most probable scenario GOPFT, but in practice it is extremely important for Iran. The transit and handling of CACFT requires other than ancillary and back up services (freight forwarding, shipping agents, finance, and insurance, etc.). It also requires berth utilisation, warehousing, truck and rail transport services. The initial step for the analysis of the forecast results of CACFT is to determine regional and countrywide shares of the CAC countries, since these have different distribution and modal split implications.

The regional demand of the CAC countries is based on the average share of total 1987-1993 trade for each country. These shares for the most probable, optimistic, and pessimistic scenarios are derived and shown in Table 9.1 and indicate that five Central Asian countries have about 87.2% of total CACFT compared with the Caucasus figure of 12.8%. The CAC shares are kept constant for all three scenarios with Azerbaijan, in the Caucasus area, and Uzbekistan in the Central Asia region having highest demand with 8.1%, and 45.2% respectively. The shares of other countries are Armenia (3.8%), Georgia (1.1%), Gyrkyzstan (3.4%), Kazakhstan (31.5%), Tadjikistan (2.5%), and Turkmenistan (4.4%).

Table 9.1 Comparisons of the three scenario forecasts at regional and individual levels for eight CAC countries (000 tonnes).

		1994	1995	1996	1997	1998	1999
Most probable scenario	CACFT	1334.81	1298.28	1277.69	1272.59	1282.78	1308.35
	Central Asia	1161.29	1129.50	1111.59	1107.15	1116.02	1138.26
	Caucasus	173.53	168.78	166.10	165.44	166.76	170.09
Optimistic scenario	CACFT	1334.81	2182.36	3029.91	3877.46	4725.01	5572.56
	Central Asia	1161.29	1898.65	2636.02	3373.39	4110.76	4848.12
	Caucasus	173.53	283.71	393.89	504.70	614.25	724.43
Pessimistic scenario	CACFT	1334.81	1266.97	1185.63	1092.14	988.00	874.87
	Central Asia	1161.29	1102.26	1031.50	950.16	859.56	761.14
	Caucasus	173.53	164.71	154.13	141.98	128.44	113.73
Azerbaijan	Most probable	108.12	105.16	103.49	103.08	103.91	105.98
	Optimistic	108.12	176.77	245.42	314.07	382.73	451.38
	Pessimistic	108.12	102.62	96.04	88.46	80.03	70.87
Armenia	Most probable	50.72	49.33	48.55	48.36	48.75	49.72
	Optimistic	50.72	82.93	115.14	147.34	179.55	211.76
	Pessimistic	50.72	48.15	45.054	41.50	37.54	33. 25
Georgia	Most probable	14.68	14.28	14.06	14.00	14.11	14.39
	Optimistic	14.68	24.01	33.33	42.65	51.98	61.30
	Pessimistic	14.68	13.94	13.04	12.01	10.87	9.62
Gyrkyzstan	Most probable	45.38	44.14	43.44	43.27	43.61	44.48
	Optimistic	45.38	74.20	103.02	131.83	160.65	189.47
	Pessimistic	45.38	43.08	40.31	37.13	33.59	29.75
Kazakhstan	Most probable	420.47	408.96	402.47	400.87	404.08	412.13
	Optimistic	420.47	687.44	954.42	1221.40	1488.38	1755.36
	Pessimistic	420.47	399.09	373.48	344.03	311.22	275.59
Tadjikistan	Most probable	33.37	32.46	31.94	31.82	32.07	32.71
	Optimistic	33.37	54.56	75.75	96.94	118.13	139.31
	Pessimistic	33.37	31.67	29.64	27.30	24.70	21.87
Turkmenistan	Most probable	58.73	57.12	56.22	55.99	56.44	57.57
	Optimistic	58.73	96.02	133.32	170.61	207.90	245.19
	Pessimistic	58.73	55.75	52.17	48.05	43.47	38.49
Uzbekistan	Most probable	603.34	586.82	577.52	575.21	579.82	591.37
	Optimistic	603.34	986.43	1369.52	1752.61	2135.70	2518.80
	Pessimistic	603.34	572.67	535.91	493.65	446.578	395.44

Table 9.1 continued.

		2000	2001	2002	2003	2004	2005
Most probable scenario	CACFT	1349.67	1407.41	1482.51	1576.25	1690.29	1826.68
	Central Asia	1174.21	1224.45	1289.78	1371.34	1470.55	1589.21
	Caucasus	175.46	177.04	192.73	204.91	219.74	237.47
Optimistic scenario	CACFT	6420.11	7267.65	8115.20	8962.75	9810.30	10657.85
	Central Asia	5585.49	6322.86	7060.23	7797.59	8534.96	9272.33
	Caucasus	834.61	944.80	1054.98	1165.16	1275.34	1385.52
Pessimistic scenario	CACFT	754.50	628.69	499.26	367.99	236.58	106.62
	Central Asia	656.41	546.96	434.36	320.15	205.83	92.76
	Caucasus	98.09	81.73	64.90	47.84	30.76	13.86
Azerbaijan	Most probable	109.32	114.00	120.08	127.68	136.91	147.96
	Optimistic	520.03	588.68	657.33	725.98	794.63	863.29
	Pessimistic	61.11	50.92	40.44	29.81	19.16	8.64
Armenia	Most probable	51.29	53.48	56.34	59.90	64.23	69.41
	Optimistic	243.96	276.17	308.38	340.59	372.79	405.00
	Pessimistic	28.67	23.89	18.97	13.98	8.99	4.05
Georgia	Most probable	14.85	15.48	16.31	17.34	18.59	20.09
	Optimistic	70.62	79.94	89.27	98.59	107.91	117.24
	Pessimistic	8.30	6.92	5.49	4.05	2.60	1.17
Gyrkyzstan	Most probable	45.89	47.85	50.41	53.59	57.47	62.11
	Optimistic	218.28	247.10	275.92	304.73	333.55	362.37
	Pessimistic	25.65	21.38	16.98	12.51	8.04	3.63
Kazakhstan	Most probable	425.15	443.33	466.99	496.52	532.44	575.40
	Optimistic	2022.33	2289.31	2556.29	2823.27	3090.20	3357.22
	Pessimistic	237.67	198.04	157.27	115.90	74.52	33.58
Tadjikistan	Most probable	33.74	35.19	37.06	39.41	42.26	45.67
	Optimistic	160.50	181.69	202.88	224.07	245.26	266.45
	Pessimistic	18.86	15.72	12.48	9.20	5.92	2.67
Turkmenistan	Most probable	59.39	61.93	65.23	69.36	74.37	80.37
	Optimistic	282.49	319.78	357.07	394.36	431.65	468.95
	Pessimistic	33.20	27.66	21.97	16.19	10.41	4.69
Uzbekistan	Most probable	610.05	636.15	670.09	712.47	764.01	825.66
	Optimistic	2901.89	3284.98	3668.07	4051.16	4434.26	4817.35
	Pessimistic	341.03	284.17	225.67	166.33	106.94	48.19

9.2.2 Justification of ISLB interfaces and distribution for combined GOPFT and CACFT

Foreign trade distribution models link both GOPFT and CACFT to the origin and destination ends as international outlets of the transport system of Iran. Both exogenous and endogenous factors affect the choice of ports. Exogenous factors at different geographical levels are concerned with port hinterland factors and include relevant macroeconomic variables. The endogenous factors or supply of port services cover those variables which affect directly the "ability of the ports to perform their basic function of managing the transfer of goods. e.g. adequacy and physical condition of terminal facilities, terminal rates and charges" (Sun and Bunamo 1973).

Sun and Bunamo (1973) and Ffrench (1979), in their studies of the competition between U.S and Canadian ports for foreign cargoes, focused on exogenous and endogenous influential factors at regional, national and international levels. The exogenous variables which cover macroeconomic and port management factors, over which there is little or no control, are considered:

* the commodity effect (types and volumes of trade)
* the trading partner or overseas trade orientation, and
* the hinterland economy

The five following endogenous or supply factors were also accounted for:

* the adequacy and physical plant condition of terminal facilities
* terminal rates and charges
* frequency and geographic coverage of steamship and freight services
* the ability to ensure that inland rail rates are equalised, and
* solicitation of trade by port development officers.

McCalla (1994) in discussing Canadian port container performance counted the following five important influencing factors:

* port facilities
* inland transport connections
* shipping lines serving the ports
* demand for container shipping, and
* diversion of containers between Canada and the United States.

On such a basis, four different ports in the south of Iran are either fully or partially capable of serving the CAC countries, while two other major ports in the north along the Caspian Sea are technically suitable as second landbridge ports between the Persian Gulf and the Indian Ocean coast of Iran. For reasons of economy, however, it seems that CAC shipments would be handled by road and rail modes to/from major potential southern ports. This is despite the fact that northern ports have the potential to function as landbridge ports for large volumes of shipments. Among four other southern ports, Bushehr and Chah-Bahar have several disadvantages compared with the larger ports of Abass and Imam, because in some essential areas they are completely lacking. These include the distance to the CAC countries, the lack of rail connections, considerable limitations in port entry by ships, the number and types of berths, warehousing, mobile and fixed cargo handling equipment, back-up ports and shipping services and city infrastructure.

According to the Department of Transport (1982, p. vi):

> "Allocating traffic to broad geographic groups seems feasible and the use of modelling techniques deserves further seriuos consideration of this level. However, considerable problems are foreseen in developing an econometric approach to allocating traffic to individual ports and .... ."

Therefore, the two modes of rail and road, and the two largest ports of Abass and Imam (since they have many more facilities and infrastructure) were considered as serving simultaneously the CAC countries and Iran as landbridge modes and interfaces.

The method used to distribute all CACFT to Iranian ports and border crossings is to allocate the closest ports and border crossings for the two regions of the Caucasus and Central Asia. Therefore, the port of Abass is expected to function for the five Central Asian countries, and the port of Imam for the three Caucasus republics. In practice, all these countries use both ports for their shipments, but since there is not any published data about these operations, it will be assumed that CAC shippers consider the cost of freight in terms of shorter road and rail distances. As a result of the assumptions made, to distribute the

CACFT, first it was disaggregated in terms of the CAC countries (see Table 9.1) and then these parts were added to the port of Abass and Imam volumes of trade. Total ISLB traffic for the combined GOPFT and CACFT, and the landbridge ports of Abass and Imam, is shown later in Table 9.4.

The allocation of the CAC countries trade flows to border crossings was based on the location of these countries near north-east and north-west Iran. Three of the CAC countries (Armenia, Azerbaijan and Turkmenistan) have a direct border with Iran, while Azerbaijan and Turkmenistan as well as Kazakhstan can be served through Caspian Sea ports. Turkmenistan and Azerbaijan each have four border crossings with Iran. The foreign trade with Turkmenistan is assumed to be shipped only through the Bajgiran and Lotf Abad border crossings while the total trade of Armenia and Georgia will be handled through the Noor Dooz border crossing on the Iranian-Armenian borders. The trade for the republic of Azerbaijan is divided so that all trade for the Autonomous Republic of Nakhjavan moves to/from Djulfa and only by rail, while, for the mainland of Azerbaijan, all trade is handled to/from Astara by road. The trade of the four more distant Central Asian countries is provided by the rail-connected border crossing at Sarakhs (see Figure 2.1 for ports and border crossings).

9.2.3 Distribution of GOPFT and CACFT to ports and border crossings

For GOPFT six major ports and ten border crossings and for CACFT two ports as well as seven border crossing have been considered as origin-destination ends of the transport system of Iran.

Both the war with Iraq and the collapse of the former USSR affected the operational aspects of Iranian ports and border crossings such that there are large variations in the tonnage of the GOPFT. The distribution and modal split of the three forecasts bring different insights into the capacity and service supply of the transport system of Iran and, in particular, in relation to interfaces (all ports and border crossings) and heavy road vehicles. The distribution of the GOPFT regression forecasts for the time horizon of 2005 is based on the 1993 distribution and modal split for Iran. This year provides a stable situation for port operations as it had the highest volume of Iranian foreign trade. It was also important since it was the end of the critical first development programme of the country since 1989. The methodology for the distribution of GOPFT to interfaces is based on the 1993 foreign trade distribution, where ports accounted for 90.2% and border crossings 9.8% by tonnage (PSO 1993, SCI 1994a). The shares of the six ports and border crossings were calculated relative to the total as shown in Table 9.2 and Figures 9.2 and 9.3 for the combined GOPFT and CACFT models, and individually for each scenario (see Appendixes 16, 17, and 18).

Table 9.2 Volume and distribution of base year and multiple regression forecast of three ISLB scenarios for GOPFT and combined GOPFT & CACFT for year 2005 at interfaces (000 tonnes).

	Type of forecast	Volume of demand	Interfaces (ports & border crossings)	
			Ports	Border crossings
	Base year 1993	30555	27575	2980
	% of Total base year	100	90.20	9.80
1	Most probable GOPFT scenario %	62097 100	56011.50 90.20	6085.50 9.80
	Most probable CACFT scenario	1826.68	1826.68	1826.68
	Most probable GOPFT & CACFT scenario % of total ports & border crossings operations	63923.67	57838.18 87.97	7912.18 12.03
2	Optimistic GOPFT scenario	78259.20	70589.80	7669.40
	Optimistic CACFT scenario	10657.85	10657.85	10657.85
	Optimistic GOPFT & CACFT scenario % of total ports & border crossings operations	88917.05	81247.65 81.59	18327.25 18.41
3	Pessimistic GOPFT scenario	22460.26	20259.16	2201.10
	Pessimistic CACFT scenario	106.62	106.62	106.62
	Pessimistic GOPFT & CACFT scenario % of total ports & border crossings operations	22566.88	20365.78 89.82	2307.72 10.18

As can be seen from Table 9.2 the combined GOPFT and CACFT most probable scenario forecast is about 39.1% lower than the optimistic scenario, and 64.7 % higher than the pessimistic scenario in 2005. The distribution for all three follows the same procedures.

Figure 9.2 Distribution of the three scenarios for combined GOPFT and CACFT forecasts over ports.

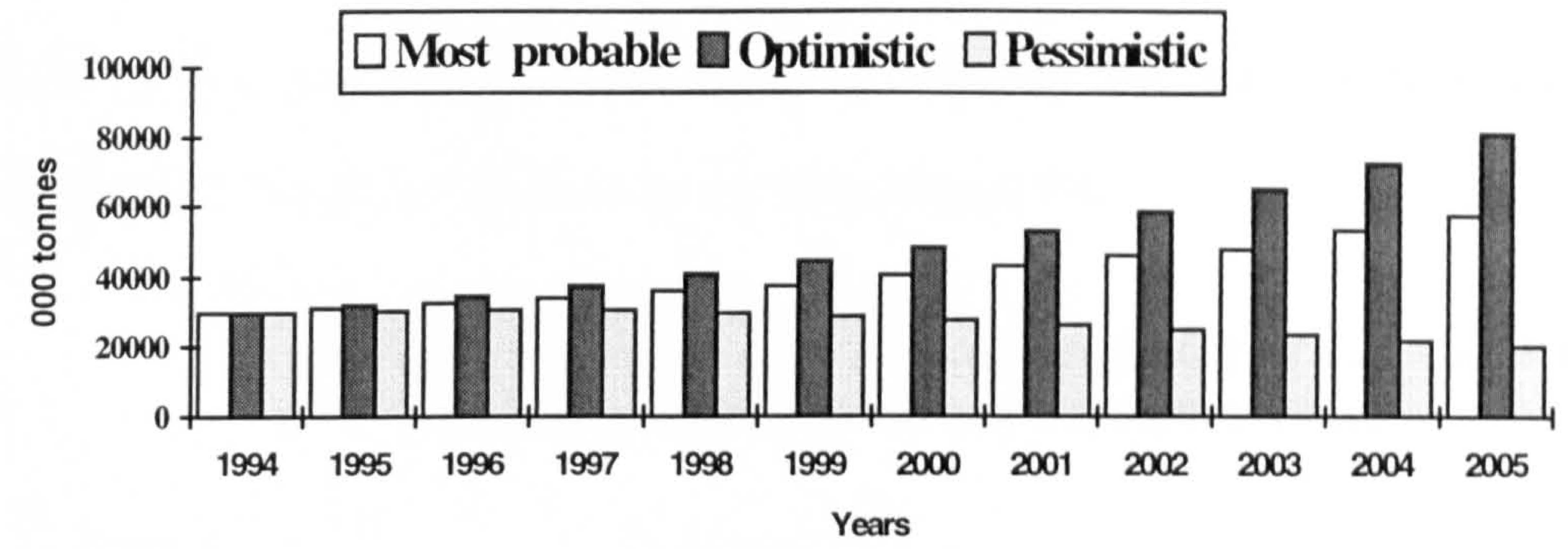


Figure 9.3 Distribution of the three scenarios for combined GOPFT and CACFT forecasts over border crossings.

9.2.3.1 Distribution of the combined GOPFT and CACFT to ports

Shneerson (1983) has suggested three phases in the port planning process:

* Forecasting the demand for port services

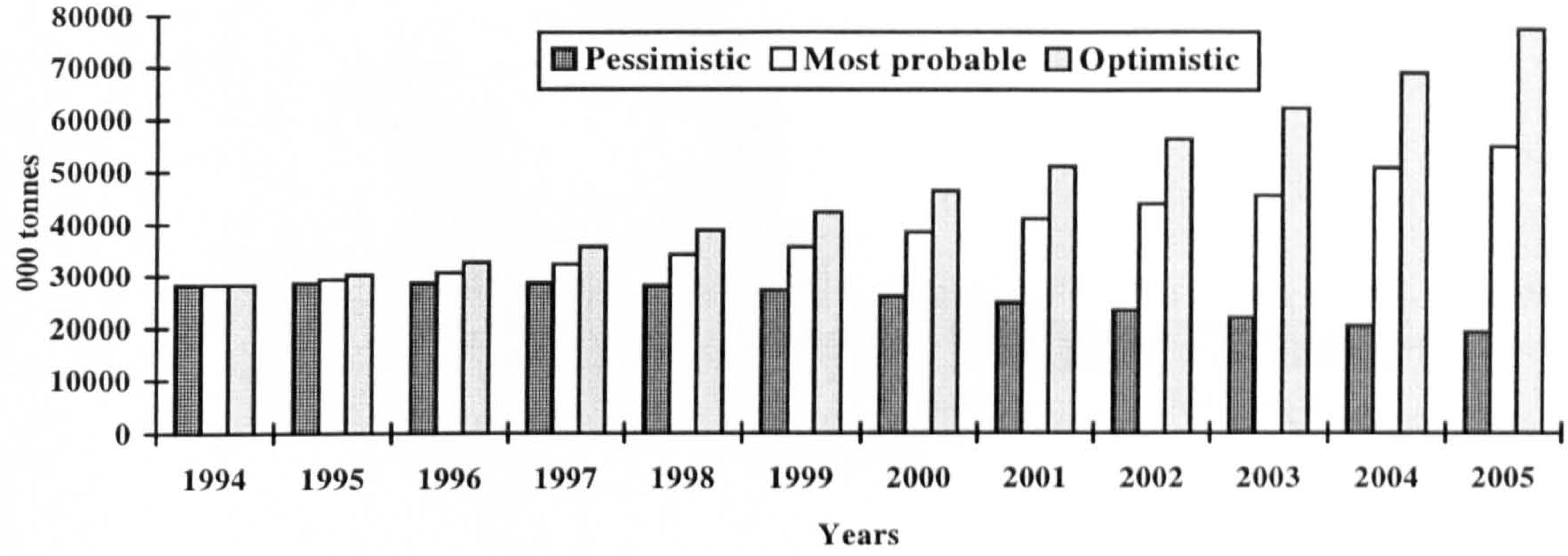
* Allocating demand to individual ports

* Determining resultant cost performance characteristics.

By extending these stages into the ISLB process, the GOPFT and combined GOPFT and CACFT forecasts can now be allocated to regional and individual ports. Therefore, the total GOPFT forecast, as the sum of both imports and exports, was allocated to the six major ports using the base year 1993 for port shares. Only the two landbridge ports of Abass and Imam receive CACFT. These are shown for the three scenarios in Table 9.3.

The future forecasts of total GOPFT is mainly composed of that part which runs through ports, and constitutes the main basis for capacity and services required along ISLB corridors as shown for the three scenarios in Figure 9.4.

Figure 9.4 Comparison of three combined GOPFT and CACFT scenario forecasts for the southern ports of Iran



The volume of trade forecast under the most probable and optimistic scenarios for 2005 for both southern and northern ports is respectively about double and triple that of 1993.

The combined GOPFT and CACFT optimistic scenario forecast share for all ports is about 40.5% higher than the most probable scenario, while the most probable scenario is 184% higher than the pessimistic scenario in 2005. The regional distribution for 1994-2005 GOPFT forecasts is based on 85.4 % for the southern and 4.8 % for the northern ports of the total GOPFT in 1993. These are shown in Table 9.3 and Figures 9.4, 9.5, 9.6 and 9.7 at regional levels and for southern and northern ports (see also Appendix 16 for 1994-2005).

Figure 9.5 Comparisons of three GOPFT scenario forecasts for two northern ports of Iran.

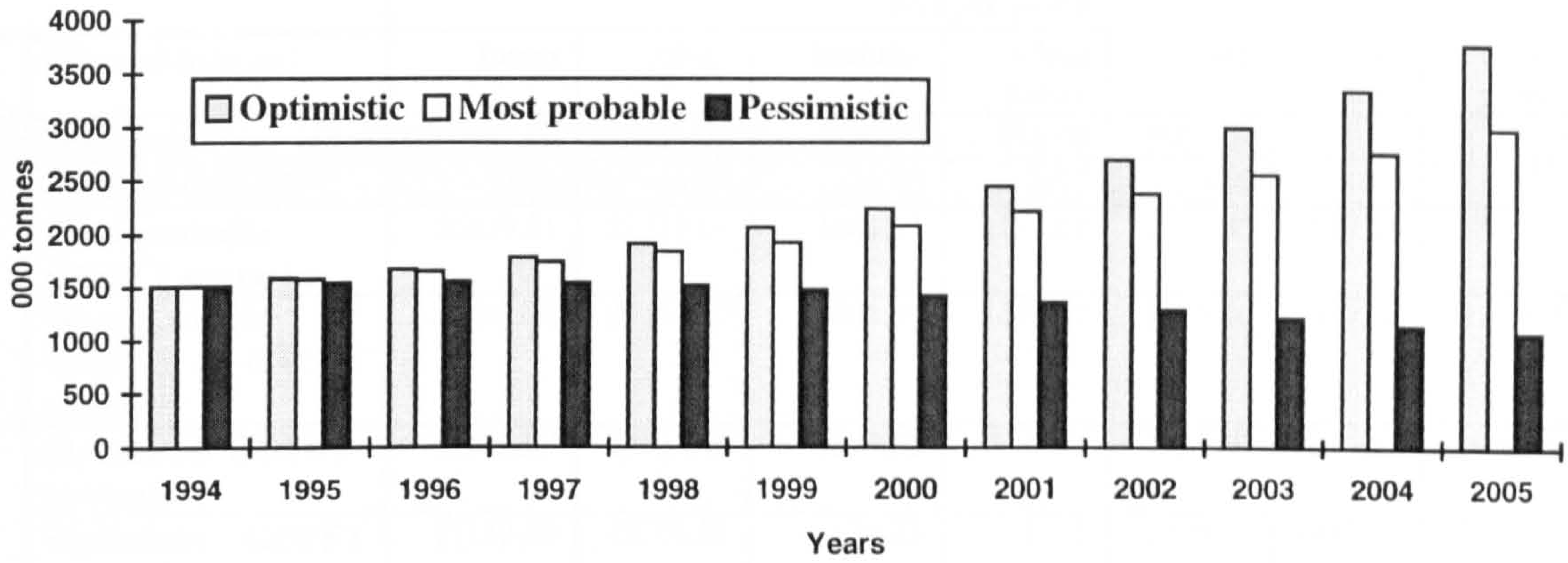


Figure 9.6 Comparisons of four southern ports of Iran for the three combined GOPFT and CACFT scenario forecasts in 2005.

