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OBJECTIVES

Liner and tramp shipping are considered as the two major service patterns for international seaborne trade. In concept, liner shipping services have fixed routes and offer port calls at regular intervals, while tramp shipping services have no fixed route and can call at any port for loading and discharging cargo upon demand. In practice, however, it is observed that some ships under tramp services also exhibit a fixed routing pattern and call at fixed ports/countries. Having the aforementioned in mind, this study aims to make the following three contributions – (i) it develops a conceptual framework to better understand the degree of 'linerness' or 'trampness' for tramp shipping service types, (ii) it estimates, with the framework, the degree of 'linerness' or 'trampness' for dry bulkers by examining the trading pattern of the corresponding vessel types using Automatic Identification System (AIS) data, and (iii) it anticipates the future trade-flow (movement) of vessels (in dry bulk sectors) that would improve the efficacy of trading activities for shipowners or ship operators by better making a maintenance plan and designing an operational activity in advance.

DATA AND METHODOLOGY

This study was conducted, with a unique set of databases composed of more than 20,000 dry bulk carriers with over 2 million individual voyages between 2013 and 2018 using AIS data collected from nine satellites by the ExactEarth, to understand the trade or movement pattern of dry bulk ships on a global scale. The dry bulkers are divided into eight different subsectors based on size (in terms of DWT) with an assumption that the larger vessel is deployed to the longer distance voyage, while the smaller one the shorter distance voyages. See more in Table 1.

Table 1. Dry Bulk Carrier subsectors

Bulk Carrier Sub-sectors	Size (dwt)
Very Large Ore Carrier (VLOC)	≥ 220,000
Capesize	220,0000 > and ≥ 120,000
Post-Panamax	120,000 > and ≥ 80,000
Panamax	80,000 > and ≥ 60,000
Supramax	60,000 > and ≥ 50,000
Handymax	50,000 > and ≥ 40,000
Handysize	40,000 > and ≥ 20,000
Mini-Bulk	20,000 >

The frequency of loading and discharge ports/countries for each (laden and ballast) voyage is used to estimate the probability of a ship type for calling at a country with loading and discharging of cargoes.

$$PL_t^{S,C} = \frac{Frequency\ of\ Loading\ Country}{Total\ number\ of\ Laden\ Voyages}$$

$$PB_t^{S,C} = \frac{Frequency\ of\ Loading\ Country}{Total\ number\ of\ Ballast\ Voyages}$$

Where, *PL (PB)* denotes the probability of loading is a country, *C* refers to a loading country in a laden (ballast) voyage for any sub-sector of ships, *S* refers to various dry bulk sub-sectors and *t* refers to years between 2013 and 2018. This study focuses on major loading countries forming a cumulative probability of 90%, such that among the reported countries the probability of loading in one of them can be expressed as:

$$DoL_t^S = \sum PL_t^{S,C} \times PB_t^{S,C}$$

Where, *DoL* represents the *degree of linerness* calculated at time *t* for the dry bulk sub-sector, *S*, and for all major countries forming cumulative probability of 90% of the loadings, *C*.

The *degree of trampness* (DoT) is defined as follows:

