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Science, Technology and Innovation Policy in Russia and China

– Mapping and comparisons in objectives, instruments and implementation

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Abstract: Science, Technology and Innovation (STI) policy of Russia and China is studied in this paper from a policy foresight perspective and with regard to policy instruments, policy objectives, and policy implementation. A structural analytical framework is developed in this study specifically for STI policy analysis in these dimensions. Analyzing a database of 418 STI policies issued in the two countries, 25 policy variables have been scrutinized for the two countries vis-à-vis the three policy dimensions. The paper then maps and compares the two countries in STI policy instruments, objectives and implementation, adopting a positivist epistemology stance. Estimating a binary logistic model, Russia has been differentiated from China in their choice of policy instruments, their devotion to policy objectives and their approaches to policy implementation, revealing the differences and similarities between the two countries in the three STI policy dimensions. Deriving observable and corroborated evidence for STI policy perspectives in Russia and China, the results and findings help gain legitimate knowledge in this field.

Key words: STI, S&T, R&D, innovation

1. Introduction

Countries or economies are considered emerging because of their developments and reforms that are radical or, more precisely in practice, fanatical. Emerging economies are characterized as transitional by the west, meaning that they are in the process of moving from an economy closed to the west, to a market economy open to the west. They were keen on transforming their systems to match western advanced systems initially. They demand their rules be adopted equally whilst confidence growing gradually. Owing to globalization, the division between developed and developing has become outdated. Turning up have been emerging economies, merging with the developed world, evidenced by the protocol of the Group of Twenty (G20). 'The G20 had become a more relevant economic grouping for the task to broaden the dialogue on key economic and financial policy issues among systemically significant economies', declared the G-20 Meeting of Finance Ministers and Central Bank Governors (1999). Emerging economies have been playing an increasingly significant role in the world economic system since the beginning of the new millennium. The two most powerful examples are Russia, with its sophisticated military technologies second only to the US, and China, one of the world's economic powerhouses alongside the US.

We study science, technology and innovation (STI) policy of Russia and China in this study, given their status of the largest emerging economic powerhouses and STI engines. Science and technology (S&T) in this study overlap with innovation and research and development (R&D), to be elucidated in the next section. One of the major driving forces for economic development is R&D, while STI policy fosters R&D. Our study is also motivated by the imparity between the significance of Russia and China's innovation capacities and the lack of research on their innovation and policy. Russia carries significant weight on the world stage politically, militarily and technologically. Whereas China possesses the economic might as the second largest economy in the world and the largest emerging economy, exerting great influence on international trade including technology diffusion through its supply of, and demand for, innovation.

Typified by emerging economies, Russia and China made every effort to transit to an economy modeled on the west at the early stage of transformation. They endured a planning economic system for the large portion of their post revolution period, in stark contrast to the US, Western Europe and Japan. They have transformed into market-oriented economies to a certain extent. As such, 'state interference was pervasive (in Russia)' (Radosevic, 2003, p1106), and 'few other countries (other than China) have intervened so systematically and invasively in their innovation system' (Liu *et al.*, 2011, p918). 'Russia has inherited a large set of strengths and weaknesses of the Soviet S&T system… many of these strengths continue to guide the S&T system in Russia today', which 'demonstrate particular path-dependencies from the times of the Soviet Union' (Klochikhin, 2012, p1624). Huang *et al.* (2004) utilize policy practices in the OECD countries as a guideline to examine China's innovation policy in five categories, whereas national characteristics in the innovation system have been broadly examined for 40 countries by Liu *et al.* (2015) among others. The present paper is a focused study of national characteristics in the innovation system between two most innovative emerging economies. Being the largest, most powerful emerging economy and R&D engine, Russia and China have been proactively integrating the rest of the world at this stage of development. It is timely to study innovation policy of Russia and China while their innovation activity is making impact beyond the national borders.

Specifically in STI, Russia and China were two of the largest economies included in the Bloomberg top 30 most innovative countries in 2015. Russia was ranked 12 and China 22 overall, up from 18 and 25 in 2014 respectively (Bloomberg, 2014, 2015). Among seven contributing factors[1] to global innovators, Russian and China were respectively ranked top ten in three factors, and China was ranked number one in Manufacturing Capability. Coupled with their size, the impact and influence of Russia and China on the world economy and global innovative capacity are considerable and worthwhile examining. While the Soviet Union and Russia have traditionally

[1] They are R&D Intensity, Manufacturing Capability, Productivity, High-Tech Density, Tertiary Efficiency, Research Concentration, and Patent Activity.

been rather sophisticated in technology, time has progressed to answer the question raised by Sigurdson 10 years ago: 'when and how will China become a technological superpower?' (Sigurdson, 2004, p345). Thus a comprehensive and comparative study on their innovation policy is of theoretical importance to research on innovation policy universally. Research on direct contrast between Russia and China is rare nonetheless.