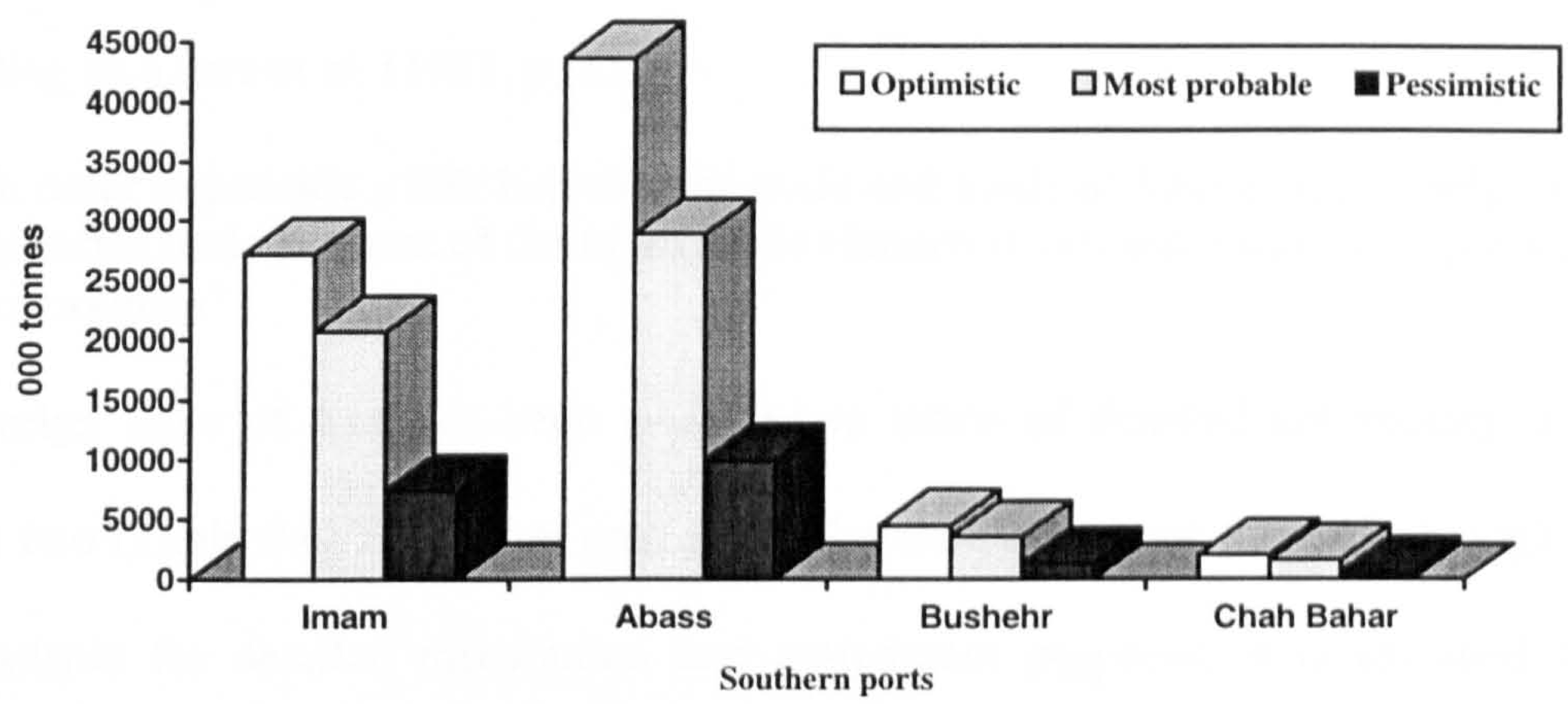


Figure 9.7 Comparisons of the three GOPFT scenarios for the two northern ports of Iran in 2005.

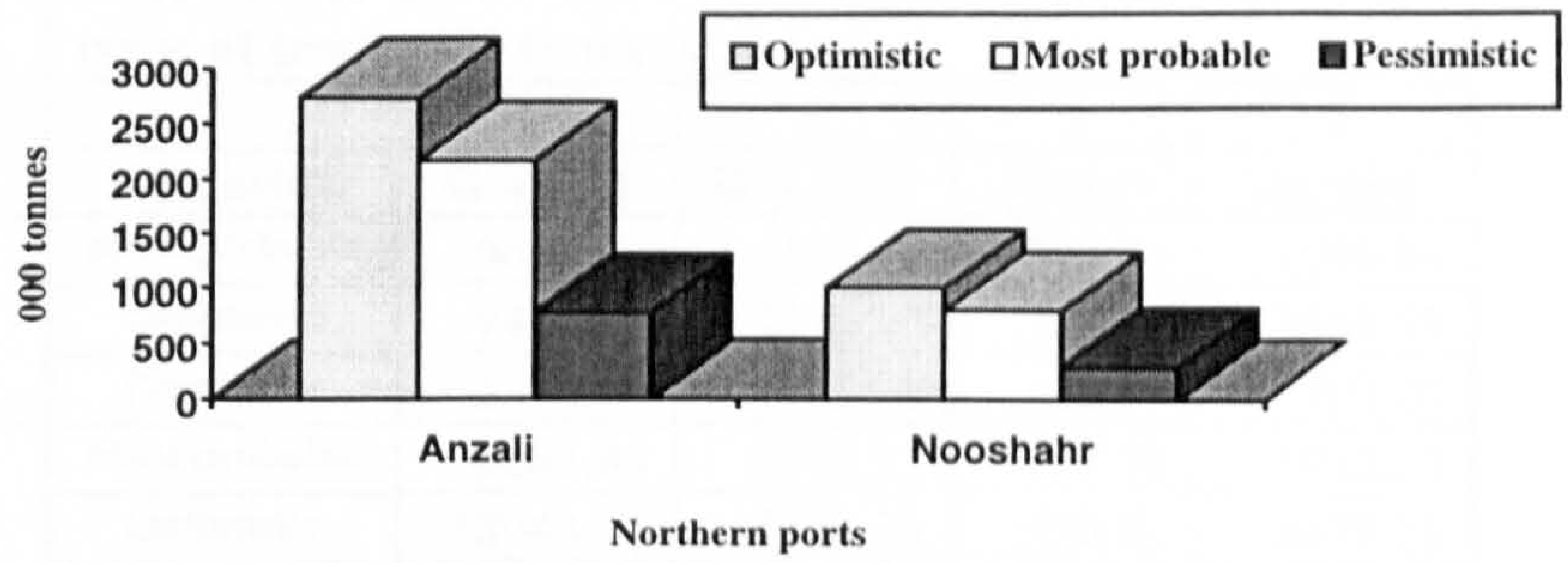


Table 9.3 Volume distribution of base year and three ISLB scenario forecasts for GOPFT and combined GOPFT & CACFT for year 2005 (000 tonnes).

		Major ports						
	Type of forecast	Imam	Abass	Bushehr	Chah Bahar	Anzali	Noo-shahr	Total ports
1	Base year	10047.00	13453.00	1783.00	818.00	1078.00	396.00	27575.00
	% of total GOPFT	32.90	44.00	5.80	2.70	3.50	1.30	90.20
2	Most probable GOPFT scenario	20429.91	27322.68	3601.63	1676.62	2173.40	807.26	56011.50
	Most probable GOPFT & CACFT scenario	20667.38	28911.89	3601.63	1676.62	2173.40	807.26	57838.18
3	Optimistic GOPFT scenario	25747.28	34434.05	4539.03	2113	2739.07	1017.37	70589.81
	Optimistic GOPFT & CACFT scenario	27132.80	43706.38	4539.03	2113	2739.07	1017.37	81247.66
4	Pessimistic GOPFT scenario	7389.43	9882.52	1302.70	606.43	786.11	291.98	20259.16
	Pessimistic GOPFT & CACFT scenario	7403.29	9975.27	1302.70	606.43	786.11	291.98	20365.77

According to Allera et al. (1981, p. 33):

> "In order to provide a link between the trade and mode of forecasts, it is helpful to categorise trade in terms of the berth mode characteristics associated with particular commodities".

The foreign trade of Iran has been reviewed in terms of detailed commodity trades in chapter two (Table 9.4). Although data about the composition of CACFT through Iran is not available for detailed distribution and assignment purposes, it is assumed that all CACFT scenarios consist of general cargo and may therefore, be added to the same category of Iranian port cargo.

Table 9.4 Distribution of GOPFT & CACFT three scenario forecasts for 2005 at ports and national levels for eight types of trade (000 tonnes).

		1	2	3	4
	Scenarios	General	Dry bulk	Reefer	Bagged
Imam with Caucasus	Most probable	6652.46	4106.41	245.16	1940.84
	Optimistic	9470.17	5175.20	308.97	2445.99
	Pessimistic	2334.14	1485.28	88.67	702.00
Abass with Central Asia	Most probable	9266.88	2978.17	437.16	1967.23
	Optimistic	18948.30	3753.31	550.95	2479.25
	Pessimistic	2869.74	1077.19	158.12	711.54
Bushehr[1]	Most probable	605.07	108.05	104.44	302.53
	Optimistic	762.56	136.17	131.63	381.28
	Pessimistic	218.85	39.08	37.78	109.43

Table 9.4 continued.

		1	2	3	4
	Scenarios	General	Dry bulk	Reefer	Bagged
Chah Bahar	Most probable	184.43	519.75	000	318.56
	Optimistic	232.43	655.03	000	401.47
	Pessimistic	66.71	187.99	000	115.22
Anzali	Most probable	456.41	000	000	21.73
	Optimistic	575.21	000	000	27.39
	Pessimistic	165.08	000	000	7.86
Nooshahr	Most probable	169.53	000	000	40.36
	Optimistic	213.65	000	000	50.87
	Pessimistic	61.33	000	000	14.60
Total Ports (GOPFT & CACFT)	Most probable	17334.78	7712.39	786.76	4591.26
	Optimistic	30202.30	9719.72	991.54	5786.25
	Pessimistic	5715.84	2789.54	284.57	1660.65

Table 9.4 continued.

		5	6	7	8	9
	Scenarios	Oil products	Metallic	Mineral	Vegetable oil	Total
Imam with Caucasus	Most probable	000	7477.35	245.16	000	20667.38
	Optimistic	000	9423.50	308.97	000	27132.80
	Pessimistic	000	2704.53	88.67	000	7403.29
Abass with Central Asia	Most probable	9918.13	1202.20	1885.27	1256.84	28911.89
	Optimistic	12499.56	1515.10	2375.95	1583.97	43706.38
	Pessimistic	3587.35	434.83	681.89	454.60	9975.27
Bushehr[1]	Most probable	2416.70	000	58.71	6.12	3601.63
	Optimistic	3045.69	000	73.99	7.72	4539.03
	Pessimistic	874.11	000	21.23	2.22	1302.70
Chah Bahar	Most probable	653.88	000	000	000	1676.62
	Optimistic	824.07	000	000	000	2113.00
	Pessimistic	236.51	000	000	000	606.43
Anzali	Most probable	1151.90	543.35	000	000	2173.40
	Optimistic	1451.71	684.77	000	000	2739.07
	Pessimistic	416.64	196.53	000	000	786.11
Nooshahr	Most probable	468.21	129.16	000	000	807.26
	Optimistic	590.07	162.78	000	000	1017.37
	Pessimistic	169.35	46.72	000	000	291.98
Total Ports (GOPFT & CACFT)	Most probable	14608.82	9352.06	2189.13	1262.97	57838.17
	Optimistic	18411.10	11786.15	2758.90	1591.68	81247.65
	Pessimistic	5283.96	3382.61	791.80	456.81	20365.77

The eight commodities which comprise GOPFT and CACFT will further help the allocation of berths and storage facilities and highlight the new requirements under different scenarios. For the six major ports of Iran the distribution of the total ISLB foreign trade for horizon year 2005, in terms of these eight main categories of trade, is based on the shares of the total composition of Iranian imports and exports in the base year of 1993 for each port, and for all CAC countries' trade (Central Asia for the port of Abass and the Caucasus for the port of Imam). The results of this process are shown in Table 9.4 for the three scenarios.

9.2.3.2 Distribution of the GOPFT and CACFT to border crossings

The methodology used for the distribution of the border crossing share of the GOPFT (9.8% of total GOPFT) is to use the base and closest year data where available for Iranian foreign trade through these crossings for all three scenarios. For the combined CACFT distribution, rail and road access to these crossings, and also their proximity to other CAC countries and capital cities, formed the basis for all scenarios. All trade therefore, for four Central Asian countries (except Turkmenistan, see below) was allocated to the border crossing at Sarakhs as it is rail connected and is the border crossing to the other four Central Asian Republics.

Bazargan is the busiest border crossing of Iran since it borders Turkey, one of Iran's major trade partners, has major trade links, and is also Iran's closest gateway to European markets. To determine the share (%) of all border crossings in the base year, Bazargan's share was deducted from the total volume of GOPFT moving through the ten border crossings shown in Table 9.5. Some of the border crossings of Iran such as Taybad and Mirjaveh mainly serve only one neighbouring country. Therefore, the total trade of Iran with Afghanistan in 1993 was assumed to go through Taybad, and the same assumption was made for Pakistan through Mirjaveh. The distribution of the 1993 base year trade of Iran with Turkmenistan was based on the proximity of the Bajgiran border crossing to the capital city of Turkmenistan (40 km). It was assumed that two-thirds of all the foreign trade of Iran with Turkmenistan moves through Bajgiran and one-third through Lotfabad. The Caspian sea trade with Turkmenistan, Azerbaijan and Kazakhstan was excluded as this trade is mainly carried out with Russia and other CIS countries. Since Iran does not have a direct border with Georgia it was assumed that all Georgia's trade is handled through Armenia at the Noor Dooz border crossing.

Table 9.5 Volume, share and distribution of base year and forecast of three ISLB scenarios for GOPFT and combined GOPFT & CACFT for the year 2005 at ten border crossings (000 tonnes).

	Type of trade and forecast	Astara	Djulfa	Bazargan	Mirjaveh	Razi	Sarakhs
1	Base year	1257.16	139.65	1146.77	172.04	5.78	67.87
	% of Total GOPFT	4.11	0.46	3.75	0.56	0.02	0.22
	Most probable GOPFT scenario	2552.19	285.65	2330.50	349.61	12.42	137.86
	Most probable GOPFT & CACFT scenarios	2647.57	300.44	2330.50	349.61	12.42	1646.69
	Optimistic GOPFT scenario	3216.45	359.99	2937.07	440.60	15.65	173.74
	Optimistic GOPFT & CACFT scenarios	3993.41	446.32	2937.07	440.60	15.65	8977.12
4	Pessimistic GOPFT scenario	923.12	103.32	842.93	126.45	4.49	49.86
	Pessimistic GOPFT & CACFT scenarios	930.89	104.18	842.93	126.45	4.49	137.93

	Type of trade and forecast	Bajgiran	Taybad	Lotfabad	Noor Dooz
1	Base year	67.62	30.35	33.81	58.95
	% of Total GOPFT	0.22	0.10	0.11	0.20
2	Most probable GOPFT scenario	137.23	62.10	68.31	124.19
	Most probable GOPFT & CACFT scenarios	190.82	62.10	95.10	213.70
3	Optimistic GOPFT scenarios	172.95	78.26	86.09	156.52
	Optimistic GOPFT & CACFT scenarios	485.58	78.26	242.40	678.74
4	Pessimistic GOPFT scenario	49.64	22.46	24.71	44.92
	Pessimistic GOPFT & CACFT scenarios	52.76	22.46	26.27	50.15

Source: Data for CAC countries and Afghanistan foreign trade with Iran is based on Sanate-Hamlo-Naghl, 1994b, pp. 15-18

Even under normal conditions before the collapse of the USSR the traffic flow through the major Iranian border crossings of Bazargan and Djulfa was usually congested, due to Customs formalities and procedures. After 1992, with the emergence of the new CAC countries and the sudden expansion of trade through these crossings, the system, including infrastructure, was not able to respond efficiently.

The Astara border crossing became very active after the independence of the Republic of Azerbaijan in 1991, and especially as a result of the decline of the Djulfa rail terminal because of conflict between Armenia and Azerbaijan. It now only serves the Autonomous

Republic of Nakhjavan. There is not yet any published data about the distribution of CAC countries' foreign trade with other countries through Iranian border crossings. Therefore, since statistics about the trade of all CAC countries (including autonomous republics) with Iran was available for 1992 and 1993 for all border crossings, it was assumed that all foreign trade of these countries also follows the same pattern as with Iran. Accordingly, the distribution of Azerbaijan trade is based on 90% for the mainland of Azerbaijan through Astara and 10% for the Autonomous Republic of Nakhjavan through Djulfa. All these calculations are shown in Appendix 19 for 1994-2005 for all three scenarios and all ten border crossings.

9.2.4 Total ISLB demand modal split

Three types of modal split were undertaken for the three ISLB scenarios. These reflect the different natures of the GOPFT, DOMTI, and CACFT demand. GOPFT uses primarily heavy goods vehicles (HGVs) 13.5 - 22.5 tonnes carrying capacity. DOMTI uses all types of vehicles. The CACFT uses a new range of modal services due to the availability of road and rail modes.

Modal share data were not directly available for all three modes. Therefore, they must be derived by calculation. The methodology used to obtain the modal shares for the three scenario forecasts during the period 1994-2005 (Appendices 20, 21, and 22) was based on the fact that the oil products trade is only handled through ports and that imports have decreased due to the reconstruction programme of Iran's oil industries after 1988. Therefore, the share of GOPFT accounted for by oil products was assumed to drop from a maximum value of 24.1% in 1993 to a minimum value of 13.3% (the average growth of oil products through ports during 1979-1993) in 2005 for all three scenarios.

Oil products are not carried by rail even from rail connected ports. The two modes of road and pipeline transport oil products from ports (by road from special terminals belonging to the Ministry of Oil and outside port limits). The distribution of oil products by pipeline mode is based on the policies of the second development programme (1994-1998) intended to increase the pipeline share from 59.8% to 61.6% by 1998. Therefore, the original share for 1994 (59.8%) was assumed for the base year of 1993 and then increased at a rate of 0.36% to 1998 (PBO 1993) and at the same rate to 2005 for all scenarios.

The GOPFT volume through non-rail connected ports was based on the available annual number of road freight journeys and the total trade of these ports issued by the PSO. Port Imam and two border crossings were the only interfaces involved. The next step modelled the average volume of tonnage carried per journey by a HGV for the port of Abass. This would be used as the basis for the HGV calculation for all ports and border crossings. Using this average tonnage per journey, the volume handled by road was computed for the port of Imam and for the two border crossings of Razi and Djulfa. This was then deducted from the total volume of the port of Imam's trade in 1993 to find the rail share, as it is the only rail and road connected port (up to 1994).

After the war, oil products were imported heavily and carried by pipeline and road. Due to improvements in the Abadan refinery production and the operation of other new refineries in the port of Abass and Arak, it is assumed that the share of oil products in the GOPFT up to 2005 falls from 24.1% in the base year to 13.3%, as the average growth over 15 years is only 0.9% each year (10.8/12 = 0.9).

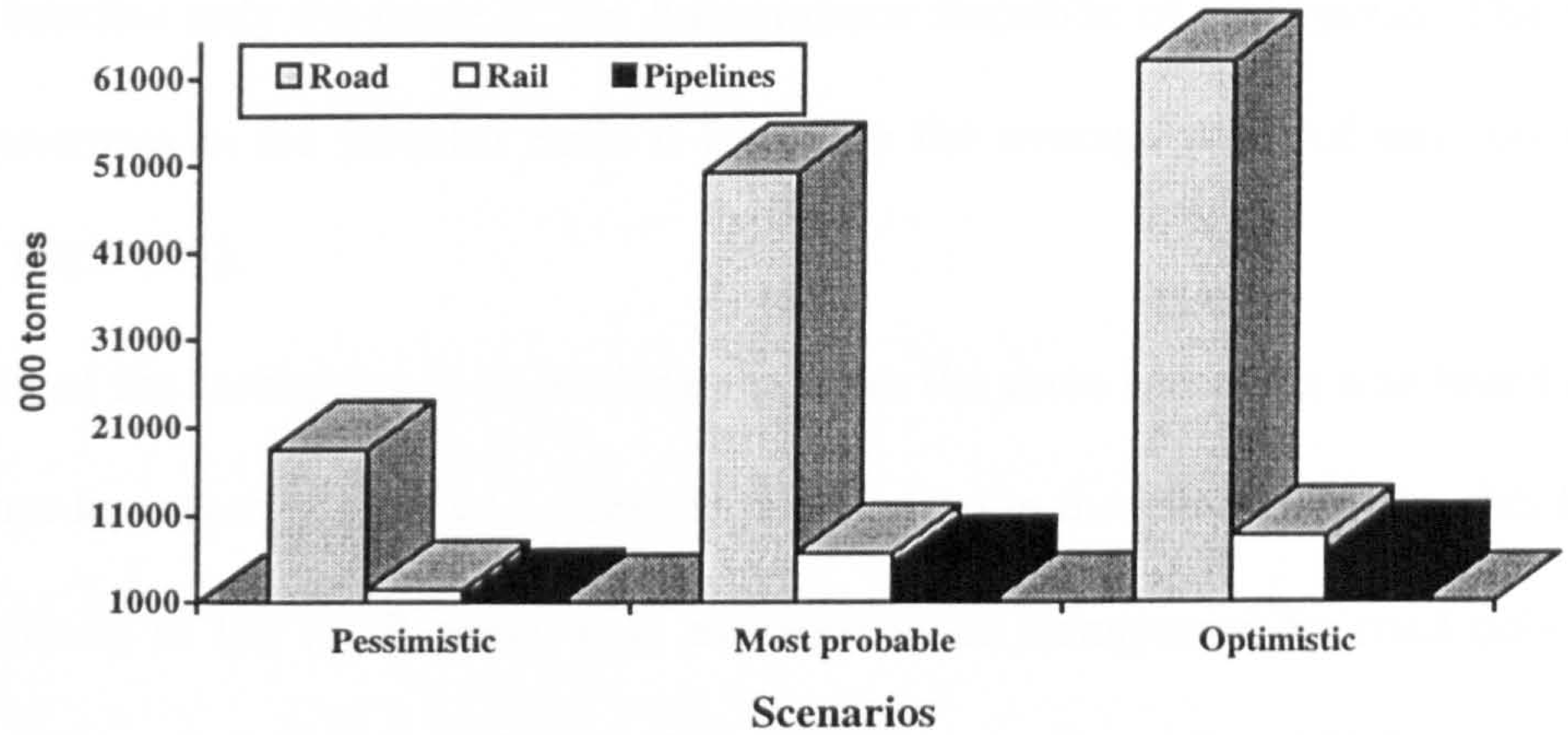
A comparison of the pipeline share between 1994 and 2005 suggests there will be about a 3.96% increase, which will cause a decline in the contribution of the road mode in transporting the total GOPFT. This conforms with the policy of the government to lighten road traffic and reduce the costs of imported oil products.