$$DoT_t^S = 1 - DoL_t^S$$

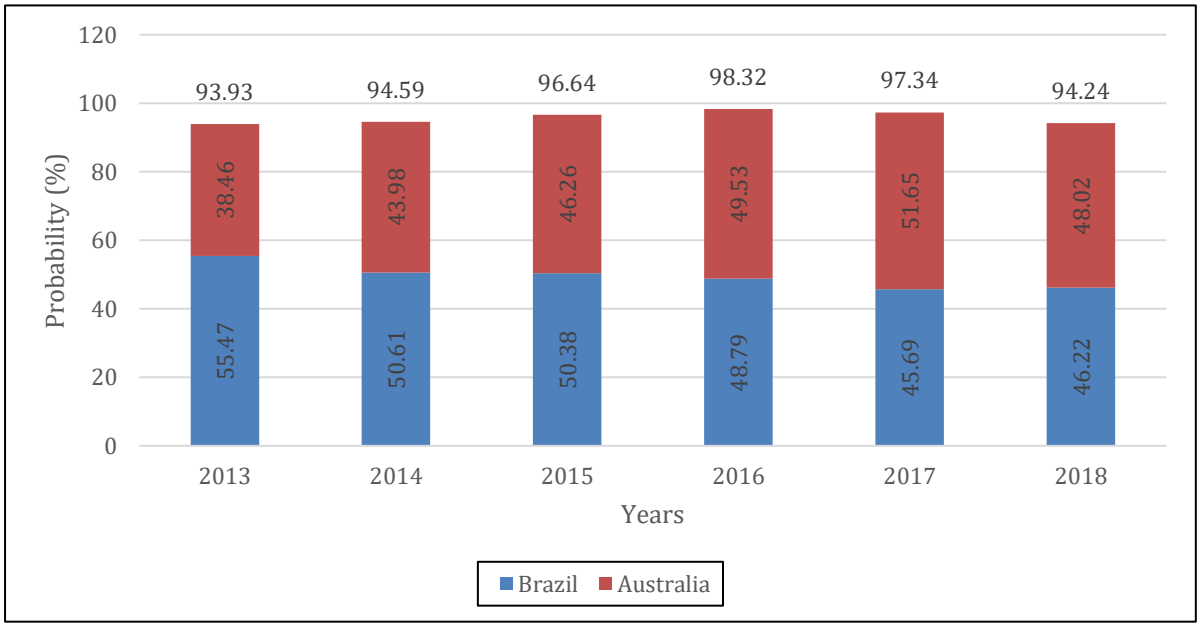
If the *degree of linerness* for a vessel type is high, then it has a high probability of trading between the specific countries and routes and the corresponding *degree of trampness* will be low.

FINDINGS

It was observed that the larger vessels call at the fewer countries, while the smaller vessels call at the larger number of countries. Figures 1 and 2 present the probability of loading countries for VLOC and Capesize bulk carriers, indicating that VLOCs mainly load cargo from two countries (Brazil and Australia), while Capesize load cargo from eight countries[1,2]. An interesting observation from Figure 1 is that there is an increasing trend for VLOCs to load from Australia over Brazil over the sampled years. In 2013, the probability of VLOC loading from Brazil (Australia) was approximately 55% (38%) that has decreased (increased) to 46% (48%). Hence, there is a changing services pattern in these two subsectors over time.

The results presented in Table 2 indicate that the *degree of linerness* depends on the size of the dry bulk vessels and decreases as the size of the vessel decreases. That is, VLOCs have the highest *degree of linerness*, and Mini-bulkers have the lowest *degree of linerness* (with the exception of Handymax DoL – potentially attributed due to the high volume of inter-China trade). Additionally, we also observe that the *degree of linerness* changes over time, indicating a dynamic trade pattern for the dry bulk shipping.

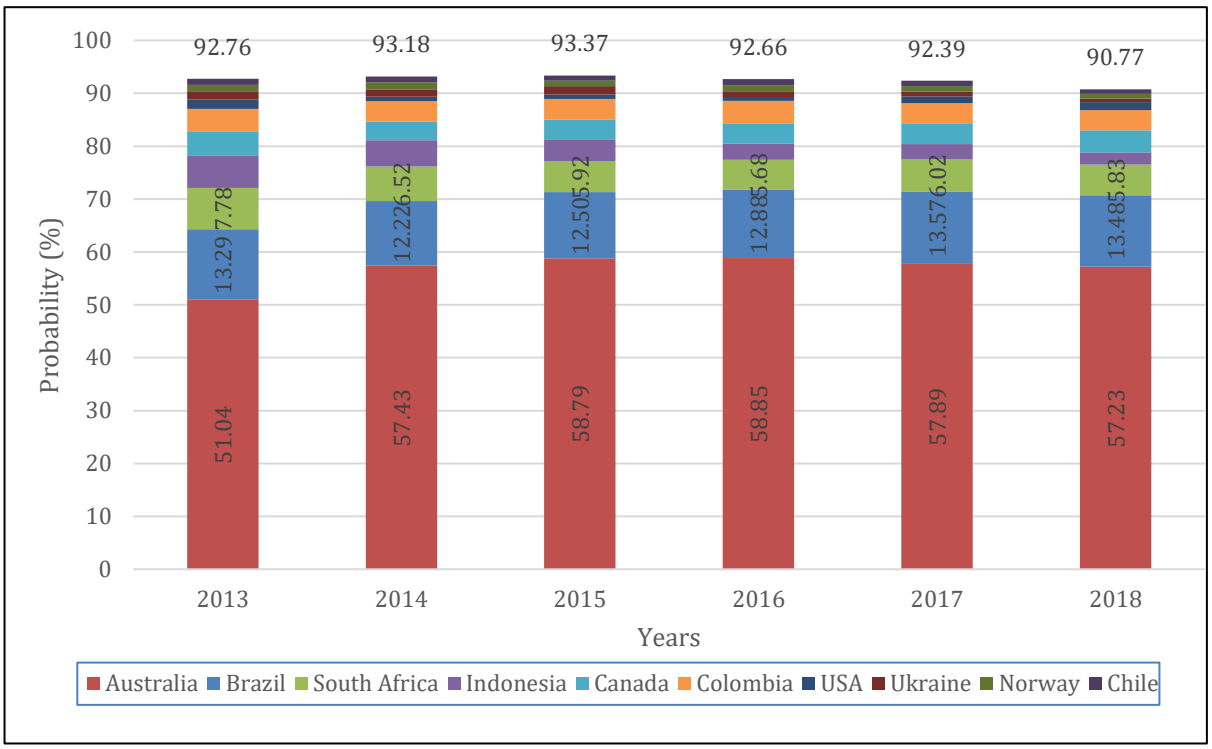
Figure 1. Probability of Loading countries for VLOCs



Note: Cumulative probability of 90% is reported.

[1] Major loading countries refers to countries whose cumulative probability of loading is 90%.
[2] Eight major loading countries for Capesize bulk carriers are Australia, Brazil, South Africa, Indonesia, Canada, Colombia, USA, Ukraine, Norway and Chile.

Figure 2. Probability of Loading countries for Capesize Bulk Carriers



Note: Cumulative probability of 90% is reported.

Table 2. The degree of Linerness for Dry Bulk Shipping

Vessel Sub-sections	2013		2014		2015		2016		2017		2018	
	DoL[3]	Calls[4]	DoL	Calls	DoL	Calls	DoL	Calls	DoL	Calls	DoL	Calls
VLOC	45.26%	2	44.94%	2	46.73%	2	48.34%	2	48.34%	2	44.35%	2
Capesize	29.49%	8	44.70%	8	37.05%	7	37.28%	7	36.02%	7	35.30%	8
Post-Panamax	12.91%	16	13.01%	14	13.79%	13	14.18%	13	13.97%	13	14.03%	14
Panamax	10.61%	16	10.15%	18	9.58%	18	8.95%	19	11.70%	19	10.59%	21
Supramax	8.59%	27	6.38%	32	6.58%	31	7.64%	28	8.21%	28	9.46%	28
Handymax	17.62%	29	22.92%	27	28.02%	24	29.89%	22	36.00%	21	37.07%	17
Handysize	7.78%	38	7.41%	38	8.37%	38	7.90%	38	8.44%	37	8.53%	38
Mini-bulk	3.92%	37	4.28%	34	4.38%	33	4.63%	33	4.52%	32	4.78%	31

Note: [3] DoL – denotes the *degree of linerness.*

[4] Calls – denotes the number of major countries calling which cumulates to 90% of the loading.

IMPLICATIONS

The study implies that the geographical concentration of loading and discharging sites (i.e. markets) changes over the years. For example, Australia is exporting more commodities (mostly iron ore) to China than any other countries, subsequently leading larger vessels to call at Australian ports. The findings also highlight such a change happened even in a short time

span; Capesize bulk carriers have reduced their routes from the Philippines and Sierra Leone, whereas Malaysia and Guinea are attractive destinations for Capesize to load commodities. The framework suggested in this study could be extended to liquid bulk shipping markets to examine trading patterns of tankers. Most importantly, this study raises a challenging issue that whether the conventional and traditional definition on liner and tramp shipping services is still valid. It would be still too early to claim that the definition is to be revised or newly made since the present study is in its preliminary stage. Further examinations across the whole shipping subsectors could guide us to consider its potentials.

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Keywords: *Dry bulk shipping, International trade-flow, Degree of linerness, AIS Data*