An important issue in the future modal split for the ISLB study is the connection of the port of Abass to the Trans-Iranian Railways at the end of 1994. This can significantly affect modal shares and increase the rail contribution to foreign trade, provided that additional rolling stock is made available. On the other hand, any increase in rail cargo from the port of Abass may cause a similar decrease in rail operations at the port of Imam or other border crossings. This latter alternative seems more probable.

The share of rail freight in GOPFT was based on a 10.9% annual increase from 1994 (PBO 1993) for all scenarios. The rail operations of the port of Abass at the end of 1994 (with an output of about 1.2 million tonnes in the first year of operation) is deducted from the rail share in 1994 (Sanate-Hamlo-Naghl 1996b).

The modal split of the GOPFT forecast for three modes (8.5%, 10.6%, and 80.9% for pipeline, rail, and road modes respectively) has resulted in the situation shown in Figure 9.8 and later in Table 9.6 for the three scenarios in 2005.

Figure 9.8 Modal split of three scenarios for GOPFT in 2005.



Oil products in the total pessimistic GOPFT follow the same trend as the most probable and optimistic scenarios and drops from 24.1% in 1993 to 13.3% in 2005. The pipeline share from ports drops from 59.8% in 1993 to 50.2% in 2005 (by an annual rate of 0.8%) as shown in column 7 of Appendix 22.

9.2.4.1 Modal split of the combined CACFT & GOPFT demand

The objective of the study is as an aggregate planning project at national level, and the model aims to forecast the likely traffic of each basic mode. Therefore, the CACFT was split only between the two modes of rail and road. It takes into account the long distances between the CAC capital cities and the two southern ports of Iran and also the observation of the past few years behaviour of the CAC shippers in preferring rail to road.

The rail trade of the Caucasus region is disrupted by Armenia and the Autonomous Republic of Nakhjavan from both the east and west routes to Djulfa in Iran. Therefore, the CAC trade through each border crossing connected with both modes (rail and road) is assumed to be handled only by rail. Consequently, all shipments to the four distant Central Asian countries which are assumed to end or originate from the port of Abass will be transported through the Iranian rail network through the Sarakhs border crossing; while Djulfa handles only the trade of the Autonomous Republic of Nakhjavan. The share of the CAC countries in the forecast trade is based on the average share of each country's trade during 1987-1993.

The split of the foreign trade of Turkmenistan for the three scenarios was based on the ratio of the border crossing trade of Lotfabad and Bajgiran in the bilateral trade with Iran. Due to its proximity to the ISLB ports, it is assumed to be transported by road only. Similarly, shares of the Azerbaijan Republic and its Autonomous Republic of Nakhjavan were based respectively on the proportion of 10% (through Djulfa) and 90% (through Astara) of trade with Iran. All combined GOPFT and CACFT modal splits at individual and combined levels are shown in Table 9.6 for 2005, and for all the three scenarios and three modes for the period 1994-2005 in Appendix 23.

The ratio of combined GOPFT and CACFT assumed road traffic for 2005 compared with the base year contributions is 290% for the optimistic scenario, 210% for the most probable scenario, and 78% for the pessimistic scenario (see Table 9.6).

Table 9.6 Volume of modal split for the GOPFT and combined GOPFT & CACFT base year and regression forecasts of three ISLB scenarios for the year 2005 (000 tonnes).

			Modes		
			Modal split		
	Type of forecast	GOPFT & CACFT	Road	Rail	Pipelines
1	Base year 1993	30555	23579.3	2581	4394.7
	% of total	100	77.1	8.5	14.4
2	Most probable GOPFT scenario	62097	50250.8	6550.6	5295.6
	% of total	100	80.9	10.6	8.5
3	Most probable GOPFT & CACFT scenarios	63923.67	50550.56	8073.87	5295.6
	% of total	100	79.1	12.6	8.5
4	Optimistic GOPFT scenario	78259.2	63055	8530.25	6673.9
	% of Total	100	80.57	10.9	8.53
	Optimistic GOPFT & CACFT scenarios	88917.49	68778.22	17417.83	6673.9
	% of Total	100	77.35	19.6	3.05
5	Pessimistic GOPFT scenario	22460.27	18512.51	2448.17	1499.58
	Pessimistic GOPFT & CACFT scenarios	22566.88	18530.01	2537.08	1499.58

9.2.4. 2 Real DOMTI modal split

DOMTI is a gross forecast and includes the volume of exports of Iran during 1994-2005 which must be excluded when estimating domestic modal split. Therefore, it was necessary to deduct exports from all three scenario forecasts of DOMTI. This was based on the average of total national export volume during 1988-1993 as reasonably stable years of the economy of the country. The average of 11.35% was deducted from DOMTI. Real DOMTI is the main body of demand for the transport supply of Iran. For example, the three GOPFT forecasts are about 9.1%, 7.7%, and 25% of the three real DOMTI forecasts in 2005 for most probable, optimistic and pessimistic scenarios respectively. Domestic transport at the national level in any country is a complex issue. On one hand, it is an essential part of production and on the other, it provides essential and other services for individuals. It covers many production centres and uses extensive routes both for receiving materials and the distribution of products. Significant factors, include the number and composition of vehicles, traffic control, prices, provision and range of services required, and fuel consumption (Sampson and Farris, 1979).

It is assumed that, for 1994-2005, the impact of different transport supply investment policies under the three scenarios creates such modal capabilities similar to 1979-1993. For example, there had been a growth of about 315% in 1993 for real DOMTI rail mode as shown in column 9 of Table 2.55, which means a rate of growth of about 23% or 819,000 tonnes annually during 1979-1993. The shares of the three modes for actual DOMTI in 1994 was based on the average share of these modes during 1979-1993. This was accounted for by rail (4.6%) and by pipeline (10.3%) and the rest for road (84.74%) with different annual growth rates from 1994 for all three scenarios as shown in appendix 24. The assumption for the three scenarios will be changed with an increase of 0.3% as the annual increase for rail (overall 4.6% from 1995) due to the new rail line to the port of Abass and an increase of 0.36% in pipeline share from 1994 to 10.3%. The share of the three modes in transporting real DOMTI for the three scenarios is shown in Table 9.7 for 2005 and Appendix 24 for the period 1994-2005.

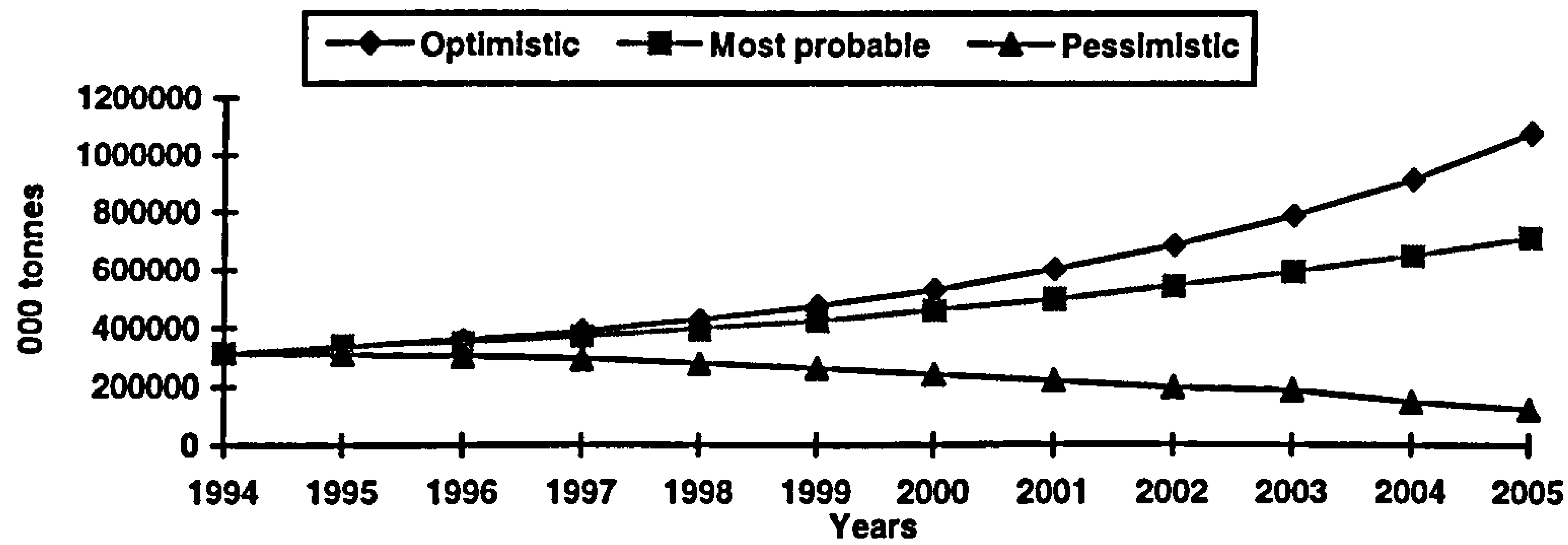
Table 9.7 Modal split of three real DOMTI in 2005 (000 tonnes)

Modes	Base Year	Scenarios 2005	
Road	220,566.6	Most probable	509,222.97
		Optimistic	773,350.75
		Pessimistic	77,176.45
Rail	16,802.0	Most probable	51,921.29
		Optimistic	78,852.23
		Pessimistic	7,650.09
Pipelines	34,291.7	Most probable	96,087.25
		Optimistic	145,926.54
		Pessimistic	14,525.23

9.2.4.3 Total demand and modal split for the Iranian transport system

The combined forecasts of the GOPFT, CACFT and DOMTI in all three scenarios represent the demand on the Iranian transport system. This is composed of the sum of the three demands for each of the road, rail and pipelines modes. The general modal trends of the three scenarios are shown in Figure 9.9 and Appendices 25 and 26.

Figure 9.9 Total future forecast volume (GOPFT, DOMTI, and CACFT) for Iranian transport networks and interfaces.



The difference between the total demand on the transport system of Iran as shown in Table 9.8 is relatively high. The base year demand compared with the optimistic, most probable and pessimistic scenarios accounts for 27%, 42% and 248% respectively.

Table 9.8 Total three demand of scenarios for Iranian transport system in 2005 (000 tonnes).

Scenarios		Base year
Demands	**Volume**	
GOPFT	78259.21	30555.0
CACFT	10657.85	000.0
Real DOMTI	998129.52	271660.3
Total optimistic	**1,087,046.58**	**302,215.3**
GOPFT	62097	30555.0
CACFT	1826.68	000.0
Real DOMTI	657231.50	271660.3
Total most probable	**721,155.18**	**302,215.3**
GOPFT	22460.27	30555.0
CACFT	106.62	000.0
Real DOMTI	99351.76	271660.3
Total pessimistic	**121,918.64**	**302,215.3**

In order to determine the future activities for the Iranian network, modal split models for total demand must be designed to see the adequacy and shortcomings of the ISLB supply system in the handling of the total forecasts which are shown in Appendix 27 and Table 9.9.

Table 9.9 Total forecast demand for Iranian road and rail transport in 2005 (000 tonnes).

Scenarios	Road	Rail	Pipelines
Most probable	559777	59996	101382
Optimistic	842173	96272	152600
Pessimistic	95707	10187	16024

As the ISLB study is at the national level, total demand was limited only to the "assignment" of the modes of road, rail and pipelines and not to every individual link (Werner 1985). The composition of the total demand for the three modes of the Iranian transport system under each of the three scenarios is shown in Table 9.8 where DOMTI has the highest and CACFT the lowest shares. The future demand for the Iranian interfaces has been assessed for GOPFT covering all six major ports and ten border crossings. It has also been assessed for the combined GOPFT and CACFT which includes two ports in the south and six border crossings.

The GOPFT and DOMTI forecasts are related to Iran and were treated as affecting internal decision making, mainly following the same modal and interface shares as they had during 1979-1993 (and in particular 1988-1993). The choice of modes for freight flows for the CAC countries is under the control of foreign decision makers and shippers and, therefore, should be treated separately.

9.3 Future Iranian transport supply requirements

Accroding to Baumgartner (1989, p. 35):

> "The capacity of a transport infrastructure may be defined as the maximum number of vehicles that can use the infrastructure over a given unit of time under specified conditions. In principle, infrastructure capacity is established or planned on the basis of projected future demand with a pre-determined shortfall in performance."

The present capacity of Iran's transport supply in terms of both modes and interfaces is limited mainly by fleet size of heavy road vehicles, rolling stock and single rail networks. Labour productivity in general is poor throughout the transport sector.

At some point in the ISLB scenario study time period, the level of demand for transport is likely to exceed the maximum available existing capacity. Therefore, the need for new capacity must be determined by analysing the different types of future demand and base year supply figures.

9.3.1 Port traffic and capacity

9.3.1.1 Maritime traffic of GOPFT and CACFT

According to Bruun (1990, p. 49):

> "The data needed for traffic analysis are information on the distribution of the vessels to be expected by size and number and their cargo considering the future development."

In terms of maritime traffic (number of visiting ships) the combined GOPFT and CACFT through Iranian ports under the three scenarios in 2005 were based on the 1993 average trade of each ship (see Appendix 28 and Table 9.10). Increases in maritime traffic directly affects the berths and cargo facilities, equipment utilisation and the deployment of marine vessels (e.g. tugs) and personnel. The daily rate of maritime traffic into the six major Iranian ports changes from 5.4 in the base year to 12.9 (most probable scenario) and 14.9 (optimistic scenario). This would require a substantial increase in pilotage and tug services which will need long-term planning as they require a skilled labour force. Also new marine vessels will be needed to support the expected extra traffic. This will require foreign currency, legal formalities and time. To some extent, this amount of maritime traffic can be reduced by the employment of larger ships and better utilisation of ship space for vessels calling at Iran's major ports.

Table 9.10 Comparisons of three ISLB scenarios with base year situation and their maritime effects on ports (unit: ship).

	Maritime traffic	Daily rate	Maritime traffic	Daily rate	Maritime traffic	Daily rate	Maritime traffic	Daily rate
	Base year		Most probable		Optimistic		Pessimistic	
Imam	584	1.60	1201	3.30	1577	4.30	430	1.20
Abass	639	1.80	2149	5.80	2076	5.70	474	1.30
Bushehr	160	0.44	323	0.89	407	1.10	117	0.32
Chah Bahar	43	0.12	88	0.24	111	0.30	32	0.09
Anzali	371	1.10	748	2.00	943	2.60	271	0.74
Nooshahr	124	0.34	253	0.69	319	0.87	91	0.25
Total	1921	5.40	4762	12.9	5433	14.90	1415	3.9

9.3.1.2 Future port capacity of Iran

Bruun (1990, p. 49) considers that port capacity:

> "Depend upon the exterior physical factors including depth, channel and basin characteristics."

Bruun then lists four following factors determining the port capacity on the land side:

* Berth capacity (length of berth in relation to depth)

* Area available for loading/uloading

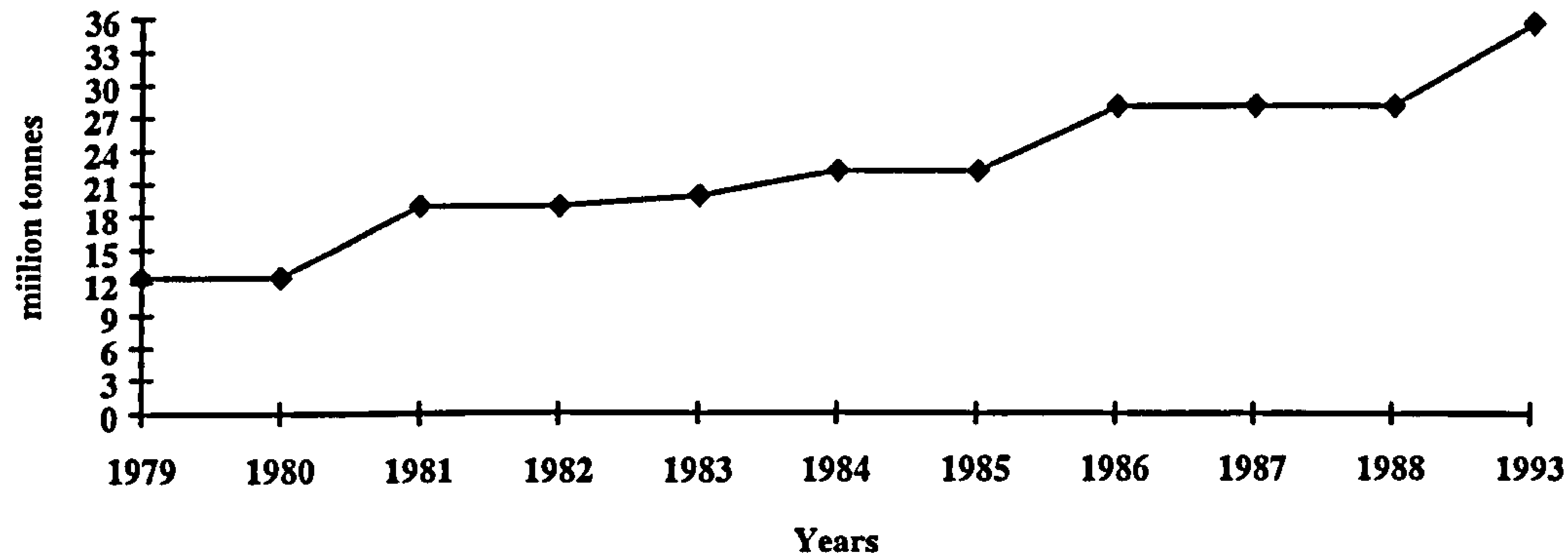
* Storage area, and

* Traffic area.

Shneerson (1983, p. 226) defines port capacity "by the number of tonnes that pass through the port in a given time" and argues that port capacity is a function of the direct (loading/unloading to rail and truck) and indirect (into transit sheds) delivery performance. This determines the level of traffic and services and also the depth of berths and entrance channels, length of berths, warehousing areas and numbers and types of cranage systems, etc.

To identify the required port capacity and bottlenecks for five different types of trade and also for the six major ports under the three scenarios, the distributed combined GOPFT and CACFT trade in 2005 was compared and assessed at national and port levels. This was achieved by the use of combined general cargo trade ports (excluding oil products of 14.6 million tonnes, 21.8 million tonnes, 5.9 million tonnes for the most probable, optimistic and pessimistic scenarios respectively). Extrapolations were made based on 1993 and are shown in Tables 9.11 and 9.12. The existing port capacity of Iran in the base year of 1993 in total and for five types of trade (general purpose berths, container, iron ore, grain and liquid food oil) were investigated based on PSO estimations for the period 1979-1993 (see Figure 9.10).

Figure 9.10 Development of the nominal (design) port capacity in Iran.



Source: Based on various PSO annual performance reports for 1979-1993.

The total capacity of 30.15 million tonnes indicated in column 3 of Table 9.11 is derived from the PSO and was increased for this study by including the food oil unloading terminal capacity of the port of Abass and the port of Imam silo, as they play a significant role in the performance volume of both ports.

Table 9.11 Capacity and trade in 1993 and 2005 under three scenarios for all six major ports at different types of berths (million tonnes).

		1993			2005		
	1	2	3		4		
	Type of Berth	No. berths	Base year capacities[1]		Forecast trade for ports and required capacities[4]		
			Estimates by PSO (3.1)	Estimated capacities[3] (3.2)	Most probable	Optimistic	Pessimistic
1	Ocean going: of which	77	26.65	31.99	43.23	62.84	15.08
1.1	General purpose	61	19.45	19.45	32.07	48.77	11.04
1.2	Container[2]	10	4	4	1.39	1.95	0.49
1.3	Iron ore	2	3.20	3.20	2.19	2.76	0.79
1.4	Grain	2	N/A	2.74	7.71	9.72	2.79
1.5	Liquid food oil	2	N/A	2.60	1.26	1.59	0.46
2	Total	90	26.65	31.99	43.23	62.84	15.08
3	Barge harbours	23	3.50	3.50			
4	Total with barge harbour		30.15	35.49			

Source: Based on PSO 1993 and 1992 annual reports.
1: PSO estimates. 2: Scenario capacities for container terminals were based on the volumes of container trade of about 2.4% of total trade through ports in 1993 base year and not included in the total. 3. for silo and liquid food oil berths. 4. excluding oil products.

The carrying capacity of the port Imam silo is 70,000 tonnes (PSO 1993) and for two ships, and was approved by the Transport Co-ordination Committee of Iran in 1992 to operate at a daily rate of 7500 tonnes (2.7 million tonnes per annum) (Payam Darya 1992). For the port of Abass food oil installations, 300 tonnes per hour output gives a nominal capacity of 2.6 million tonnes. On this basis the ports have been expanded and improved from 12.5 million tonnes in 1979 to 35.5 in 1993.

The assessment and comparison of the three scenarios shows that, for the four types of trade, the pessimistic forecast (15.04 million tonnes) is well below the base year capacity (35.5 million tonnes) for total ocean going berths. For both the most probable and optimistic scenarios, the port capacity issue is significant and indicates the need for an increase as shown in Table 9.11. Further expansion is required by expanding port productivity. The shortfall in performance of the ports could be filled by the increase and development of port technology and changes in daily shifts for some particular categories of trade, since the output of Iranian berths is low due to the dependence of cargo operations on ships' gear and on the many untrained port workers, both of which are below international averages (Shneerson 1981).

The assessment indicates that under the most probable scenario, if the ports are expanded at the same average annual increase of 1.54 million tonnes per year during 1979-1993, then in 2005, the combined ports in Iran will have a 53.92 million tonnes capacity which is higher than the combined GOPFT & CACFT for the combined ports most probable scenario (43.2 million tonnes). Using 53.92 million tonnes probable trade "as a preferred capacity utilisation" (Chang 1978) there will be about 10.69 million tonnes excess capacity for the most probable scenario for all cargoes (except oil products).

For the most probable scenario containers, iron ore, and food oil will still have surplus port capacity with general cargo and grain in deficit. Under the optimistic scenario all except food oil installations will have a shortage of capacity.

According to the PBO (1993), it is planned to increase the port utilisation coefficient from 90% in 1994 with 28 million tonnes port capacity to 95% of 34 million tonnes in 1998. This is in addition to an increase of 8.5 million tonnes in the foreign trade of minerals, making 42.5 million tonnes. On this basis, roughly another 5 million tonnes capacity (with 100% utilisation) is needed in 2003, providing ports with 47.5 million tonnes capacity, which should cover the most probable scenario growth rate, but is still less than the optimistic scenario requirements. It should also be borne in mind that, according to the PSO (1993), mineral installations, even under the optimistic scenario forecasts, have surplus capacity but cannot be used for general cargo purposes. This is a critical requirement for the optimistic scenario where, in the case of northern ports, even if all the expected 4 million tonnes of port capacity development is implemented, in the optimistic scenario GOPFT alone requires about 3.8 million tonnes (Torkan 1994).

The critical shortage is in general cargo berths for refrigerated, bagged, metal and grain cargoes, while iron ore and vegetable oil installations still have spare capacity. For the optimistic scenario with the same trend (1.54 million tonne annual expansion from 1994) there will be about a 5.53 million tonne shortage of capacity and a consequent demand for changes in the policies of port development and improvement.

On an individual port basis, the required capacities for 2005 were also compared with the base year of 1993 and are shown in Table 9.12.

Assessment indicates that almost all six ports have had a high margin of spare capacity of about 16.17 million tonnes in 1993, but there will be shortages under the most probable and optimistic scenarios if port capacities remain frozen at the base year levels. Under both the most probable and optimistic scenarios the two largest landbridge ports of Abass and Imam will have serious shortages of capacity, while all others are expected to be reasonably safe under the most probable scenario, except for the port of Anzali which needs about 50% extra capacity. With only slight improvements, the others also can cope with the optimistic demand.

Table 9.12 Capacity and trade in 1993 and 2005 under three ISLB scenarios for every major port of Iran (million tonnes).

Ports	Actual in 1993 (million tonnes)		Trade for 2005 (million tonnes)		
	Capacity	Trade*	GOPFT & CACFT forecast scenarios*		
		Base year	Most probable	Optimistic	Pessimistic
	1	2	3	4	5
Imam	12+ (Silo 2.74)	10.05	20.67	27.13	7.40
Abass	12.9 + (Food oil 2.6)	8.43	18.99	31.21	6.39
Bushehr	1.35	0.59	1.19	1.49	0.43
Chah Bahar	1.05	0.50	1.02	1.29	0.37
Total south	31.60	19.56	41.87	61.12	14.59
Anzali	0.80	0.46	1.02	1.29	0.37
Nooshahr	0.45	0.16	0.34	0.43	0.12
Total north	1.25	0.62	1.36	1.72	0.49
Total Iran	30.15 (35.49)	20.18	43.23	62.84	15.08
		Ports' trade without oil products			

Source: Data for 1993 is based on PSO annual port performance for 1993. * : Trade excluding oil products.

9.3.1.3 Required length of berths for combined GOPFT and CACFT

The argument that an increase in total port demand and traffic will produce medium and long term need for increases in the number of suitable berths, rests on the assumption that existing facilities are utilised appropriately to handle the required demand. Therefore, changes in past and present working practices (e.g. the number and composition of shifts on quays and ships) and the quantity and performance capability of the cargo handling technology (e.g. the number and types of shore cranes) can play a significant role. However, an analysis of cost and project time is required before any judgement should be passed on to the further extensions of port infrastructure.

According to PSO practices, each berth has about 189.5 metres length for each ship (the ratio of the total length of ocean-going berths (14,592 metres) to the number of berths (77) in 1993. The nominal maximum number of ships which could have been accepted in these six major ports in 1993 was found from the following equations for 77 ocean-going berths for two situations. First with 7.10 service days per ship as derived for 1993 (see column 3 in Table 7.7) and second for best situations if ports were able to provide a one service day per ship during the same year (see Table 9.13):

$$Y = 77 \times 365 / 7.1 = 3958.5 \qquad \textbf{(EQ. 1)}$$

where **Y** is the maximum number of ships which could be accepted in 1993 with one service day.

This is the ideal estimated number of ships in 1993 with 365 days a year working and 77 berths for ocean-going ships.

$$Y = 77 \times 365 / 1 = 28105 \qquad \textbf{(EQ.2)}$$

where **Y** is the estimated number of ships in 1993 provided by 77 berths and with 7.1 service days.

The estimated number of ships in 2005 for all scenarios is shown and compared with the above two estimations in Table 9.13. It shows that under the same working standards of 1993 (7.1 service days per ship) there would be a serious shortage in the number of berths. It can be argued that, with the same number of berths, the service days for each ship must be reduced to 5.9 and 5.2 days respectively for the most probable and the optimistic scenarios.

Similarly, on the basis of 189.5 metres length of berth and 7.1 ship service days of 7.1 (as in 1993), the required number of ocean-going berths under the most probable and the optimistic scenarios is 93 and 106 respectively.

This can be achieved through improvements in the productivity of port manpower, the use of larger ships with higher average carrying capacity than in 1993, the application of new technology, or changes in the pattern of foreign trade, e.g. containerisation.

Table 9.13 Estimated length and number of berths for Iranian ports under three ISLB scenarios.

	Number of possible ships				
	1993		2005		
Scenarios	1 service day	7.1 service day	Most probable	Optimistic	Pessimistic
Maritime traffic	28105	3958.5	4762	5432	1416
No. of berths	-	77	93	106	lower than base year
Length of berths/m[1]	-	14592	17624	20087	lower than base year

Note: 189.5 metres per post of berth in 1993.

9.3.1.4 Required storage areas for combined GOPFT and CACFT

One aspect of port operations is the form of direct and indirect delivery. The former relates to the road and rail transport link and vehicles calling at ports, whereas the latter relates to the availability of open and covered storage facilities within port boundaries. Therefore, another aspect of the GOPFT and CACFT scenarios is the impact these forecasts have on the storage facilities of ports which directly affect future port throughput. According to the PSO (1993), the volume of direct and indirect deliveries of the six major Iranian ports in 1993 is shown in Table 9.13 and indicates that direct delivery accounts for about 68.1% of total trade through ports, whereas only 31.9% moves to inland destinations from storage areas. Assuming that these proportions remain fixed in the future, the expected delivery operations in 2005 for these scenarios are shown in Table 9.14.

Table 9.14 Direct and indirect delivery in base year 1993 and three ISLB scenarios for combined GOPFT & CACFT (excluding oil products) in 2005 through Iranian ports (000 tonnes).

	Direct	Indirect	Total
Base Year	12221.00	5730.00	17951.00
% of total delivery to inland	68.10	31.90	100.00
Most probable	29439.19	13790.17	43229.36
Optimistic	42791.69	20044.86	62836.55
Pessimistic	10270.72	4811.10	15081.82

The analysis indicates that the two delivery systems for the pessimistic scenario are slightly under the base year figures. The critical figures for the most probable and optimistic scenarios, requiring the road trucks and wagons to carry 29.4 and 42.8 million tonnes in direct delivery from/to ships in limited port and quay areas, or storage of 13.8 million tonnes and 20.04 million tonnes in an indirect system, is highly questionable.

Among all eight broad types of trade identified through Iranian ports only general cargo, metals, refrigerated, bagged cargoes and container are using both types of open and closed storage areas. Therefore, excluding oil products, dry bulk, vegetable oil and minerals from the total forecast, the combined trade through Iranian ports in 2005, which needs storage, is derived on the basis of the base year's existing open and covered storage. It is shown in column 4 of Table 9.15. Since data about the composition and volume and tarnsit time of cargoes stowed in warehouses is not available, it is not possible to estimate future storage places by cargo types. Therefore, the required area and the number of covered and open storage facilities under the most probable and the optimistic scenarios were determined by extrapolating the total indirect delivery volumes. This was based on each type of storage in the base year. Having considered 45 covered warehouses in 1993, each will have about 9786 m^2 (440351/45) average area. The number of warehouses required under the three scenarios is shown in Table 9.15.

Table 9.15 Covered and open storage areas required under three ISLB scenarios.

	Storage (sq./m)			Trade (000 tonnes)	
	1	2	3	4	5
Scenarios	No. covered	Covered	Open	Indirect warehousing delivery*	Total
Base Year	45	440,351	4229775	5730	17,951
% of total	100	9.40	80.60	31.90	
Most probable	80 (35 new)	786,076	7,550,624	10228.69	32,064.87
Optimistic	122 (77 new)	1,195,513	11,483,457	15556.43	48,766.25
Pessimistic	28 of 45	270,737	2,600,558	3522.93	11,043.66

Note: * : GOPFT & CACFT which requires storage in ports excluding oil products, vegetable oil, grain (dry bulk), and minerals.

Under the most probable scenario, a total of 80 warehouses (i.e. 35 new warehouses) are required within the Customs limits, and 122 under the optimistic scenario. The estimated figures for warehouses under the most probable and optimistic scenarios are significant indicators in terms of numbers required (about 1 and 2.7 times the base year figure), construction time and cost, if alternative policies, such as increasing direct delivery, cannot be implemented. The development of open areas are cheaper and faster to make available, but in many ports, may bring social, administrative, and legal conflicts.

9.3.1.5 Required inland road and rail equipment

Inland road and rail transport plays a significant role in the success and performance of overall transport supply. This is especially the case for heavy goods vehicles (HGVs) which are the primary mode serving ports. The road and rail transport are not controlled by the ports. Therefore, their utilisation and acquisition for the transport of foreign trade is important at national policy levels. Combined GOPFT and CACFT use the biggest proportion of the common HGVs of between 13.5 and 22.5 tonnes carrying capacity with 48% of the total number of vehicles employed for transporting foreign trade from ports and border crossings in 1994 (Atrchian 1995). Assuming that the same 48% share of HGVs of this size is applied to the total number of vehicles in 1993 (198,957) then, the number of HGVs for the three scenarios can be calculated (see Table 9.16). The provision of this number of HVGs is far away from the expected figure in 2005 for both foreign and domestic trade trucks (PBO 1993).

For rolling stock in 2005, on the basis of total rail trade and the number of wagons and locomotives in service in 1993, there will be 44,572 wagons and 644 locomotives required for the most probable scenario. According to the second five year development programme of Iran during 1994-1998, (PBO 1993) there is an annual renewal programme of 740 wagons for the period 1994-1998. If this is continued at the same growth rate until 2005 there will be a total addition of another 8,880 freight wagons. This makes a total 23,280 rail wagons, which is about 52% of the required number for the most probable scenario and 33% for the optimistic scenario. For locomotives there is a significant difference between the number of locomotives in 1993 according to IRIRC (208) and as quoted by the PBO

(373). It is planned to increase the number by 14 per annum (based on PBO 1993) so that there will be another 168 new locomotives by 2005. The rail motive power fleet for IRIRC and PBO locomotive numbers in 2005 will then be 376 and 541 respectively, but both estimates are far lower than that estimated under the most probable and optimistic scenarios as shown in Table 9.16.

Table 9.16 Number of vehicles & rolling stock required in base and horizon years under three scenarios.

		1993	2005		
		Base year	Most probable	Optimistic	Pessimistic
1	Volume of total road demand (combined GOPFT, DOMTI & CACFT by road)	244145.90	559773.52	842128.97	1011729.79
2	Total no. of HGVs	198975	456207	686322	less than base year
3	No. of total HGVs with 13.5, 18, & 22.5 tonnes carrying capacity (48% of 2 for base year)	95508	218979	329435	less than base year
4	No. HGVs with 13.5 tonnes carrying capacity (18% of 2)	35816	82117	123538	less than base year
5	No. HGVs with 18 tonnes carrying capacity (7% of 2)	13928	31935	48043	less than base year
6	No. trucks with 22.5 tonnes carrying capacity (23% of 2)	45764	104928	157854	less than base year
7	Volume of total rail demand (combined GOPFT, DOMTI & CACFT by rail)	19383	59995.15	96270.07	10187.16
8	Total no. of wagons used & required	14400	44572	71521	less than base year
9	Total locomotives	208	644	1033	less than base year

The weight of a train and the average speed of a freight wagon are important capacity issues, and, if Iran is to provide a landbridge system, these are two sensitive characteristics, by which national and international services for CAC countries will be assessed. According to the second development programme, Iran is trying to improve the weight of trains and the average speed of wagons by renewing the old rail lines and other construction projects. The total number of required trains (including light, moderate and heavy weight criteria) is based on the share of rail in the import/export trade for the four central Asian countries and the Autonomous Republic of Nakhjavan (see Table 9.17).

For Iran, where rail makes very little contribution to exports, it is assumed that all rail trade under the three scenarios consists of imports. On the basis of the rail GOPFT and CACFT scenarios shown in Table 9.17, the annual and daily number of required trains was allocated to the import and exports of CAC countries and Iranian imports as shown in Tables 9.18 and 9.19.

Table 9.17 Import/export rail freight of Iran and CAC countries in 2005 under three ISLB scenarios.

Countries		Import		Export		Total
		% (of 1993 value for CAC)	Tonnes	% (of 1993 value for CAC)	Tonnes	Tonnes (000)
Iran GOPFT rail for ports	Most probable	-	6550.60	-	-	6550.60
	Optimistic	-	8530.25	-	-	8530.25
	Pessimistic	-	2448.17	-	-	2448.17
Azerbaijan (10% for Nakhjavan)	Most probable	41	6066.36	59	8729.64	14796.00
	Optimistic	41	35394.70	59	50933.80	86328.5.00
	Optimistic	41	354.08	59	509.50	863.58
Gyrkyzstan	Most probable	22	13663.50	78	48443.50	62.11
	Optimistic	22	79720.70	78	282646.30	362.37
	Optimistic	22	797.43	78	2827.50	3.63
Kazakhstan	Most probable	50	287701.50	50	287701.50	575.40
	Optimistic	50	1678611.00	50	1678611.00	3357.22
	Optimistic	50	16791.95	50	16791.95	33.58
Tadjikstan	Most probable	41	18723.50	59	26943.50	45.67
	Optimistic	41	109251.10	59	157214.90	266.47
	Optimistic	41	1092.79	59	1572.60	2.67
Uzbekistan	Most probable	57	470624.50	43	355032.50	825.66
	Optimistic	57	2745888.40	43	2071459.60	4817.35
	Optimistic	57	27468.40	43	20721.80	48.19
		Import	Export			
Total CAC countries by rail	Most probable	796779.37	726850.64			
	Optimistic	4648865.90	4240865.60			
	Optimistic	46504.65	42423.35			

Table 9.18 Annual and daily number of block train required in horizon years for imports under three demand scenarios for GOPFT and CACFT.

	Freight train weight	2005					
		Most probable		Optimistic		Pessimistic	
		CACFT	GOPFT	CACFT	GOPFT	CACFT	GOPFT
1	Light freight train of 4500 tonnes	177	1456	1033	1896	10	544
	Daily number	0.5	4	2.8	5	0.03	1.5
2	Moderate freight train of 8000 tonnes	100	819	581	1066	6	306
	Daily number	0.3	2	1.6	3	0.02	0.8
3	Heavy freight train of 16000 tonnes	50	409	291	533	3	153
	Daily number	0.14	1	0.8	1.5	0.01	0.4

The effectiveness of the block train can be seen in these tables. It requires sufficient locomotives and wagons and, most importantly, strong foundations for rail tracks to allow the movement of moderate and heavy trains compared with the currently operating light trains.

Table 9.19 Annual and daily number of block trains required in 2005 for exports under three demand scenarios for CACFT.

	Freight train weight	2005		
		Most probable	Optimistic	Pessimistic
		CACFT	CACFT	CACFT
1	Light freight train of 4500 tonnes	162.00	942.00	9.00
	Daily number	0.44	2.60	0.03
2	Moderate freight train of 8000 tonnes	91.00	530.00	5.00
	Daily number	0.25	1.50	0.02
3	Heavy freight train of 16000 tonnes	45.00	265.00	3.00
	Daily number	0.12	0.72	0.01

9.4 Conclusions

This chapter described and distributed the forecasts for the scenarios for two foreign trade interfaces (six major ports, ten border crossings) and the two modes of road and rail. An estimation was then made of physical capacity for transport supply that would be required in 2005.

The pessimistic forecasts gave values that were mainly less than base year figures and therefore, it was assumed that the existing transport supply of Iran can match physical demands.

Maximum estimated throughputs were seen in the optimistic forecasts. These cannot physically be handled by the Iranian transport system under present development programmes. But there are significant changes in the present national policies under the second development programmes of 1994-1998. These changes concern extending existing facilities. Most of the most probable throughputs are achievable by improvements in working procedures and by renewing in particular the road and rail modes.

10. Conclusions and recommendations

10.1 Introduction

The concept of a landbridge refers to different types of integrated origin-destination international movements of shipments (in various combinations of sea, land and air) under a single waybill. There are different examples of landbridges with different characteristics related to transport supply facilities, organisational structure and managerial skills. Certain limitations of existing landbridge studies were discussed. They include the failure of a comprehensive academic study to account jointly for both demand and supply of landbridge services. Most articles on landbridges discuss the Trans-Siberian Railway or east-west coast landbridges of the United States of America. Comprehensive and valuable studies include Hayuth (1982) and (1987), Miller (1978), Mahony (1985), Damas (1992a) and (1992b), and Raguraman and Chan (1994). No comprehensive academic studies of landbridges in general were found.

The main features of the research can be summarised as:

* A comprehensive review of literature related to landbridges

* An investigation and analysis of Iranian transport supply and demand including both domestic and foreign trade.

* An investigation and analysis of the demand of the Central Asian and Caucasus countries (former USSR republics) for transport

* The development of a demand and supply model related to an Iranian Sea-landbridge (ISLB) for eight Central Asian and Caucasus countries and Iran.

* Evaluation of the impacts of demand on landbridge supply.

* A comprehensive review of the scenario approach and its application to the Iranian Sea landbridge study using a regression technique.

This study seeks to be an original contribution both to the specific Iranian context and to the study of landbridges in general. Although data in general was difficult to obtain (particularly for the CAC republics), the study provides a comprehensive and systematic analysis. Further complications in the analysis relate to the uncertainty of currency exchange rates, the shipping fleet and border crossing statistics.

10.2 Changes required for the Iranian transport system

In chapter four it was found that a landbridge competes with all-water transport and can offer advantages in terms of distance and transit time and costs. A landbridge operation due to its multi-modal and multi-country characteristics depends and requires highly effective co-ordination. Therefore, its performance and efficiency is dependent on the level, economy and reliability of the services provided.

The changes needed for the transport system of Iran to function effectively as a landbridge are substantial. The following provides a summary of the major issues.

If Iranian ports are to increase their landbridge traffic for the CAC republics there will need to be changes in port behaviour, marketing and performance. In chapter two it was seen that both the ports and the rail service will need to replace their undereducated or poorly trained labour with greater expertise. In the ports there is no effective controlling organisation responsible for training of dockers and also no extensive facilities for training of port workers in general.

In chapter two it was found that transport modes and interfaces in Iran (excluding road vehicles) are owned and operated by the government and thus highly centralised. The Ministry of Roads and Transport (MRT) functions as the highest authority for transport matters, but there are eight ministries involved directly in transport issues of freight, construction, management and supervision. MRT has ports and railways under its supervision but not the merchant fleet, border crossings, pipelines and oil tankers. The exclusion of the merchant fleet and border crossings from integrated control may cause practical problems in the development of a single waybill landbridge concept as investigated in chapters four and five. On the other hand, greater integration may lead to much greater bureaucracy.

One important characteristic of an effective landbridge is its close dependence on containerisation. Containerisation, however, was seen in chapter two to have a very low share of the foreign trade of Iran (2.4% in 1993 of total foreign trade of general cargo and oil products). In this respect it seems that there is no effective co-ordination between the Programming and Budgeting Organisation (PBO), ports, Customs, Ministry of Economics and Commerce, and both private and government cargo owners. Given a growing volume of foreign trade of Iran and the CAC countries, there will be a greater need for improved and faster port services. It will become increasingly necessary for the maritime fleet, ports, road and rail modes to develop their infrastructure to handle container trade and operations.

The border crossings have become much more important in the transport chain since the collapse of the former USSR. Analysis of Iranian trade with the CAC countries for the two years following 1991 showed a significant increase in the volume passing through inadequate terminals. It requires a further expansion of the infrastructure and superstructure of these crossing points to reduce long waiting times and increase the efficiency of nodal supply services.

The literature review showed that the landbridge concept is an international service where land transport plays a significant role. Therefore, joint venture transport service companies from both Iran and the CAC countries could effectively implement the landbridge single waybill along appropriate corridors.

10.3 Landbridge demand and supply

The ISLB study provided an operational method for the investigation of landbridge demand and supply at the macroeconomic level. The scenario forecasts were initially based on the relationship to a number of explanatory predictors of tonnage resulting from three types of demand in the eight CAC countries as well as Iran. The three types of demand were the general cargo and oil product foreign trade (GOPFT), the domestic trade of Iran (DOMTI) and the Central Asian and Caucasus foreign trade (CACFT). The forecast tonnage was then assigned to the transport system of Iran to assess the impact and the required strategies. A limitation of this approach was that the demand data for the CAC countries was restricted only to 1987-1993 and for Iran to 1979-1993.

Forty-six independent variables are used in the empirical analysis for three ISLB demands. Six of these variables were shown to have significance for estimating these volumes of trade as they were higher than the required level of accuracy (0.95%). Two independent variables (GDP and population) were specific for the general cargo and oil product of foreign trade of Iran, three (GDP, value added of agriculture, and productivity of the agricultural sector/employee) for the domestic trade of Iran, and total GDP per capita for the foreign trade of the Central Asian and Caucasus countries.

In chapter two it was found that demand for foreign and domestic transport in Iran is focused on the main centre of consumption in Tehran. In order to operate an effective landbridge it will be necessary to operate a north-south system, including the upgrading of the Astara, Bajgiran and Sarakhs border crossings. In other words, if freight transport is to be an integral part of foreign and domestic trade, it has to be developed to match the demand and needs of a changing pattern of a landbridge demand.

10.4 Transport structure in Iran

The single rail network is distributed unevenly throughout the country and covers only 14 of 24 provinces which has created an uneven balance between road and rail in Iran. Rail as well as road mainly carries domestic and foreign trade from only the two largest major southern ports to Tehran and central provinces such as Arak and Esfahan, while heavy road vehicles are the only means to carry foreign trade from all the other four major ports (including the two northern ports of Iran along the Caspian sea) to the above areas. This structural imbalance of traffic flows leads to empty running and, possibly, higher costs for freight. Two northern ports as well as three key border crossings of Astara, Bajgiran and Noor Dooz do not have rail connections despite their significant recent operation for CAC countries and Russia after 1991.

Road freight is operated mainly by the private sector, consisting of individuals, companies or co-operatives, and has the highest share of both foreign and domestic trade. Heavy goods vehicles in Iran are old. Therefore, to have an effective landbridge service it is necessary to adopt and implement a more productive and comprehensive renewal policy in Iran.

Manufacturing of the rolling stock and heavy goods vehicles in Iran is low and the renewal is below that required. Therefore, future landbridge services in terms of transit time and cost are affected.

In chapter two it was found that the container fleet accounts for only about 2.8% of the total IRISL fleet in number and 2.2% of the dwt. In a successful landbridge system, it is likely that a container fleet (national or otherwise) and effective container ports play a significant role in terms of transit time and cost.

The government of Iran is the main source for transport finance while the private sector, such as banks, has become more important since 1988 with the end of the war with Iraq. Some organisations such as ports are mainly self-supporting, but the railways are supported by government credits.

Iranian roads are reasonably well developed and connect all provinces and more than 470 towns but expressways with four or more lanes form a very low share of total roads (about 2.4%). Because of the internationally competitive nature of the landbridge service, there is a need for more direct routes.

An increase in transport productivity in Iran probably requires more training and education in different general transport sectors. Currently in Iran such study is given by one university and several high schools for maritime and navigation, while some universities deal only with road construction and other engineering aspects, but not with commercial transport planning and operational areas.

10.5 Main findings of the scenario analysis

Three types of forecast developed under three scenarios up to the year 2005 in chapter eight were distributed and assigned to Iranian interfaces and land modes using 1993 as a base year. The evaluation was carried out and where available, impacts were compared with Iran's present and future policies for its freight transport system.

In chapter two it was found that the transport system of Iran has been faced since the early 1970s with serious congestion in ports which ended in 1993. To some extent this inefficiency was due to the inadequate port infrastructure and later to the war with Iraq, which resulted in the closure of the largest commercial port in the country (Khoramshahr) and a reduction in the operation of port Imam. However, the road fleet, in terms of both number and frequency of journeys, may be considered as the most important influence on this insufficiency.

The volume of total combined trade for Iran and the CAC countries, estimated to pass through the six major Iranian ports under the most probable and optimistic scenarios, is respectively 2.1 and 2.9 times that of the base year 1993 (about 30.6 million tonnes). The implication of such increases in the volume of port traffic is considerable.

The results suggest that maritime traffic will rise from 1921 ships in 1993 by 148% (most probable scenario) and 183% (optimistic scenario) but drop by 26% under the pessimistic scenario.

The estimated increase in maritime traffic will cause serious shortfalls in infrastructure such as berths and maritime support services (e.g. tugs, pilots, and other key personnel) and also in land cargo handling equipment and technology, and warehousing facilities.

The impacts of the most probable and optimistic scenarios in terms of port capacities shows that there is a significant need for improvements in performance by an expansion of ports and productivity projects. These are required to achieve the estimated cargo trade for the above scenarios (about 43.2 million tonnes and 62.8 million tonnes respectively, excluding oil products). For ports, the critical capacity requirement appears to be in Imam and Abass, as the largest ports in the country, and in port Anzali in the north. Other ports should be able to absorb the increased capacity.

Increases in port capacity can be implemented by the expansion of port infrastructure, cargo handling technology and also through an increase in human and facilities productivity. The extent of maritime traffic under the most probable and optimistic scenarios (applying ships' service days of the base year 1993 (7.1 service days)) reveals the insufficiency of the length of berths. This suggests a requirement for port infrastructure expansion (17.6 km and 20.1 km for the most probable and optimistic scenarios respectively, compared with 14.6 km in the base year).

In chapter eight it was found that about 40% of the total port trade (excluding oil products) is carried out as an indirect delivery system using closed warehouses and open storage areas within the ports' Customs areas. Under the most probable and optimistic scenarios there will be a considerable need for expansion of storage to about 35 and 77 new warehouses, and to 7.6 million sq. m and 11.5 million sq. m of open storage respectively for these two scenarios in 2005.

It was seen that heavy goods vehicles have a dominant role in foreign trade, but the average journey per vehicle is low (about 9 per annum) due to the age of the fleet and consequent high cost of repairs. It was found that the road fleet needed to be expanded by 129% (most probable scenario) and 245% (optimistic scenario) in 2005 compared with 1993. This could have a serious long term policy implication due to the lack of currency for imports and low domestic production.

Under both the most probable and optimistic scenarios the rail mode of Iran will be highly utilised and effective. In chapter two it was found that the rate of renewal of rolling stock is low due to war effects, import restrictions and low domestic output, while rail tracks still need extensive repair. The present freight train weight (4500 tonnes) for the three ISLB scenarios was compared with two other heavy train types (8000 tonnes and 16000 tonnes). It was seen that it is an effective way of optimum utilisation of the present facilities when combined with the block train concept, especially for the CAC countries, given that the rail lines in 2005 provide such infrastructure.

10.6 Recommendations

This research has approached the landbridge concept and its application to Iran in both demand and supply areas, at national policy levels and for eight customer countries. But much further research in each of these areas needs to be carried out to identify further insights and implications. On the basis of the findings presented earlier, a number of steps are recommended and summarised for improving the existing situation:

10.6.1 Recommendations to the Iranian government

The ISLB like other landbridge services in the world requires the implementation of the single waybill. Therefore, among the eight ministries involved in Iranian transport matters, three (MRT, Ministry of Commerce, and Ministry of Finance and Economic) should be in charge of the ISLB service operated by or through the PSO, IRIRC, IRISL, and Customs. These all need a national co-ordination centre to facilitate services internally with each other and the private sector, and also with CAC shippers to cover and secure the level, economy and reliability of the landbridge services provided.

ISLB operations for the CAC countries, as with international services, require joint venture transport and stevedoring companies. This should greatly facilitate new investment, flows of shipments along internal and external ISLB routes and maintain transit times and costs at economic levels.

Funding transport infrastructure and superstructure in Iran is mainly a government issue, in particular during the war with Iraq. The new CAC countries along and close to northern Iranian borders and the existence of the ECO, has brought about a need for more economic, political, and social integration. This makes foreign investment inevitable, in particular in the field of transport. Specific areas for foreign investment are prioritised rail networks, expansion of the rolling stock and road freight vehicle manufacturing, if ISLB services are to be economic.

The transport sector in Iran is mainly a government owned and operated sector, although there have been changes since 1988. To prevent the harmful consequences of rush into privatisation, there should be a systematic approach to management and ownership in transport, and in particular for the ISLB as an international service. Even under private ownership there should be a degree of integration of freight services, modes and interfaces. Any private entity in the transport service must be strongly established, able to operate for a long term and backed by parliament.

10.6.1.1 Recommendations to Programming and Budgeting Organisation

The Programming and Budgeting Organisation (PBO) is a national centre for policy making and implementation affiliated to the Ministry of Finance and Economics, and, also, has the Statistical Centre of Iran under its supervision. The collection and preparation of data for the ISLB study took a considerable time. Information given in different PBO annual and occasional reports, although valuable, were not comprehensive and consistent in the transport sector. One reason for the poor level of academic research into the operational transport system of Iran might be the lack and unavailability of these data for the public. In Iran, as a centralised and planned economy, all private and public sectors should report their statistics annually to the PBO. This would enable the PBO to enforce a comprehensive national policy towards the collection of different levels of data in both demand for and supply of transport at a more modal and provincial level.

The PBO and the Central Bank of Iran (Bank Markazi) should be responsible for the provision and implementation of policies to improve and increase the present low level containerised trade in Iranian and CAC foreign trade, in particular for Iran as it is mainly government based trade.

10.6.1.2 Recommendations to Ministry of Road and Transport

The ISLB road links must play an essential role in the success of the proposed services, in particular for the three CAC countries connected to Iran (Azerbaijan, Armenia, and Turkmenistan). New transit trunk routes to the east and west borders must be provided and equipped by the Ministry of Road and Transport (MRT). The south-west north-west provincial route should be given priority as a transit route and expanded by express-ways in the longer term, as it also can play a significant role in any future landbridge between the Persian Gulf and the Black Sea port of Batumi, and as an alternative to the Suez Canal in trade between Europe and Asia and Australia.

10.6.1.3 Recommendations to Ports and Shipping Organisation

The Ports and Shipping Organisation (PSO), which functions as the port state body and operator of the major ports, plays a central role in the potential ISLB services. The present and traditional structure and working practices should be changed and improved in such a way as to allow the port functions to perform in accordance with international port marketing requirements.

The training programmes of the PSO should include new courses in landbridge operations to relevant port workers and agents within port areas to assure the improvement of the key role of the private sector in the ISLB port cargo operations and other services.

The PSO should take into account that containerised trade will improve foreign trade. It is necessary to expand the present container-related infrastructure and in particular, container clearance and handling in the yards at ports.

The present port capacities can be greatly increased if the PSO uses quay cranes for berths. This change in the port operational technology is recommended before any infrastructure expansion.

10.6.1.4 Recommendations to Islamic Republic of Iran Railway Company

The rail network in Iran should be expanded (by passing Tehran) along south-west/ north-west and south-east/ north east routes which will facilitate more direct and economic services for GOPFT, DOMTI, and in particular CACFT through higher speed and frequency of freight trains and railcars.

The present rail projects of the two key ports (Anazali and Nooshahr) and one border crossing (Astara) must be given higher priorities for trade from CAC republics and, probably trade from Russia and other CIS landbridge trade in the future.

The renewal of the present old rolling stock to support economic and competitive ISLB services is vital. Application of the moderate and heavy train concept should increase the output of the ISLB rail services but it needs appropriate rail track and much more heavy duty locomotives.

10.6.1.5 Recommendations to Islamic Republic of the Iranian Shipping Line

IRISL is one of the major merchant fleets in the middle east and the main carrier of the national foreign trade. IRISL, in joint venture with the CAC countries and with the ECO shipping company, should be considered as a main carrier along the ISLB sea legs, its inland transport and in the implementation of the ISLB single waybill. The present number and capacity of the container fleet of the IRISL is very low to cover the markets of the CAC trade partners in the world and to keep ISLB services viable. Therefore, they need to be expanded.

10.6.1.6 Recommendations to the Iranian Customs administration

The approach of the Iranian Customs need, to be revised, in particular in containerised trade. The importance of landbridge services for CAC and other countries needs to be recognised.

Border crossings in Iran need to be treated like seaports and their superstructure developed to handle container trade effectively and efficiently, and to prevent occasional bottlenecks.

The Iranian Customs administration within the ISLB system must be considered as a vital transport organisation similar to the PSO for ports, and not simply as a revenue maker. Border crossings should be upgraded and expanded for through transport services and the implementation of the single waybill concept of the ISLB.

10.6.2 Recommendations to Iranian transport operators

After the collapse of the former Soviet Union, Iranian road freight operators have expanded into new areas, including the CAC countries. The importance of the Iranian road freight private sector as a major carrying mode of the ISLB service (in particular for the three land-locked countries) must be recognised by the centralised system of Iran which mainly owns and operates the transport infrastructure and services. Road freight operators need more government support and stability of working conditions to contribute reliably and competitively in the new ISLB working environment. This means that there is a need for different Iranian ministries to facilitate road freight movements in terms of transit traffic with all the CAC countries (e.g. insurance, passport issues, travel expenditures, etc.).

10.6.3 Recommendations to Economic Co-operation Organisation

ECO as a regional organisation has been given a new international role. The significance and centrality of the transport role of Iran has already been recognised by ECO. ECO should now move toward the development of common transport and trade policies for all member states which consequently will greatly benefit ISLB services.

10.6.4 Recommendations for further research

10.6.4.1 Recommendations for research into the Iranian Sea-landbridge

The ISLB study focuses on a landbridge study at an international and macroenvironmental level. This is appropriate for the objectives of the study, but may be too broad to observe properly other problems at a disaggregate level. Such problems include extensive landbridge services provided by different ports, border crossings, or modes whose functions require a high degree of co-ordination.

In some landbridges both rail and road modes are effectively involved in the operations. There is a need for further and detailed studies at the level of individual road, rail link, and port and border crossing. The treatment of landbridge transit time, cost, and frequency of service at modal and origin-destination levels requires further elaboration, refinement and development of the model for each CAC country.

Iran as a new landbridge country needs the formation of a national landbridge policy based on international transport service characteristics. (e.g. a single waybill).

Due to the lack of data, forecasts of the CACFT tonnage was based on converted figures using values and volumes of Iran's foreign trade with each of the CAC countries in 1992 and 1993 as the basis of conversion. Future research should consider different CAC shippers' options with real and longer period data, and more explanatory variables. In particular, recent trade experiences through Iran may lead to more accurate forecasts of demand for ISLB services.

The Iranian foreign trade forecasts in the ISLB study include a considerable volume of oil products through ports, instead of through pipelines, mainly due to the war and reconstruction period. Future studies may consider much lower movements of oil products through ports, which should affect greatly the volume of demand for the Iranian transport supply.

10.6.4.2 Recommendations for research into landbridges in general

Although modern landbridges have been in operation since the 1970s, they are poorly covered in the literature. There is a need for a more systematic approach to the collection and publication of operational data related to landbridges, and for a more comprehensive definition and conceptual approach to landbridges. At present, published data is generally orientated toward single modes.

Information and education on the landbridge concept and practices should focus on critical physical supply and service issues, integrated transport systems, and modal movements, all of which can be perceived as landbridge practice and not as traditional modal carrying of goods.

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Appendices

Appendices of chapter two

Appendix 1: Ports Directorates of Iran in the Persian Gulf and the Caspian Sea

1. In the Persian Gulf, the Ports' Authority Directorate of Khosistan Province includes mainly the Ports of Khoramshahr, Abadan, and Imam which is the head port for the province.

2. The Ports' Authority Directorate of Bushehr Province, which basically covers the port of Bushehr and Kharg Island port authority.

3. The Ports' Authority of Hormozgan Province, includes mainly the port of Abass, the port of Shaheed Rajayee, and some minor ports.

Indian Ocean ports

4. The Ports' Authorities Directorate of Sistan and Baluchestan province includes mainly the port of Chah Bahar in Oman Sea.

Caspian Sea ports

5. In the Caspian Sea there are the Ports' Authorities Directorate of Gilan Province with the main port of Anzali and ,

6. The ports' Authority Directorate of Mazandaran with the principal port of Nooshahr on the southern coast of the Caspian Sea. The locations of all seaports are shown in Figure 2.3.

7. Inland water ports of the lake Urumiyeh

Traditionally and economically, each of the said commercial ports mainly serves certain provinces as hinterland. Before the war with Iraq, the ports of Khoramshahr and Imam used to be the largest ports of Iran, but after these ports closed, there was a great effort to complete the port complex of Shaheed Rajayee; the ports of Imam and Abass are the largest in the country.

For the oil ports and terminals PSO ports act as a legal national port authority, giving services such as pilotage and tugs, buoyage services and the collection of dues and charges. In commercial ports where PSO branches are not active and where there is no compulsory pilotage, Iran's Customs carry out the entire operation and act on behalf of PSO wherever necessary and when provided.

Appendices of chapter seven

Appendix 2 The dependent (Y) and independent variable values of the ISLB study for GOPFT, DOMTI, and CACFT

	GDP per capita X_1		GOPFT & DOMTI				X_6		GOPFT & DOMTI	X_8		X_9	
	Iran	CAC	X_2	X_3	X_4	X_5	GOPFT	DOMTI	X_7	GOPFT	DOMTI	GOPFT	DOMTI
1979	145800	N/A	70.475	19186	568800	1815800	1574500	15908	9402	150	890000	12265	1851200
1980	142100	N/A	70.615	13286	688600	1848400	1900900	13713	9611	164	1106000	12150	1914900
1981	167000	N/A	78.328	12053	809300	1724200	2068700	14240	10001	225	1279000	12422	1952700
1982	212800	N/A	83.603	19233	767100	1841500	2935100	14867	10302	237	1641000	12422	2091400
1983	257700	N/A	86.358	19225	890000	2551100	3724600	15228	10570	320	1931000	12247	2193000
1984	270700	N/A	89.107	12255	992900	2562200	3119300	15628	10847	318	1675000	11750	2353700
1985	277500	31800	91.052	15590	962400	2153300	2643800	16009	10925	320	1625830	11750	2537600
1986	269400	31700	78.760	6261	825200	1645900	2140400	16389	11036	313	1699098	12205	2650500
1987	320800	32700	71.460	10098	836100	1360600	2540000	16872	11305	304	1731807	13074	2715800
1988	150800	35400	68.683	9210	866400	1143600	2505500	16872	11450	206	1427998	13074	2648000
1989	150900	36800	72.015	10809	945400	1216800	2792200	14830	11781	236	1674217	12439	2746000
1990	166700	36100	68.096	17300	1163900	1378800	3495300	17744	12189	241	1459292	12224	2967500
1991	184300	33400	67.505	16700	1397600	1942900	4090200	15050	12641	213	2114444	12629	3120200
1992	188500	23100	65.552	15600	1404100	2077300	4255600	18170	13450	216	2608558	13000	3351600
1993	215800	21200	1261.99	14889.7	1382100	2133400	4462200	19169	14934	208	1680749	14400	3535700

Appendix 2 continued.

	X_{10}		X_{11}		X_{12}		GOPFT & DOMTI		X_{15}	
	GOPFT	DOMTI	GOPFT	DOMTI	GOPFT	DOMTI	X_{13}	X_{14}	GOPFT	DOMTI
1979	125198	114000	7.74	8500	1404.08	294400	760300	10551300	1722.59	237100
1980	130325	120900	11.58	4900	806.42	363800	815300	9555500	1538.00	266400
1981	134797	128400	15.25	14000	777.99	474400	650300	9320700	1619.19	317500
1982	140750	108900	9.31	7000	1924.33	424100	669000	10539800	1830.05	327400
1983	146988	150500	11.31	13600	1271.46	482200	782800	11934700	2632.87	410900
1984	165605	106600	10.17	6000	1466.17	524800	806800	12043800	1889.33	491400
1985	170431	110700	7.70	7700	1807.85	502700	804500	12072300	1848.14	462700
1986	173902	94000	9.93	4600	1820.05	466400	705400	10248900	1941.98	358200
1987	124843	86900	9.99	500	1524.43	511700	569400	10368100	2491.30	425400
1988	125793	83400	8.72	16100	1754.12	475100	543900	9468000	2120.95	421000
1989	126615	78400	11.11	19400	1565.23	522200	592900	9781500	2476.66	450200
1990	127445	108900	8.70	23100	1744.83	643900	725600	10930200	2737.60	553200
1991	134688	12400	7.20	35600	2101.27	705700	850800	12181200	3219.77	722500
1992	143786	108500	7.15	34800	2003.27	694400	956200	12477800	4092.27	753100
1993	147385	104400	7.10	37100	2240.25	704700	1015200	13101000	4629.79	716400

Appendix 2 continued.

	X_{16}			X_{18}		GOPFT &DOMTI		DOMTI					Y		
	GOPFT	DOMTI	X_{17}	GOPFT	DOMTI	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	GOPFT	DOMTI	CACFT
1979	23.01	117100	2177300	2358900	39100	204900	37991000	2535200	224600	11.36	34.81	272.25	16247	159713.50	N/A
1980	45.19	149300	1968400	2796600	10300	219200	39646000	866100	664200	11.08	34.22	268.05	13027	156657.59	N/A
1981	49.23	170400	1947900	3401600	20700	222900	41221000	882600	792100	9.39	32.44	243.83	14166	143905.97	N/A
1982	42.20	128800	1910100	4190600	41200	240800	42800000	1947700	1845800	12.58	42.79	285.23	17289	187046.21	N/A
1983	50.94	126800	1930100	5345800	63000	338000	44438000	2006300	1871700	15.59	48.57	315.97	23756	214483.34	N/A
1984	49.16	117000	1810800	5899900	74300	396400	46201000	1625600	1468100	12.14	49.38	330.03	19250	207417.78	N/A
1985	70.69	129100	1898100	5978100	21900	326700	47807000	164400	1500200	13.30	52.74	341.66	18723	221041.09	N/A
1986	110.15	117500	1507600	6331000	4700	170600	49363000	1403000	1303400	14.75	48.27	300.82	17660	209298.56	N/A
1987	132.95	86700	1402800	8219700	2700	150800	50995000	1598700	1495500	14.97	41.82	299.15	18747	192223.03	3628583.6
1988	86.70	127700	1396100	10070000	2200	149500	52672000	1617900	1617900	13.53	41.00	288.46	16489	187630.97	3778654.9
1989	96.07	148200	1189400	12153700	3400	175200	54504000	1722800	1722800	12.33	36.77	339.65	22850	185742.17	3507617.9
1990	114.42	182400	1336600	16351100	8600	175500	56401000	2064100	2064100	15.51	40.85	333.17	24956	217939.21	2726218.4
1991	68.00	206300	1450000	25148500	19000	271200	57799000	2516700	2275600	14.96	47.24	365.00	28700	252590.10	1894990.9
1992	62.74	195100	1551900	33764100	4900	288500	59229000	2553500	2313700	16.49	47.30	348.00	27773	262396.35	1645795.9
1993	74.69	206300	1820300	45509500	74400	303900	60708000	2645300	2394500	15.85	38.33	481.88	30555	277223.84	1349905.3

Sources: 1. Different national accounts of the Central bank of the I.R. Iran for 1974-1987, 1988-1990,1991, 1992, and 1993 2. CAC data is based on E.I.U, Country Report, 4th quarter, 1994, pp. 81-82.

Appendix 2 continued.

	Y		
	GOPFT	DOMTI	CACFT
1979	16247	159713.50	N/A
1980	13027	156657.59	N/A
1981	14166	143905.97	N/A
1982	17289	187046.21	N/A
1983	23756	214483.34	N/A
1984	19250	207417.78	N/A
1985	18723	221041.09	N/A
1986	17660	209298.56	N/A
1987	18747	192223.03	3628583.60
1988	16489	187630.97	3778654.90
1989	22850	185742.17	3507617.90
1990	24956	217939.21	2726218.40
1991	28700	252590.103	1894990.90
1992	27773	262396.35	1645795.90
1993	30555	277223.84	1349905.30

Appendix 3 The average main ship indicators of Iranian seaports during 1979-1993.

Year	No. ships	Staying days (3 + 4)	Service days (5 + 6)	Waiting days	Idle days	Operation days (3 - 5)	Non-oil	Total Sea trade (000)	Average shipment with oil products (ton) (8/1)	Berth (ship) Productivity with oil products (tonnes)(9 /3)
	1	2	3	4	5	6	7	8	9	10
1979	1495	-	7.74	-	-	-	9623	11626	7776.59	710.19
1980	1395	14.69	11.58	3.11	0.43	11.15	10460	10450	7491.05	646.89
1981	1194	27.17	15.25	11.93	1.36	13.89	10152	11357	9511.74	623.72
1982	1326	16.08	9.31	6.76	0.79	8.52	14966	12276	9257.92	994.41
1983	1652	21.83	11.31	10.53	1.03	10.28	11515	17090	10345.04	914.00
1984	1291	20.71	10.17	10.53	1.03	9.14	11138	12855	9957.40	978.10
1985	1345	12.31	7.70	4.61	0.5	7.20	9968	13107	9744.98	1265.58
1986	1032	16.19	9.93	6.26	0.50	9.43	12241	13155	12747.09	1283.70
1987	1231	15.67	9.99	5.68	0.45	9.54	9303	16602	13486.60	1350.01
1988	1078	11.21	8.72	2.49	0.33	8.39	14485	13695	12704.08	1456.90
1989	1314	15.55	11.11	4.43	0.44	6.68	16168	16341	12436.07	1119.36
1990	1644	12.37	8.70	3.70	N/A	N/A	18495	18717	11385.04	1308.63
1991	1897	9.76	7.20	2.55	N/A	N/A	19816	21756	11468.64	1592.87
1992	1939	9.60	7.15	2.45	0.48	6.67	20226	25147	12969.06	1350.94
1993	1921	N/A	7.10	N/A	N/A	N/A	21022	27575	14354.50	2021.76

Sources: SCI annual reports 1981 and 1992, p. 589 and p. 392, PSO, Port performances during 1941-1990. p. 91. and Operational report 1992, p.108. * : staying days 7.10 is assumption.

Appendices of chapter eight

Appendix 4: Matrix of the correlation between GOPFT variables of Iran during 1979-1993.

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X15	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
Y	1.00																				
X_1	0.06	1.00																			
X_2	0.50	0.05	1.00																		
X_3	0.31	-0.18	0.06	1.00																	
X_4	0.91	0.03	0.44	0.14	1.00																
X_5	0.24	0.37	0.21	0.46	0.22	1.00															
X_6	0.93	0.13	0.47	0.35	0.91	0.38	1.00														
X_7	0.88	0.04	0.66	-0.03	0.91	0.02	0.83	1.00													
X_8	0.04	0.87	-0.16	-0.24	0.02	0.30	0.12	-0.03	1.00												
X_9	0.51	-0.08	0.77	-0.08	0.48	-0.18	0.48	0.74	-0.33	1.00											
X_{10}	0.05	0.62	0.12	-0.16	0.13	0.60	0.12	0.06	0.66	-0.29	1.00										
X_{11}	-0.56	-0.06	-0.30	-0.32	-0.51	-0.10	-0.47	-0.56	0.14	-0.32	-0.11	1.00									
X_{12}	0.73	0.22	0.61	-0.14	0.75	-0.10	0.68	0.90	0.10	0.70	0.13	-0.67	1.00								
X_{13}	0.59	0.02	0.55	0.43	0.62	0.71	0.61	0.52	-0.15	0.26	0.37	-0.48	0.32	1.00							
X_{14}	0.77	0.38	0.49	0.45	0.73	0.71	0.80	0.63	0.25	0.26	0.46	-0.63	0.55	0.82	1.00						
X_{15}	0.92	0.02	0.65	0.18	0.87	0.16	0.87	0.94	-0.11	0.76	-0.03	-0.54	0.78	0.63	0.70	1.00					
X_{16}	0.22	0.34	0.02	-0.57	0.23	-0.59	0.11	0.39	0.39	0.24	-0.05	-0.09	0.53	-0.37	-0.13	0.22	1.00				
X_{17}	-0.39	0.01	0.14	0.49	-0.42	0.62	-0.28	-0.48	-0.16	-0.21	0.22	0.15	-0.52	0.35	0.12	-0.31	-0.82	1.00			
X_{18}	0.87	-0.09	0.71	0.12	0.89	0.11	0.82	0.96	-0.23	0.77	-0.01	-0.57	0.80	0.66	0.66	0.97	0.18	-0.30	1.00		
X_{19}	0.33	0.34	0.24	0.42	0.36	0.95	0.49	0.15	0.34	-0.15	0.59	-0.15	0.03	0.68	0.77	0.23	-0.53	0.47	0.20	1.00	
X_{20}	0.83	0.03	0.41	-0.15	0.88	-0.18	0.76	0.94	0.05	0.59	-0.01	-0.54	0.89	0.30	0.49	0.84	0.58	-0.73	0.85	-0.02	1.00

Appendix 5 Summary output and ANOVA of the run 12 of the preliminary GOPFT model

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.96	0.93	0.91	1669.16	15			
	df	SS	MS	F	Significance F			
Regression	3	382401435.10	127467145.00	45.75	1.67349E-06			
Residual	11	30647175.26	2786106.84					
Total	14	413048610.40						
	Coefficients	Standard Error	t -Stat	P-value	Lower 95%	Upper 95%	Lower 95. 000%	Upper 95. 000%
Intercept	-7365.87	5770.98	-1.28	0.228	-20067.72	5335.99	-20067.72	5335.99
X_5	-0.0048	-0.0048	-2.93	0.014	-0.008	-0.008	-0.008	-0.008
X_6	0.0041	0.0041	4.30	0.001	0.002	0.002	0.002	0.002
X_{14}	0.0023	0.0023	2.52	0.028	0.0003	0.0003	0.0003	0.0003

Appendix 6 General feature of the estimation procedure searching for best fit of the GOPFT of Iran.

Runs	Model r^2	Intercept	Independent variables	Description of the run and variables
1	1	-117093.49	$X_1\ X_2\ X_3\ X_4\ X_5\ X_6\ X_7\ X_8\ X_9\ X_{10}\ X_{11}\ X_{12}\ X_{13}\ X_{14}$	Searching for best predictive variables
2	0.99	-113443.19	$X_1\ X_2\ X_3\ X_4\ X_5\ X_6\ X_8\ X_9\ X_{10}\ X_{11}\ X_{12}\ X_{13}\ X_{14}$	''
3	0.99	-115135.29	$X_2\ X_3\ X_4\ X_5\ X_6\ X_8\ X_9\ X_{10}\ X_{11}\ X_{12}\ X_{13}\ X_{14}$	''''''''''''''''''''''''''''
4	0.99	-111438.60	$X_2\ X_3\ X_4\ X_5\ X_6\ X_8\ X_9\ X_{10}\ X_{11}\ X_{12}\ X_{14}$	''''''''''''''''''''''''''''
5	0.97	-51981.52	$X_2\ X_3\ X_4\ X_5\ X_6\ X_8\ X_9\ X_{10}\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
6	0.96	-13659.02	$X_3\ X_4\ X_5\ X_6\ X_8\ X_9\ X_{10}\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
7	0.96	-9658.17	$X_3\ X_4\ X_5\ X_6\ X_8\ X_9\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
8	0.95	-21130.09	$X_4\ X_5\ X_6\ X_8\ X_9\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
9	0.94	-18726.59	$X_5\ X_6\ X_8\ X_9\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
10	0.94	-25251.57	$X_5\ X_6\ X_8\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
11	0.93	-18032.47	$X_5\ X_6\ X_{11}\ X_{14}$	''''''''''''''''''''''''''''
12	0.92	-7365.87	$X_5\ X_6\ X_{14}$	First estimated model
13	0.80	-24277.46	$X_5\ X_{14}$	Second estimated model and exclusion of X_6
14	0.89	-8074.45	$X_5\ X_{15}\ X_{14}$	Searching
15	0.80	-24168.39	$X_5\ X_{16}\ X_{14}$	''''''''''''''''''''''''''''
16	0.84	-12321.19	$X_5\ X_{17}\ X_{14}$	''''''''''''''''''''''''''''
17	0.85	-9691.20	$X_5\ X_{18}\ X_{14}$	''''''''''''''''''''''''''''
18	0.80	-24749.13	$X_5\ X_{19}\ X_{14}$	''''''''''''''''''''''''''''
19	0.87	-24493.36	$X_5\ X_{20}\ X_{14}$	''''''''''''''''''''''''''''
20	0.85	-22008.88	$X_5\ X_7\ X_{14}$	''''''''''''''''''''''''''''
21	0.60	-16815.49	X_{14}	Assessment
22	0.05	15257.62	X_5	Assessment of the independent variable
23	0.87	-224552.80	$X_{20}\ X_{14}$	Final model
24	0.87	-24610.92	$X_{20}\ X_7\ X_{14}$	Searching for more independent variables
25	0.90	-9684.54	$X_{20}\ X_{15}\ X_{14}$	''''''''''''''''''''''''''''
26	0.88	-23288.91	$X_{20}\ X_{16}\ X_{14}$	''''''''''''''''''''''''''''''''
27	0.87	-25052.35	$X_{20}\ X_{17}\ X_{14}$	''''''''''''''''''''''''''''
28	0.88	-17164.76	$X_{20}\ X_{18}\ X_{14}$	''''''''''''''''''''''''''
29	0.87	-26156.59	$X_{20}\ X_{19}\ X_{14}$	''''''''''''''''''''''''''
30	0.70	-9809.60	X_{20}	Assessment
31	0.88	-18543.90	$X_{14}\ X_{20}\ X_4$	Searching
32	0.88	-27942.80	$X_{14}\ X_{20}\ X_{12}$	''''''''''''''''''''''''''

Appendix 7 Summary output and ANOVA of the run 23 of the final GOPFT model

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.93	0.87	0.85	2088.90	15			
	df	SS	MS	F	Significance F			
Regression	2	360686642.60	180343321.30	41.33	4.15039E-06			
Residual	12	52361967.76	4363497.31					
Total	14	413048610.40						
	Coefficients	Standard Error	t -Stat	P-value	Lower 95%	Upper 95%	Lower 95. 000%	Upper 95. 000%
Intercept	-24552.79	5231.08	-4.69	0.0005	-35950.34	-13155.26	-35950.34	-13155.26
X14	0.0021	0.0005	4.09	0.0015	0.001	0.003	0.001	0.003
X20	0.0004	8.70151E-05	5.09	0.0003	0.0003	0.0006	0.0003	0.0006

Appendix 8 Matrix of the correlation between DOMTI variables of Iran during 1979-1993

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}
Y	1.00																									
X_1	0.29	1.00																								
X_2	0.52	0.05	1.00																							
X_3	0.18	-0.18	0.06	1.00																						
X_4	0.90	0.03	0.44	0.14	1.00																					
X_5	0.36	0.37	0.21	0.46	0.22	1.00																				
X_6	0.69	0.19	0.56	-0.03	0.58	-0.05	1.00																			
X_7	0.88	0.04	0.66	-0.03	0.91	0.02	0.77	1.00																		
X_8	0.76	0.35	0.03	0.04	0.74	0.29	0.35	0.62	1.00																	
X_9	0.88	0.11	0.50	-0.12	0.90	-0.08	0.77	0.97	0.67	1.00																
X_{10}	-0.32	0.09	0.04	0.22	-0.43	0.34	-0.04	-0.38	-0.29	-0.48	1.00															
X_{11}	0.72	-0.38	0.48	0.27	0.88	0.08	0.49	0.83	0.53	0.77	-0.38	1.00														
X_{12}	0.86	0.10	0.41	0.05	0.98	0.11	0.59	0.91	0.73	0.91	-0.43	0.82	1.00													
X_{13}	0.68	0.02	0.55	0.43	0.62	0.71	0.37	0.51	0.37	0.42	0.07	0.57	0.49	1.00												
X_{14}	0.87	0.38	0.48	0.45	0.73	0.71	0.52	0.63	0.61	0.58	-0.08	0.55	0.65	0.82	1.00											
X_{15}	0.92	0.08	0.43	0.12	0.99	0.21	0.63	0.92	0.76	0.92	-0.45	0.85	0.97	0.60	0.75	1.00										
X_{16}	0.55	-0.48	0.43	0.28	0.78	0.10	0.28	0.67	0.35	0.59	-0.27	0.91	0.73	0.61	0.41	0.71	1.00									
X_{17}	-0.29	0.01	0.14	0.49	-0.42	0.62	-0.30	-0.48	-0.42	-0.62	0.60	-0.30	-0.52	0.35	0.12	-0.44	-0.14	1.00								
X_{18}	0.24	0.26	0.53	0.44	0.09	0.77	0.07	0.08	-0.03	-0.10	0.34	0.07	0.03	0.49	0.57	0.09	0.03	0.59	1.00							
X_{19}	0.44	0.34	0.24	0.42	0.36	0.95	0.00	0.15	0.36	0.05	0.23	0.19	0.26	0.68	0.76	0.36	0.18	0.47	0.75	1.00						
X_{20}	0.82	0.03	0.41	-0.15	0.88	-0.18	0.71	0.94	0.66	0.98	-0.53	0.77	0.91	0.30	0.49	0.90	0.58	-0.73	-0.17	-0.02	1.00					
X_{21}	0.49	-0.22	0.34	0.40	0.47	0.07	0.47	0.53	0.35	0.46	-0.27	0.62	0.42	0.36	0.43	0.50	0.40	-0.16	0.28	0.03	0.45	1.00				
X_{22}	0.85	0.19	0.36	0.15	0.85	0.12	0.54	0.83	0.79	0.83	-0.35	0.69	0.87	0.34	0.63	0.85	0.52	-0.53	0.11	0.27	0.85	0.45	1.00			
X_{23}	0.85	0.36	0.30	0.11	0.68	0.11	0.73	0.73	0.71	0.79	-0.21	0.51	0.69	0.38	0.63	0.72	0.28	-0.46	0.00	0.11	0.75	0.51	0.79	1.00		
X_{24}	0.58	0.67	-0.17	0.05	0.36	0.49	0.20	0.20	0.65	0.30	-0.14	0.01	0.33	0.25	0.60	0.39	-0.14	-0.13	0.15	0.54	0.27	-0.06	0.48	0.55	1.00	
X_{25}	0.87	0.17	0.79	0.14	0.80	0.28	0.65	0.89	0.46	0.82	-0.27	0.70	0.76	0.65	0.78	0.81	0.56	-0.21	0.40	0.41	0.76	0.45	0.73	0.63	0.27	1.00

Appendix 9 General feature of the estimation procedure searching for best fit of the DOMTI of Iran.

Runs	Model r^2	Intercept	Independent variables	Description of the run and variables
1	1.00	758205.20	$X_1\ X_2\ X_3\ X_4\ X_5\ X_6\ X_7\ X_8\ X_9\ X_{10}\ X_{11}\ X_{12}\ X_{13}\ X_{14}$	Searching for best predictive variables
2	0.99	202955.30	$X_1\ X_3\ X_4\ X_5\ X_6\ X_7\ X_8\ X_9\ X_{10}\ X_{11}\ X_{12}\ X_{13}\ X_{14}$	""""""""""
3	0.99	218127.20	$X_1\ X_3\ X_4 X_5 X_6\ X_7 X_8\ X_9\ X_{11}\ X_{12}\ X_{13} X_{14}$	""""""""""
4	0.99	212872.90	$X_1\ X_3\ X_4\ X_5\ X_7 X_8\ X_9\ X_{11} X_{12}\ X_{13} X_{14}$	""""""""""
5	0.99	147386.20	$X_1\ X_3\ X_4 X_5\ X_7 X_8\ X_9\ X_{12}\ X_{13} X_{14}$	""""""""""
6	0.99	88121.10	$X_1\ X_3\ X_4 X_5\ X_8\ X_9\ X_{12}\ X_{13} X_{14}$	""""""""""
7	0.98	-1982.40	$X_1\ X_3\ X_4\ X_5\ X_9\ X_{12} X_{13} X_{14}$	""""""""""
8	0.98	-5536.20	$X_1\ X_3\ X_4\ X_5\ X_9\ X_{12}\ X_{14}$	""""""""""
9	0.99	-31402.10	$X_1\ X_3\ X_4\ X_5\ X_9\ X_{12}$	""""""""""
10	0.98	-62060.20	$X_1\ X_3\ X_5\ X_9\ X_{12}$	""""""""""
11	0.97	-56773.00	$X_3\ X_5\ X_9\ X_{12}$	""""""""""
12	0.97	-46401.00	$X_3\ X_5\ X_9$	""""""""""
13	**0.96**	**-37740.70**	$X_5\ X_9$	**First estimated model**
14	0.96	-42595.80	$X_5\ X_9\ X_2$	Searching
15	0.96	-52758.80	$X_{15}\ X_5\ X_9$	""""""""""
16	0.96	-36997.60	$X_{16}\ X_5\ X_9$	""""""""""
17	0.96	-41736.10	$X_{17}\ X_5\ X_9$	""""""""""
18	0.96	-38444.40	$X_{18}\ X_5\ X_9$	""""""""""
19	0.96	-48809.30	$X_{19}\ X_5\ X_9$	""""""""""
20	0.96	-35316.30	$X_{20}\ X_5\ X_9$	""""""""""
21	0.96	-37094.90	$X_{21}\ X_5\ X_9$	Assessment
22	0.97	-21796.80	$X_{22}\ X_5\ X_9$	Assessment
23	**0.98**	**-54345.30**	$X_{23}\ X_5\ X_9$	**Second estimated model**
24	0.98	-59087.30	$X_{24}\ X_{23}\ X_5\ X_9$	Searching
25	0.98	-56212.10	$X_{25}\ X_{23} X_5\ X_9$	""""""""""
26	0.97	-52886.80	$X_{24}\ X_5\ X_9$	""""""""""
27	0.96	-37765.00	$X_{25}\ X_5\ X_9$	""""""""""
28	0.98	-50999.10	$X_4\ X_{23}\ X_5\ X_9$	""""""""""
29	0.98	-51214.20	$X_7\ X_{23}\ X_5\ X_9$	""""""""""

Appendix 9 continued.

30	0.98	-55972.30	$X_8\ X_{23}\ X_5\ X_9$	Assessment
31	0.98	-49296.90	$X_{11}\ X_{23}\ X_5\ X_9$	””””””””””””””
32	0.98	-56166.40	$X_{12}\ X_{23}\ X_5\ X_9$	””””””””””””””
33	0.98	-78996.60	$X_{14}\ X_{23}\ X_5\ X_9$	””””””””””””””
34	0.98	-51357.20	$X_{15}\ X_{23}\ X_5\ X_9$	””””””””””””””
35	0.98	-54760.50	$X_{20}\ X_{23}\ X_5\ X_9$	””””””””””””””
36	0.98	-43448.70	$X_{22}\ X_{23}\ X_5\ X_9$	””””””””””””””
37	0.13	146712.80	X_5	Assessment
38	0.76	39218.30	X_9	Assessment
39	0.91	9943.70	$X_4X_{23}\ X_9$	X_5 was eliminated due to low correlation
40	0.87	-94238.60	$X_7X_{23}\ X_9$	””””””””””””””
41	0.86	-1850.10	$X_{12}X_{23}\ X_9$	””””””””””””””
42	**0.98**	**-95088.70**	$X_{14}X_{23}\ X_9$	**Final DOMTI model**
43	0.98	-88361.50	$X_{14}\ X_{15}X_{23}\ X_9$	””””””””””””””
44	0.98	-98145.90	$X_{20}X_{14}X_{23}\ X_9$	””””””””””””””
45	0.98	-80510.80	$X_{22}X_{14}\ X_{23}\ X_9$	””””””””””””””
46	0.98	-94256.90	$X_{25}X_{14}\ X_{23}\ X_9$	””””””””””””””
47	0.72	-7775.60	X_{23}	Assessment
48	0.76	-93084.90	X_{14}	Assessment

Appendix 10 Summary output and ANOVA of the run 13 of first estimated DOMTI model.

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.98	0.96	0.77	0.95	15			
	df	SS	MS	F	Significance F			
Regression	2	19696150128	9848075064	131.78	6.8192E-09			
Residual	12	896753590.40	74729465.87					
Total	14	20592903718						
	Coefficients	Standard Error	t -Stat	P-value	Lower 95%	Upper 95%	Lower 95.000%	Upper 95.000%
Intercept	-37740.65	15774.37	-2.39	0.0340	-72110.04	-3371.26	-72110.04	-3371.26
X5	0.0385	0.0053	7.21	1.07111E-05	0.027	0.0501	0.027	0.0501
X9	0.0670	0.0044	15.08	3.64699E-09	0.057	0.0767	0.057	0.0767

Appendix 11 Summary output and ANOVA of the run 23 of second DOMTI estimated model.

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.98	0.97	0.97	6843.99	15			
	df	SS	MS	F	Significance F			
Regression	3	20077661560	6692553853	142.88	4.33049E-09			
Residual	11	515242158.40	46840196.22					
Total	14	20592903718						
	Coefficients	Standard Error	t -Stat	P-value	Lower 95%	Upper 95%	Lower 95.000%	Upper 95.000%
Intercept	-54345.34	13777.42	-3.95	0.0023	-84669.26	-24021.43	-84669.26	-24021.43
X5	0.0350	0.0044	7.95	6.93158E-06	0.0253	0.0447	0.0253	0.0447
X9	0.0534	0.0059	9.03	2.02289E-06	0.0404	0.0664	0.0404	0.0664
X23	4264.21	1494.15	2.85	0.0157	975.61	7552.81	975.61	7552.81

Appendix 12 Summary output and ANOVA of the run 42 of final DOMTI estimated model.

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.98	0.98	0.97	6595.23	15			
	df	SS	MS	F	Significance F			
Regression	3	20114436311	6704812104	154.14	2.88401E-09			
Residual	11	478467407.50	43497037.05					
Total	14	20592903718						
	Coefficients	Standard Error	t -Stat	P-value	Lower 95%	Upper 95%	Lower 95. 000%	Upper 95. 000%
Intercept	-95088.67	16152.77	-5.89	0.0001	-130640.70	-59536.64	-130640.70	-59536.64
X5	0.0326	0.0056	5.86	0.0001	0.0204	0.0449	0.0204	0.0449
X9	3311.96	1475.09	2.25	0.0463	65.31	6558.61	65.31	6558.61
X23	0.0156	0.0019	8.30	4.58916E-06	0.0115	0.0197	0.0115	0.0197

Appendix 13 Matrix of the correlation between Asian CACFT with GDP per capita and time for 1987-1993.

		1	2	3
1	Year	1.00		
2	Y_{CAC}	-0.96	1.00	
3	GDP per capita CAC	-0.75	0.79	1.00

Appendix 14 summary output and ANOVA of the CACFT estimated model

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.79	0.62	0.55	687838.57	7			
	df	SS	MS	F	Significance F			
Regression	1	3.87583E+12	3.87583E+12	8.19	0.04			
Residual	5	2.36561E+12	4.73122E+11					
Total	6	6.24144E+12						
	Coefficients	Standard Error	t -Stat	P-value	Lower 95%	Upper 95%	Lower 95. 000%	Upper 95. 000%
Intercept	-1274653.29	1395431.04	-0.91	0.40	-4861717.11	2312410.53	-4861717.11	2312410.53
GDP per Capita	125.60	43.88	2.86	0.04	12.80	238.40	12.80	238.40

Appendix 15 Residual output of the domestic trade of Iran in the final estimated model 1979-1993.

Observation	Actual Y	Predicted Y	Residuals	Standard Residuals	Accuracy as % of Actual Y
1	159713.50	167458.41	-7744.91	-1.17	- 4.85
2	156657.59	153082.35	3575.25	0.54	2.30
3	143905.97	145057.33	-1151.36	-0.18	- 0.80
4	187046.21	179156.93	7889.28	1.20	4.20
5	214483.34	214191.06	292.27	0.04	0.14
6	207417.78	209709.27	-2291.49	-0.35	- 1.10
7	221041.09	219995.82	1045.27	0.16	0.47
8	209298.56	200050.30	9248.26	1.40	4.40
9	192223.03	204768.17	-12545.14	-1.90	- 6.50
10	187630.97	183751.87	3879.11	0.59	2.10
11	185742.17	187863.34	-2121.17	-0.32	- 1.10
12	217939.21	223533.70	-5594.50	-0.85	- 2.60
13	252590.10	246200.77	6389.33	0.97	2.50
14	262396.35	263442.95	-1046.61	-0.16	- 0.40
15	277223.84	277047.43	176.41	0.03	0.06

	Appendix 16: Share of regional ports of Iran in the forecast of the most probable GOPFT and CACFT scenario.					
	1994	1995	1996	1997	1998	1999
GOPFT	31426.30	32860	34486.80	36321.80	38384.80	39977.40
Border crossings	3079.80	3220.3	3379.70	3559.50	3761.70	3917.80
All ports	28346.50	29639.72	31107.10	32762.27	34623.09	36059.62
Imam	10339.25	10810.94	11346.16	11949.87	12628.60	13152.57
Abass	13827.57	14458.4	15174.19	15981.59	16889.31	17590.06
Bushehr	1822.73	1905.88	2000.23	2106.66	2226.32	2318.69
Chah Bahar	848.51	887.22	931.14	980.69	1036.39	1079.39
Total Southern ports	28172.87	29360.72	30729.42	32291.41	34063.40	35449.05
Anzali	1099.92	1150.1	1207.04	1271.26	1343.47	1399.21
Nooshahr	408.54	427.18	448.33	472.18	499	519.71
Total Northern ports	1508.46	1577.28	1655.37	1743.45	1842.47	1918.92
All ports GOPFT	28346.50	29639.72	31107.1	32762.27	34623.09	36059.62
CACFT	1334.81	1298.28	1277.69	1272.59	1282.78	1308.35
Combined GOPFT and CACFT ports	29681.31	30938	32384.79	34034.86	35905.87	37367.97
Imam	10339.25	10810.94	11346.16	11949.87	12628.60	13152.57
Caucasus	173.53	168.78	166.10	165.44	166.76	170.09
Imam GOPFT & Caucasus	10512.78	10979.72	11512.26	12115.31	12795.36	13322.65
Abass	13827.57	14458.4	15174.19	15981.59	16889.31	17590.06
Central Asia	1161.29	1129.50	1111.59	1107.15	1116.02	1138.26
Abass GOPFT & Central Asia	14988.86	15587.90	16285.78	17088.75	18005.33	18728.32
	2000	2001	2002	2003	2004	2005
GOPFT	43298.80	462160	49496.10	53191.70	57366.60	62097
Border crossings	4243.30	4529.20	4850.60	5212.80	5621.90	6085.50
All ports	39055.52	41686.83	44645.48	47978.91	51744.68	56011.5
Imam	14245.31	15205.06	16284.22	17500.07	18873.61	20429.91
Abass	19051.47	20335.04	21778.28	23404.35	25241.30	27322.68
Bushehr	2511.33	2680.53	2870.77	3085.12	3327.63	3601.63
Chah Bahar	1169.07	1247.83	1336.40	1436.18	1548.90	1676.62
Total Southern ports	38326.85	40869.95	43749.21	45425.71	50681.73	54857.51
Anzali	1515.46	1617.56	1732.36	1861.71	2007.83	2173.40
Nooshahr	562.88	600.81	643.45	691.49	745.77	807.26
Total Northern ports	2078.34	2218.37	2375.81	2553.20	2753.60	2980.66
All ports GOPFT	39055.52	41686.83	44645.48	47978.91	51744.68	56011.50
CACFT	1349.67	1407.41	1482.51	1576.25	1690.29	1826.68
Combined Most probable GOPFT and CACFT ports scenario	40405.19	43094.24	46127.99	49555.16	53434.97	57838.18
Imam	14245.31	15205.06	16284.22	17500.07	18873.61	20429.91
Caucasus	175.46	177.04	192.73	204.91	219.74	237.47
Imam GOPFT & Caucasus	14420.76	15382.10	16473.98	17704.98	19093.35	20667.38
Abass	19051.47	20335.04	21778.28	23404.35	25241.30	27322.68
Central Asia	1174.21	1224.45	1289.78	1371.34	1470.55	1589.21
Abass GOPFT & Central Asia	20225.69	21559.49	23068.06	24775.69	26711.85	28911.89

	Appendix 17: Share of regional ports of Iran in the forecast of the optimistic scenario in the GOPFT and CACFT.					
	1994	1995	1996	1997	1998	1999
GOPFT (1)	31426.26	32988.20	34882.26	37142.84	39816.88	42966.22
Border crossings (2)	3079.77	3232.84	3418.46	3640.00	3902.05	4210.69
All ports GOPFT (3)	28346.49	29755.36	31463.80	33502.84	35914.82	38755.53
Imam (32.9% of 1)	10339.24	10853.12	11476.27	12219.99	13099.75	14135.89
Abass (44% of 1)	13827.56	14514.81	15348.20	16342.85	17519.43	18905.14
Bushehr (5.8% of 1)	1822.72	1913.32	2023.17	2154.28	2309.38	2492.04
Chah Bahar (2.7% of 1)	848.51	890.68	941.82	1002.86	1075.06	1160.09
Total Southern ports	28172.84	30354.29	32819.36	35598.07	38728.62	42265.71
Anzali	1099.92	1154.59	1220.88	1300.00	1393.59	1503.82
Nooshahr	408.54	428.85	453.47	482.86	517.62	558.56
Total Northern ports	1508.46	1583.43	1674.35	1782.86	1911.21	2062.38
All ports GOPFT	28346.49	29755.36	31463.80	33502.84	35914.82	38755.53
CACFT	1334.81	2182.36	3029.91	3877.46	4725.01	5572.56
Combined GOPFT ports and CACFT (3+13)	29681.30	31937.72	34493.71	37380.30	40639.83	44328.09
Imam	10339.24	10853.12	11476.27	12219.99	13099.75	14135.89
Caucasus	173.53	283.71	393.89	504.70	614.25	724.43
Imam GOPFT & Caucasus (15+16)	10512.77	11136.83	11870.15	12724.69	13714.00	14860.32
Abass	13827.56	14514.81	15348.20	16342.85	17519.43	18905.14
Central Asia	1161.29	1898.65	2636.02	3373.39	4110.76	4848.12
Abass GOPFT & Central Asia	14988.84	16413.46	17984.22	19716.24	21630.18	23753.26
	2000	2001	2002	2003	2004	2005
GOPFT	46670.82	51032.99	56183.06	62286.89	69555.70	78259.21
Border crossings	4573.74	5001.23	5505.94	6104.12	6816.46	7669.40
All ports GOPFT	42097.08	46031.75	50677.12	56182.78	62739.24	70589.81
Imam (32.9% of 1)	15354.70	16789.85	18484.23	20492.39	22883.83	25747.28
Abass (44% of 1)	20535.16	22454.51	24720.55	27406.23	30604.51	34434.05
Bushehr (5.8% of 1)	2706.91	2959.91	3258.62	3612.64	4034.23	4539.03
Chah Bahar (2.7% of 1)	1260.11	1377.89	1516.94	1681.75	1878.00	2113.00
Total Southern ports	46276.99	50849.83	56095.54	62155.76	69210.87	77491.21
Anzali	1633.48	1786.15	1966.41	2180.04	2434.45	2739.07
Nooshahr	606.72	663.43	730.38	809.73	904.22	1017.37
Total Northern ports	2240.20	2449.58	2696.79	2989.77	3338.67	3756.44
All ports GOPFT	42097.08	46031.75	50677.12	56182.78	62739.24	70589.81
CACFT	6420.11	7267.65	8115.20	8962.75	9810.30	10657.85
Combined GOPFT ports and CACFT (3+13)	48517.19	53299.41	58792.33	65145.53	72549.54	81247.65
Imam	15354.70	16789.85	18484.23	20492.39	22883.83	25747.28
Caucasus	834.61	944.80	1054.98	1165.16	1275.34	1385.52
Imam GOPFT & Caucasus (15+16)	16189.31	17734.65	19539.20	21657.55	24159.16	27132.80
Abass	20535.16	22454.51	24720.55	27406.23	30604.51	34434.05
Central Asia	5585.49	6322.86	7060.23	7797.59	8534.96	9272.33
Abass GOPFT & Central Asia	26120.65	28777.37	31780.77	35203.83	39139.47	43706.38

	Appendix 18: Share of regional ports of Iran in the forecast of the combined pessimistic GOPFT and CACFT.					
	1994	1995	1996	1997	1998	1999
GOPFT	31426.26	32064.05	32418.63	32330.22	31830.68	30970.99
Border crossings (9.8%)	3079.77	3142.28	3177.03	3168.36	3119.41	3035.16
All ports Iran's demand	28346.49	28921.77	29241.60	29161.86	28711.27	27935.83
Imam (32.9% of total GOPFT)	10339.24	10549.07	10665.73	10636.64	10472.29	10189.45
Abass (44%)	13827.56	14108.18	14264.20	14335.30	14005.50	13627.23
Bushehr (5.8%)	1822.72	1859.72	1880.28	1875.15	1846.18	1796.32
Chah Bahar (2.7%)	848.51	865.73	875.30	872.92	859.43	836.22
Total Southern ports	28172.84	28649.67	28871.14	28812.15	28171.40	27324.09
Anzali (3.5%)	1099.92	1122.24	1134.65	1131.56	1114.07	1083.98
Nooshahr (1.3%)	408.54	416.83	421.44	420.29	413.80	402.62
Total Northern ports	1508.46	1539.07	1556.09	1551.85	1527.87	1486.61
All ports GOPFT	28346.49	28921.77	29241.60	29161.86	28711.27	27935.83
CACFT	1334.81	1266.97	1185.63	1092.14	988.00	874.87
Combined GOPFT ports and CACFT	29681.30	30188.74	30427.24	30254.01	29699.28	28810.70
Imam	10339.24	10549.07	10665.73	10636.64	10472.29	10189.45
Caucasus	173.53	164.71	154.13	141.98	128.44	113.73
Imam GOPFT & Caucasus	10512.77	10713.78	10819.86	10778.62	10600.73	10303.19
Abass	13827.56	14108.18	14264.20	14335.30	14005.50	13627.23
Central Asia	1161.29	1102.26	1031.50	950.16	859.56	761.14
Abass GOPFT & Central Asia	14988.84	15210.44	15295.70	15285.46	14865.06	14388.37
	2000	2001	2002	2003	2004	2005
GOPFT	29818.01	28449.68	26949.49	25400.86	23881.77	22460.26
Border crossings	2922.16	2788.07	2641.05	2489.28	2340.43	2201.11
All ports Iran's demand	26895.84	25661.61	24308.44	22911.58	21541.36	20259.16
Imam (32.9% of total GOPFT)	9810.13	9359.94	8866.38	8356.88	7857.10	7389.43
Abass (44%)	13119.92	12517.86	11857.78	11176.38	10507.98	9882.52
Bushehr (5.8%)	1729.44	1650.08	1563.07	1473.25	1385.14	1302.70
Chah Bahar (2.7%)	805.09	768.14	727.64	685.82	644.81	606.43
Total Southern ports	26219.08	24924.71	23514.13	22060.33	20631.62	19287.68
Anzali (3.5%)	1043.63	995.74	943.23	889.03	835.86	786.11
Nooshahr (1.3%)	387.63	369.85	350.34	330.21	310.46	291.98
Total Northern ports	1431.26	1365.58	1293.58	1219.24	1146.33	1078.09
All ports GOPFT	26895.84	25661.61	24308.44	22911.58	21541.36	20259.16
CACFT	754.50	628.69	499.26	367.99	236.58	106.62
Combined GOPFT ports and CACFT	27650.34	26290.30	24807.70	23279.57	21777.94	20365.77
Imam	9810.13	9359.94	8866.38	8356.88	7857.10	7389.43
Caucasus	98.08	81.73	64.90	47.84	30.76	13.86
Imam GOPFT & Caucasus	9908.21	9441.67	8931.29	8404.72	7887.86	7403.29
Abass	13119.92	12517.86	11857.78	11176.38	10507.98	9882.52
Central Asia	656.41	546.96	434.36	320.15	205.83	92.76
Abass GOPFT & Central Asia	13776.34	13064.82	12292.13	11496.53	10713.81	9975.27

	Appendix 19: Distribution of three GOPFT and CACFT scenario forecasts on ten border crossings (000 tonnes).						
	Scenarios	1994	1995	1996	1997	1998	1999
Astara	Most probable	1388.93	1445.19	1510.55	1585.60	1671.13	1738.45
	Optimistic	1388.93	1514.91	1654.54	1809.24	1980.93	2172.15
	Pessimistic	1388.93	1410.19	1418.84	1408.39	1380.27	1336.69
Djulfa	Most probable	155.37	161.67	168.99	177.39	186.96	194.49
	Optimistic	155.37	169.42	185.00	199.12	217.60	242.78
	Pessimistic	155.37	157.76	158.73	157.57	154.42	149.55
Bazargan	Most probable	1179.43	1233.24	1294.29	1363.16	1440.58	1500.35
	Optimistic	1179.43	1238.05	1309.13	1393.97	1494.33	1612.52
	Pessimistic	1179.43	1203.36	1216.67	1213.35	1194.61	1162.34
Mirjaveh	Most probable	176.93	185.00	194.16	204.49	216.11	225.07
	Optimistic	176.93	185.72	196.39	209.11	224.17	241.90
	Pessimistic	176.93	180.52	182.52	182.02	179.21	174.37
Razi	Most probable	6.29	6.57	6.90	7.26	7.68	8.00
	Optimistic	6.29	6.60	6.98	7.43	7.96	8.59
	Pessimistic	6.29	6.41	6.48	6.47	6.37	6.19
Taybad	Most probable	31.43	32.86	34.49	36.32	38.38	39.98
	Optimistic	31.43	32.99	34.88	37.14	39.82	42.97
	Pessimistic	31.43	32.06	32.42	32.33	31.83	30.97
Noordooz	Most probable	128.26	129.34	131.58	135.00	139.63	144.06
	Optimistic	128.26	172.91	218.23	264.28	311.16	358.99
	Pessimistic	128.26	126.21	122.93	118.18	112.07	9.62
Bajgiran	Most probable	108.61	110.70	113.69	117.60	122.46	126.73
	Optimistic	108.61	136.92	165.97	195.82	226.60	258.42
	Pessimistic	108.61	108.03	106.42	103.49	99.33	94.11
Lotfabad	Most probable	54.15	55.19	56.67	58.62	61.04	63.16
	Optimistic	54.15	68.30	82.81	97.73	113.10	128.99
	Pessimistic	54.15	53.85	53.05	51.58	49.50	46.90
Sarakhs	Most probable	1172.32	1145.32	1131.93	1131.79	1144.79	1169.45
	Optimistic	1172.32	1875.86	2580.14	3285.24	3991.25	4698.32
	Pessimistic	1172.32	1117.70	1051.30	973.88	886.76	791.40
	Scenarios	2000	2001	2002	2003	2004	2005
Astara	Most probable	1876.89	1994.12	2127.43	2278.95	2451.28	2647.57
	Optimistic	2386.20	2627.27	2900.72	3213.38	3573.91	3993.41
	Pessimistic	1280.52	1215.11	1144.02	1070.80	998.79	930.89
Djulfa	Most probable	197.12	223.99	239.69	257.45	277.58	300.44
	Optimistic	266.69	293.62	324.18	359.12	391.47	446.32
	Pessimistic	143.27	135.96	128.01	119.82	111.77	104.18
Bazargan	Most probable	1519.03	1734.49	1857.59	1996.28	2152.97	2330.50
	Optimistic	1751.56	1915.27	2108.55	2337.63	2610.43	2937.07
	Pessimistic	1119.07	1067.72	1011.41	953.29	896.28	842.93
Mirjaveh	Most probable	243.77	260.20	278.66	299.47	322.97	349.61
	Optimistic	262.76	287.32	316.31	350.68	391.60	440.60
	Pessimistic	167.88	160.17	151.73	143.01	134.45	126.45
Razi	Most probable	8.66	9.24	9.90	10.64	11.47	12.42
	Optimistic	9.33	10.21	11.24	12.46	13.91	15.65
	Pessimistic	5.96	5.69	5.39	5.08	4.78	4.49

Appendix 19 continued.

Taybad	Most probable	43.30	46.22	49.50	53.19	57.37	62.10
	Optimistic	46.67	51.03	56.18	62.29	69.56	78.26
	Pessimistic	29.82	28.45	26.95	25.40	23.88	22.46
Noordooz	Most probable	152.73	161.40	171.64	183.62	197.56	213.70
	Optimistic	407.93	458.18	510.01	563.75	619.82	678.75
	Pessimistic	96.61	87.71	78.36	68.83	59.36	50.14
Bajgiran	Most probable	135.28	143.42	152.87	163.79	176.36	190.82
	Optimistic	291.47	325.97	362.21	400.56	441.49	485.58
	Pessimistic	88.03	81.31	74.20	66.93	59.72	52.76
Lotfabad	Most probable	67.42	71.48	76.19	81.63	87.89	95.10
	Optimistic	145.50	162.73	180.82	199.97	220.40	242.40
	Pessimistic	43.87	40.52	36.97	33.34	29.74	26.27
Sarakhs	Most probable	1210.95	1265.12	1334.43	1420.07	1523.53	1646.69
	Optimistic	5406.62	6116.38	6827.88	7541.51	8257.68	8977.12
	Pessimistic	689.41	582.46	472.22	360.33	248.43	137.93

Appendix 20: Modal split of most probable scenario for GOPFT .

			Tonnage share of three modes in GOPFT				Total forecast volume of oil products in GOPFT	
	GOPFT (1)	Road and rail GOPFT (2 = 1-5)	Rail (3) 10.9% x 1	Road (4=2-3)	Pipeline (5)	Pipelines share in GOPFT (59.8+0.36 t) (6)	Volume (7)	Share of oil products in GOPFT* (8)
1994	31426.3	27040.1	2225.7	24814.6	4386.2	60.16	7290.9	23.2
1995	32860.2	28425.4	3581.8	24843.6	4434.8	60.52	7327.8	22.3
1996	34486.8	29993.7	3759.1	26234.6	4493.1	60.88	7380.2	21.4
1997	36321.8	31761.9	3959.1	27802.8	4559.9	61.24	7446	20.5
1998	38384.8	33750.4	4183.9	29566.5	4634.4	61.6	7523.4	19.6
1999	39977.4	35345.4	4357.5	30987.9	4632	61.96	7475.8	18.7
2000	43298.8	38495.7	4719.6	33776.1	4803.1	62.32	7707.2	17.8
2001	46216	41320.4	5037.5	36282.9	4895.6	62.68	7810.5	16.9
2002	49496.1	44503.7	5395.1	39108.6	4992.4	63.04	7919.4	16
2003	53191.7	48099.5	5797.9	42301.6	5092.2	63.4	8031.9	15.1
2004	57366.6	52172.6	6253	45919.6	5194	63.76	8146.1	14.2
2005	62097	56801.4	6550.6	50250.8	5295.6	64.12	8258.9	13.3
%	100		10.6	80.9	8.5			

Note: * : (drops from 24.1 of base years to 13.3 as the average growth of 15 years (24.1 -1 3.3/12=0.9 each year backward).

Appendix 21: Modal split of optimistic scenario for GOPFT.							
			Tonnage share of three modes in GOPFT			Modal share and total forecast volume of oil products in GOPFT[2]	
	GOPFT (1)	Road and rail GOPFT (2=1-5)	Rail (3) 10.9% x 1	Road (4=2-3)	Pipeline (5)	Pipelines modal share in GOPFT[1] (6)	Volume (7)
1994	31426.26	27040.06	2225.46	24814.60	4386.2	60.16	7290.9
1995	32988.20	28536.10	3595.71	24940.39	4452.1	60.52	7356.4
1996	34882.27	30337.67	3802.17	26535.50	4544.6	60.88	7464.8
1997	37142.84	32479.84	4048.57	28431.27	4663.0	61.24	7614.3
1998	39816.88	35009.58	4340.04	30669.54	4807.3	61.60	7804.1
1999	42966.22	37987.92	4683.32	33304.60	4978.3	61.96	8034.7
2000	46670.82	41493.62	5087.12	36406.50	5177.2	62.32	8307.4
2001	51032.99	45627.09	5562.60	40064.49	5405.9	62.68	8624.6
2002	56183.06	50516.16	6123.95	44392.21	5666.9	63.04	8989.3
2003	62286.89	56323.89	6789.27	49534.62	5963.0	63.40	9405.3
2004	69555.70	63258.20	7581.57	55676.63	6297.5	63.76	9876.9
2005	78259.21	71585.29	8530.25	63055.04	6673.9	64.12	10408.5

Note:
1: (59.8+0.36 t) % of 7 where t is year, 59.8% share of pipeline mode in total oil products from ports.
2 : drops from 24.1 of base years to 13.3 in 2005 as the average growth of 15 years during 1979-1993 (24.1 -1 3.3/12=0.9 each year backward).

Appendix 22: Modal split of pessimistic for GOPFT.							
		Tonnage share of three modes in GOPFT				Total forecast volume of oil products in GOPFT	
	GOPFT (1)	Rail (2) 10.9% x 1	Road (3=1-2+4)	Pipeline (4)	Pipelines modal share in GOPFT (59.8-0.8 t) (5)	Volume (6)	Share of oil products in GOPFT[1] (7)
1994	31426.26	3425.46	23699.17	4301.63	59	7290.89	23.2
1995	32064.05	3494.98	24407.61	4161.47	58.2	7150.28	22.3
1996	32418.63	3533.63	24902.82	3982.18	57.4	6937.59	21.4
1997	32330.22	3523.99	25054.95	3751.28	56.6	6627.70	20.5
1998	31830.68	3469.54	24879.88	3481.26	55.8	6238.81	19.6
1999	30970.99	3375.84	24409.78	3185.37	55	5791.57	18.7
2000	29818.01	3250.16	23691.12	2876.72	54.2	5307.61	17.8
2001	28449.68	3101.02	22781.19	2567.47	53.4	4808.00	16.9
2002	26949.49	2937.50	21743.93	2268.07	52.6	4311.92	16
2003	25400.86	2768.69	20645.37	1986.81	51.8	3835.53	15.1
2004	23881.77	2603.11	19549.14	1729.52	51	3391.21	14.2
2005	22460.27	2448.17	18512.51	1499.58	50.2	2987.22	13.3

Note: 1: drops from 24.1 of base years to 13.3 as the average growth of 15 years with a rate of 0.9 annually (24.1 -1 3.3 /12=0.9 each year backward).

Appendix 23: Modal split of individual and combined GOPFT and CACFT for three scenarios of ISLB study (000 tonnes).

	Scenarios	1994	1995	1996	1997	1998	1999
Road	Most probable GOPFT	24814.60	24843.60	26234.60	27802.80	29566.50	30987.90
	Most probable CAC FT	221.45	215.38	211.97	211.12	212.81	217.06
Total Road	Most probable	**25036.05**	**25058.98**	**26446.57**	**28013.92**	**29779.31**	**31204.96**
	Optimistic GOPFT	24814.60	24940.39	26535.50	28431.27	30669.54	33304.60
	Optimistic CACFT	221.45	362.05	502.66	643.27	783.88	924.49
Total Road	Optimistic	**25036.05**	**25302.44**	**27038.16**	**29074.54**	**31453.41**	**34229.09**
	Pessimistic GOPFT	23699.17	24407.61	24902.82	25054.95	24879.88	24409.78
	Pessimistic CACFT	221.45	210.19	196.70	181.19	163.91	145.14
Total Road	Pessimistic	**23920.62**	**24617.80**	**25099.52**	**25236.14**	**25043.79**	**24554.92**
Rail	Most probable GOPFT	2225.70	3581.80	3759.10	3959.10	4183.90	4357.50
	Most probable CAC FT	1113.37	1082.89	1065.72	1061.47	1069.96	1091.30
Total	Most probable scneario	**3339.07**	**4664.69**	**4824.82**	**5020.57**	**5253.86**	**5448.80**
	Optimistic GOPFT	2225.46	3595.71	3802.17	4048.57	4340.04	4683.32
	Optimistic CACFT	1113.37	1820.31	2527.25	3231.05	3937.30	4648.07
Total	Optimistic	**3338.83**	**5416.02**	**6329.42**	**7279.62**	**8277.34**	**9331.39**
	Pessimistic GOPFT	3425.46	3494.98	3533.632	3524	3469.54	3375.84
	Pessimistic CACFT	1113.37	1056.78	988.94	910.96	824.09	729.73
Total	Pessimistic	**4538.83**	**4551.76**	**4522.57**	**4434.95**	**4293.64**	**4105.57**
Total	Most probable GOPFT	4386.20	4434.80	4493.10	4559.90	4634.40	4632
Pipelines	Optimistic GOPFT	4386.20	4452.10	4544.60	46630	4663	4807.30
Total	Pessimistic GOPFT	4301.63	4161.47	3982.18	3751.28	3481.26	3185.37

Appendix 23 continued.

	Scenarios	2000	2001	2002	2003	2004	2005
Road	Most probable GOPFT	33776.10	36282.90	39108.60	42301.60	45919.60	50250.80
	Most probable CACFT	223.910	233.49	245.95	261.50	280.42	303.05
Total	Most probable	**34000.01**	**36516.39**	**39354.55**	**42563.10**	**46200.02**	**50553.85**
	Optimistic GOPFT	36406.50	40064.49	44392.21	49534.62	55676.63	63055.04
	Optimistic CACFT	1065.10	1205.70	1346.31	1486.92	1627.53	1768.14
Total	Optimistic	**37471.60**	**41270.20**	**45738.52**	**51021.54**	**57304.16**	**64823.18**
	Pessimistic GOPFT	23691.12	22781.19	21743.93	20645.37	19549.15	18512.51
	Pessimistic CACFT	125.17	104.30	82.83	61.05	39.25	17.69
Total	Pessimistic	**23816.30**	**22885.49**	**21826.76**	**20706.42**	**19588.39**	**18530.20**
Rail	Most probable GOPFT	4719.60	5037.50	5395.10	5797.90	6253	6550.60
	Most probable CACFT	1125.76	1173.92	1236.56	1314.75	1409.87	1523.63
Total Rail	Most probable scenario	**5845.36**	**6211.42**	**6631.66**	**7112.65**	**7662.87**	**8074.23**
	Optimistic GOPFT	5087.12	5562.60	6123.95	6789.27	7581.57	8530.25
	Optimistic CACFT	5355.01	6061.95	6768.89	7475.83	8174.78	8889.71
Total Rail	Optimistic	**10442.13**	**11624.55**	**12892.85**	**14265.10**	**15756.35**	**17419.97**
	Pessimistic GOPFT	3250.16	3101.02	2937.50	2768.69	2603.11	2448.17
	Pessimistic CACFT	629.33	524.39	416.44	306.92	197.33	88.93
Total Rail	Pessimistic	**3879.49**	**3625.41**	**3353.93**	**3075.6179**	**2800.45**	**2537.10**
Pipelines	Most probable GOPFT	4803.10	4895.60	4992.40	5092.20	5194	5295.60
	Optimistic GOPFT	4978.30	5177.20	5405.90	5963	6297.50	6673.90
	Pessimistic GOPFT	2876.72	2567.47	2268.07	1986.81	1729.52	1499.58

	Appendix 24: Modal split of real DOMTI for three scenarios of ISLB study (000 tonnes).						
	Scenario	1994	1995	1996	1997	1998	1999
Road	Most probable	241553.07	256816.73	263561.15	277803.22	294433.10	313741.17
	%	84.74	84.08	83.42	82.76	82.1	81.44
	Optimistic	244575.66	256365.04	272267.56	292787.35	318620.21	350825.51
	Pessimistic	241553.08	234082.61	226396.20	215823.94	202564.44	187481.55
Rail	Most probable	13112.39	14966.72	16429.13	18462.03	20800.39	23499.77
	%	4.6	4.9	5.2	5.5	5.8	6.1
	Optimistic	13276.47	14940.40	16971.85	19457.84	22509.10	26277.65
	Pessimistic	13112.39	13641.83	14112.45	14343.06	14310.28	14042.70
Pipelines	Most probable	30386.54	33659.85	35954.52	39408.05	43393.92	48001.17
	%	10.66	11.02	11.38	11.74	12.1	12.46
	Optimistic	30766.78	33600.65	37142.23	41533.63	46958.64	53674.95
	Pessimistic	30386.55	30680.19	30884.55	30615.92	29854.20	28683.94
	Scenario	2000	2001	2002	2003	2004	2005
Road	Most probable	336066.61	361932.17	391659.69	425977.28	464290.06	509222.97
	%	80.78	80.12	79.46	78.8	78.34	77.68
	Optimistic	390405.43	439100.88	499063.37	573145.82	658989.36	773350.75
	Pessimistic	170717.34	153116.10	134181.51	127802.49	95650.26	77176.45
Rail	Most probable	26625.73	30266.42	34503.12	39462.36	45157.47	51921.29
	%	6.4	6.7	7	7.3	7.6	7.9
	Optimistic	30930.86	36719.62	43964.81	53096	64094.18	78852.23
	Pessimistic	13525.51	12804.27	11820.67	11839.57	92779.32	7650.086
Pipelines	Most probable	53334.66	59539.02	66738.89	75140.66	84729.67	96087.25
	%	12.82	13.18	13.54	13.9	14.26	14.62
	Optimistic	61958.38	72233.52	85040.50	101100.60	120260.92	145926.54
	Pessimistic	27093.30	25188.10	22864.56	22543.84	17410.94	14525.23

Notes: 1: 4.6% with 0.3 annual growth rate from 1994 for all three scenarios. 2: 10.66% with 0.36% growth annual rate from 1994.

	Appendix 25: Modal split of the total demand for three ISLB scenarios (000, tonnes).						
	scenarios	1994	1995	1996	1997	1998	1999
Total Road	Most probable	266589.11	281875.71	290007.72	305817.15	324212.41	344946.12
	Optimistic	269611.70	281667.48	299305.72	321861.89	350073.62	385054.60
	Pessimistic	265473.70	258700.41	251495.72	241060.08	227608.23	212036.48
Total Rail	Most probable	16451.46	19631.41	21253.95	23482.60	26054.25	28948.56
	Optimistic	16615.30	20356.42	23301.26	26737.45	30786.44	35609.03
	Pessimistic	17651.22	18193.59	18635.01	18778.01	18603.92	18148.27
Total Pipelines	Most probable	34772.74	38094.65	40447.62	43967.95	48028.32	52633.17
	Optimistic	35152.98	38052.75	41686.83	46196.63	51621.64	58482.25
	Pessimistic	34688.17	34841.66	34866.72	34367.19	33335.46	31869.31
Years		2000	2001	2002	2003	2004	2005
Total Road	Most probable	370066.62	398448.56	431014.24	468540.38	510490.08	559776.81
	Optimistic	427877.02	480371.08	544801.89	624167.37	716293.52	838173.93
	Pessimistic	194533.64	176001.59	156008.26	148508.90	115238.65	95706.65
Total Rail	Most probable	32471.09	36477.84	41134.78	46575.02	52820.34	59995.52
	Optimistic	41372.99	48344.17	56857.65	67361.10	79850.53	96272.20
	Pessimistic	17405.00	16429.67	15174.60	14915.19	95579.77	10187.18
Total Pipelines	Most probable	58137.76	64434.62	71731.29	80232.86	89923.67	101382.85
	Optimistic	66936.68	77410.72	90446.40	107063.60	126558.42	152600.44
	Pessimistic	29970.02	27755.57	25132.63	24530.65	19140.45	16024.81

Appendix 26: Modal Split of the total three types of demand for three scenarios of ISLB study (000 tonnes).

ISLB demands	Scenario	1994	1995	1996	1997	1998	1999
Road DOMTI	Most probable	241553.07	256816.73	263561.15	277803.22	294433.10	313741.17
GOPFT	Most probable	24814.60	24843.60	26234.60	27802.80	29566.50	30987.90
CACFT	Most probable	221.45	215.38	211.97	211.12	212.81	217.06
Total Road Demand	Most probable	266589.11	281875.71	290007.72	305817.15	324212.41	344946.12
Road DOMTI	Optimistic	244575.66	256365.04	272267.56	292787.35	318620.21	350825.51
GOPFT	Optimistic	24814.60	24940.39	26535.498	28431.27	30669.54	33304.60
CACFT	Optimistic	221.45	362.05	502.662439	643.27	783.88	924.49
Total road demand	Optimistic	269611.70	281667.48	299305.72	321861.89	350073.62	385054.60
Road DOMTI	Pessimistic	241553.08	234082.61	226396.20	215823.94	202564.44	187481.55
GOPFT	Pessimistic	23699.17	24407.61	24902.82	25054.95	24879.88	24409.78
CACFT	Pessimistic	221.45	210.19	196.70	181.19	163.91	145.14
Total road demand	Pessimistic	265473.70	258700.41	251495.72	241060.08	227608.23	212036.48
Rail DOMTI	Most probable	13112.39	14966.72	16429.13	18462.03	20800.39	23499.77
GOPFT	Most probable	2225.70	3581.80	3759.10	3959.10	4183.90	4357.50
CACFT	Most probable	1113.37	1082.89	1065.72	1061.47	1069.96	1091.30
Total rail demand	Most probable	16451.46	19631.41	21253.95	23482.60	26054.25	28948.56
Rail DOMTI	Optimistic	13276.47	14940.40	16971.85	19457.84	22509.10	26277.65
GOPFT	Optimistic	2225.46	3595.71	3802.17	4048.57	4340.04	4683.32
CACFT	Optimistic	1113.37	1820.31	2527.25	3231.047	3937.30	4648.07
Total rail demand	Optimistic	16615.30	20356.42	23301.26	26737.45	30786.44	35609.03
Rail DOMTI	Pessimistic	13112.39	13641.83	14112.45	14343.06	14310.28	14042.70
GOPFT	Pessimistic	3425.46	3494.98	3533.63	3523.99	3469.54	3375.84
CACFT	Pessimistic	1113.37	1056.78	988.94	910.96	824.09	729.73
Total rail demand	Pessimistic	17651.22	18193.59	18635.01	18778.01	18603.92	18148.27
DOMTI Pipelines	Most probable	30386.54	33659.85	35954.52	39408.05	43393.92	48001.17
GOPFT	Most probable	4386.20	4434.80	4493.10	4559.90	4634.40	4632.00
Total Pipeline demand	Most probable	34772.74	38094.65	40447.62	43967.95	48028.32	52633.17
Pipelines DOMTI	Optimistic	30766.78	33600.6505	37142.23	41533.63	46958.64	53674.95
GOPFT	Optimistic	4386.20	4452.1	4544.60	4663.00	4663.00	4807.30
Total Pipeline demand	Optimistic	35152.98	38052.7505	41686.83	46196.63	51621.64	58482.25
DOMTI Pipelines	Pessimistic	30386.55	30680.19	30884.55	30615.92	29854.20	28683.94
GOPFT	Pessimistic	4301.63	4161.47	3982.18	3751.28	3481.26	3185.37
Total Pipeline demand	Pessimistic	34688.17	34841.66	34866.72	34367.19	33335.46	31869.31

Appendix 26 continued.

	Scenarios	2000	2001	2002	2003	2004	2005
Road DOMTI	Most probable	336066.61	361932.17	391659.69	425977.28	464290.06	509222.9662
GOPFT	Most probable	33776.10	36282.90	39108.60	42301.60	45919.60	50250.8
CACFT	Most probable	223.91	233.49	245.95	261.50	280.42	303.045571
Total road demand	**Most probable**	**370066.62**	**398448.56**	**431014.24**	**468540.38**	**510490.08**	**559776.811771**
Road DOMTI	Optimistic	390405.43	439100.88	499063.37	573145.82	658989.36	773350.7506
GOPFT	Optimistic	36406.50	40064.49	44392.21	49534.62	55676.63	63055.04
CACFT	Optimistic	1065.10	1205.70	1346.31	1486.92	1627.53	1768.136265
Total road demand	**Optimistic**	**427877.02**	**480371.08**	**544801.89**	**624167.37**	**716293.52**	**838173.926865**
Road DOMTI	Pessimistic	170717.34	153116.10	134181.51	127802.49	95650.26	77176.44717
GOPFT	Pessimistic	23691.12	22781.19	21743.93	20645.37	19549.14	18512.51379
CACFT	Pessimistic	125.17	104.30	82.83	61.05	39.25	17.6874805
Total road demand	**Pessimistic**	**194533.64**	**176001.59**	**156008.26**	**148508.90**	**115238.65**	**95706.6484405**
Rail DOMTI	Most probable	26625.73	30266.42	34503.12	39462.36	45157.47	51921.2885
GOPFT	Most probable	4719.60	5037.50	5395.10	5797.90	6253.00	6550.6
CACFT	Most probable	1125.76	1173.92	1236.56	1314.75	1409.87	1523.63006345
Total rail demand	**Most probable**	**32471.09**	**36477.84**	**41134.78**	**46575.02**	**52820.34**	**59995.51856345**
Rail DOMTI	Optimistic	30930.86	36719.62	43964.81	53096.00	64094.18	78852.23192
GOPFT	Optimistic	5087.12	5562.60	6123.95	6789.27	7581.57	8530.254
CACFT	Optimistic	5355.01	6061.95	6768.89	7475.83	8174.78	8889.711585
Total rail demand	**Optimistic**	**41372.99**	**48344.17**	**56857.65**	**67361.10**	**79850.53**	**96272.197505**
Rail DOMTI	Pessimistic	13525.51	12804.27	11820.67	11839.57	92779.32	7650.08552
GOPFT	Pessimistic	3250.16	3101.02	2937.50	2768.69	2603.11	2448.168847
CACFT	Pessimistic	629.33	524.39	416.44	306.92	197.33	88.9280305
Total rail demand	**Pessimistic**	**17405.00**	**16429.67**	**15174.60**	**14915.19**	**95579.77**	**10187.1823975**
DOMTI Pipelines	Most probable	53334.66	59539.02	66738.89	75140.66	84729.67	96087.2453
GOPFT	Most probable	4803.10	4895.60	4992.40	5092.20	5194.00	5295.6
Total Pipeline demand	**Most probable**	**58137.76**	**64434.62**	**71731.29**	**80232.86**	**89923.67**	**101382.8453**
DOMTI Pipelines	Optimistic	61958.38	72233.52	85040.50	101100.60	120260.92	145926.5355
GOPFT	Optimistic	4978.30	5177.20	5405.90	5963.00	6297.50	6673.9
Total Pipeline demand	**Optimistic**	**66936.68**	**77410.72**	**90446.40**	**107063.60**	**126558.42**	**152600.4355**
DOMTI Pipelines	Pessimistic	27093.30	25188.10	22864.56	22543.84	17410.94	14525.22731
GOPFT	Pessimistic	2876.72	2567.47	2268.07	1986.81	1729.52	1499.582029
Total Pipeline demand	**Pessimistic**	**29970.02**	**27755.57**	**25132.63**	**24530.65**	**19140.45**	**16024.809339**

Notes: 1: 4.6% with 0.3 annual growth rate from 1994 for all three scenarios. 2: 10.66% with 0.36% growth annual rate from 1994.

Appendix 27: Total and modal demand for transport of Iran under three scenario 1994-2005 (000 tonnes).

Scenarios	1994	1995	1996	1997	1998	1999
Most probable GOPFT	31426.30	32860.00	34486.80	36321.80	38384.80	39977.40
Most probable CACFT	1334.81	1298.28	1277.69	1272.59	1282.78	1308.35
Most probable Real DOMTI	285052.00	305443.30	315944.80	335673.30	358627.40	385242.10
Total most probable demand	**317813.11**	**339601.58**	**351709.29**	**373267.69**	**398294.98**	**426527.85**
Optimistic GOPFT	31426.26	32988.20	34882.27	37142.84	39816.88	42966.22
Optimistic CACFT	1334.81	2182.36	3029.91	3877.46	4725.01	5572.56
Optimistic Real DOMTI	285052.02	301161.92	322422.50	349563.11	383568.74	425901.44
Total optimistic demand scenario	**317813.10**	**336332.49**	**360334.67**	**390583.41**	**428110.62**	**474440.22**
Pessimistic GOPFT	31426.26	32064.05	32418.63	32330.22	31830.68	30970.99
Pessimistic CACFT	1334.81	1266.97	1183.63	1092.14	988.00	874.87
Pessimistic Real DOMTI	285052.02	278404.63	271393.19	260782.92	246728.92	230208.19
Total pessimistic demand	**317813.10**	**311735.65**	**304995.45**	**294205.29**	**279547.60**	**262054.05**
	2000	2001	2002	2003	2004	2005
Most probable GOPFT	43298.80	46216	49496.10	53191.70	57366.60	62097.00
Most probable CACFT	1349.67	1407.41	1482.51	1576.25	1690.29	1826.68
Most probable Real DOMTI	416027.00	451737.60	492901.70	540580.30	594177.20	657231.50
Total most probable demand	**460675.47**	**499361.01**	**543880.31**	**595348.25**	**653234.09**	**721155.18**
Optimistic GOPFT	46670.82	51032.99	56183.06	62286.89	69555.70	78259.21
Optimistic CACFT	6420.11	7267.65	8115.20	8962.75	9810.30	10657.85
Optimistic Real DOMTI	477997.52	542261.78	621691.90	720272.85	843344.46	998129.52
Total optimistic demand scenario	**531088.45**	**600562.42**	**685990.17**	**791522.50**	**922710.46**	**1087046.58**
Pessimistic GOPFT	29818.01	28449.68	26949.49	25400.86	23881.77	22460.27
Pessimistic CACFT	754.50	628.69	499.26	367.99	236.58	106.62
Pessimistic Real DOMTI	211336.16	191108.46	168866.73	162185.90	122096.32	99351.76
Total pessimistic demand	**241908.66**	**220186.83**	**196315.49**	**187954.76**	**146214.67**	**121918.64**

Appendix 28: Maritime traffic characteristics of Iranian ports in base years 1993 and horizon 2005 for three most probable, optimistic and pessimistic GOPFT & CACFT scenarios (000 tonnes).

	1993				2005		
	Base Year				Most probable		
	Maritime traffic	Daily rate (1 / 365)	Total port GOPFT	Average trade per ships (tons)	Maritime traffic	Daily rate	Total port GOPFT & CACFT
	1	2	3	4 (3/1)	5 (7/4)	6 (5 / 365)	7
Imam	584	1.60	10047	17203.80	1201	3.30	20667.38
Abass	639	1.80	13453	21053.20	2149	5.80	28911.89
Bushehr	160	0.44	1783	11143.80	323	0.89	3601.63
Chah Bahar	43	0.12	818	19023.30	88	0.24	1676.62
Anzali	371	1.10	1078	2905.70	748	2.00	2173.40
Nooshahr	124	0.34	396	3193.50	253	0.69	807.26
Total	1921	5.40	27575		4762	12.93	57838.17

	2005					
	Optimistic			Pessimistic		
	Maritime traffic	Daily rate	Total port (GOPFT & CACFT)	Maritime traffic	Daily rate	Total port (GOPFT & CACFT)
	8 (10/4)	9 (8/365)	10	11 (13/4)	12 (11/365)	13
Imam	1577	4.30	27132.80	430	1.20	7403.29
Abass	2076	5.70	43706.38	474	1.30	9975.27
Bushehr	407	1.10	4539.034	117	0.32	1302.70
Chah Bahar	111	0.30	2113.00	32	0.09	606.43
Anzali	943	2.60	2739.07	271	0.74	786.11
Nooshahr	319	0.87	1017.37	91	0.25	291.98
Total GOPFT & CACFT	5433	14.87	81247.65	1415	3.90	20365.77

Source: Base year data are based on PSO 1993.

List of the Iranian institutions used in this project:

Institution	Description	Persian name
Statistical Centre of the Islamic Republic of Iran	Research and provision of data at national, provincial and local levels.	Markaze Amare Jomhooriyeh Islamiyeh Iran
Central Bank of Iran	Affairs related to the national currency and foreign revenues, trade and national accounts of the country.	Bank Markaziyeh Jomhooriyeh Islamiyeh Iran
Ministry of Road and Transport	Administration for the management, maintenance and construction of the transport infrastructure of the country in particular for rail, national and provincial and inter-provincial roads, ports, civil aviation and national airline.	Vezarate Rah va Tarabari Jomhooriyeh Islamiyeh Iran
Ministry of Constructive Jehad	Responsible for rural roads and developments and fishing.	Vezarate Jahad Sazandagi Jomhooriyeh Islamiyeh Iran
Ministry of Oil	Management and exploitation, exploration and, refining, national and international marketing of oil fields, terminals and regions of the country.	Vezarate Naft Jomhooriyeh Islamiyeh Iran
Ministry of Interior	In charge of all municipalities and governorships administration at provincial and local levels of the urban and inter-urban areas. Responsible for borderial roads and connections and Coast Guard and road traffic system of the country.	Vezarate Keshvar Jomhooriyeh Islamiyeh Iran
Ministry of Defence	In charge of the three military forces and defence of the country including military air passenger and cargo transport.	Vezarate Defa Jomhooriyeh Islamiyeh Iran
Ministry of Industry and Mining	Responsible for the development and management of the industrial and mining sector of the country and roads in the mining areas.	Vezarate Sanaye va Ma A Den Jomhooriyeh Islamiyeh Iran
Ministry of Commerce	In charge of the foreign trade issues and the national shipping company of the country.	Vezarate Bazargani Jomhooriyeh Islamiyeh Iran
Ministry of Finance and Economic	Responsible for the collection of the national revenues, expenditure, programming and Budgeting and Customs of the country.	Vezarate Dara Yee and Egh Te Saad Jomhooriyeh Islamiyeh Iran
Ministry of Justice	In charge of the Justice and legal issues and private companies	Vezarate Dad gostari Jomhooriyeh Islamiyeh Iran
Ports and Shipping	In charge of the management, operation,	Sazemane Banader va Kashti

Organisation	construction of the ports and maritime administration of the country.	Rani Jomhooriyeh Islamiyeh Iran
Planning and Budgeting Organisation	In charge of the national planning and development programmes of the country and also Statistical Centre of Iran.	Sazemane Bar Nameh va Boodjeh Jomhooriyeh Islamiyeh Iran
Islamic Republic of the Iran Railway Company	In charge of the rail networks and rail passenger and freight operations and traffic.	Rah Ahaneh Jomhooriyeh Islamiyeh Iran
Islamic Republic of the Iran Shipping Line Company	In charge of the national merchant shipping fleet and most part of the foreign trade of the country.	Kashti Rani Jomhooriyeh Islamiyeh Iran
National Iranian Tanker Company	In charge of the national tanker fleet and most part of the crude oil transport trade of the country.	Sherkate Kashti Rani Meli Naft Keshe Jomhooriyeh Islamiyeh Iran