A structural 3×3^2 analytical framework is derived and formulated in this study specifically for STI policy analysis. STI policy of Russia and China is then analyzed from a policy foresight perspective in the 3×3^2 analytical framework for policy instruments, policy goals and policy implementation. Policy instruments, policy goals/objectives and policy implementation, which are usually non-coexistent in individual pieces of theoretical and empirical research, form an outer layer of three policy dimensions. Policy instruments are also considered three dimensional, so are policy goals/objectives, which constitute the next 3^2 constructs in the inner layer. This 3×3^2 framework is beneficial to conducting a structured study on the one hand, and helpful in conciliating the seemingly disagreeing views in the empirical literature on the other hand.

The rest of the paper proceeds as follows. The next section provides a literature review in STI policy studies centered on developing the theoretical framework in which the present study is carried out. STI policy and S&T foresight and planning in Russia and China are introduced and reflected upon next in section 3. It is followed by research design in section 4, introducing our samples and variables, together with their sources, features and coding. The paper then proceeds to implement the empirical work in conformity to the theoretical framework in section 5, analyzing and contrasting the results between the two countries. Section 6 further deliberates on the results and findings, together with their implications. The last section summarizes this study.

2. The literature and theoretical framework for STI policy studies – the 3×3^2 framework

It has been long recognized that technological advance and technical application of science is pivotal to economic growth. The role of innovative application of technology in human society

and its evolution have been debated and envisaged, tracing back to the works by Marx and Schumpeter in their analysis of economic growth and business cycles. 'Science and technology give capital a power of expansion independent of the given magnitude of the capital actually functioning', Marx maintained (Marx, 1867, p418). Schumpeter (1942) conceived creative destruction from exploring Marx's analysis of bourgeois society, its relations of production and means of production and of exchange. The concept of creative destruction was subsequently developed into innovation economics, where evolving institutions, entrepreneurs, and technological change were at the heart of economic growth as well as output fluctuations. The process of creative destruction 'incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one' (Schumpeter, 1942, p83). The above views on STI are revolutionary, which is and points to the origin of STI. From the perspective of business operations, spreading STI is vital to staying profitable and sustainable.

Synthesizing the different sets of literature in policy objectives, policy instruments and policy implementation, a structural 3×3^2 analytical framework is derived and formulated in this study specifically for STI policy analysis. Policy instruments, policy goals/objectives and policy implementation, which are usually non-coexistent in individual pieces of theoretical and empirical research, form an outer layer of three policy dimensions, i.e., the first 3, in our study. Thereafter, policy instruments are considered three dimensional, so are policy goals/objectives, which constitute the next 3^2 constructs in the inner layer. These three dimensions in policy instruments, policy goals and policy implementation constitute the ontology that dominates this study. Specifically, we have synthesized and categorized various numbers of policy goals, which are also interchangeably used with policy objectives in the literature, into three sub-sets of innovation generation, innovation diffusion and innovation adoption. Meanwhile, we consider it necessary to take in the type of environmental side policies to moderate the unilateral emphasis on either demand side or supply side policies. These form the foundations for a 3×3^2 analytical framework. This 3×3^2 framework is beneficial to conducting a structured study on the one hand, and helpful

in conciliating the seemingly disagreeing views in the empirical literature. Adopting a positivist epistemology stance, the empirical investigation is then carried out with mapping in objectives, instruments and implementation. It helps gain legitimate knowledge in this field while deriving observable and corroborated evidence for STI policy perspectives in Russia and China.

{Figure 1 about here}

Figure 1 illustrates the 3×3^2 analytical framework. Policy implementation, policy instruments and policy goals/objectives make an overall framework in three policy dimensions. Policy makers issue policies by means of policy instruments that are implemented to achieve policy objectives. Implementation also involves enforcement in achieving policy objectives. The arrows indicate the processes and relationships. Then to the left, policy instruments are expressed in three dimensions of demand side, supply side and environmental side policies in three sub-sets of policy instruments. To the right, policy goals are shown in three dimensions of innovation generation, innovation diffusion and innovation adoption in three sub-sets of policy objectives. In the following, three dimensions in policy instruments, policy goals and policy implementation that constitute the ontology in this study are briefly deliberated.

Policy goals/ objectives

Policy objectives are specific and measurable while policy goals are broad and general. To organize innovation policies into typologies, Edler *et al.* (2013) have identified seven major innovation policy goals through synthesizing the key findings and insights in the reports and documents they reviewed. Whereas there are five stated policy goals in Flanagan *et al.* (2011). There is a vast set of literature on diffusion of technology, innovation and/or R&D. In this regard, Suriñach *et al.* (2009) provide a comprehensive review of the diffusion/adoption literature, as well as empirical evidence. They reveal that: 'Generation of innovation would be mainly driven by some sectors and then

adopted in other sectors' (ibid, p44). Pierce and Delbecq (1977) define 'innovation is a process including three stages: generation, acceptance, and implementation' (p29). Synthesizing the above analysis, generation of innovation, diffusion of innovation, and adoption of innovation are adopted as the three broad innovation policy goals in this study, into which specific policy objectives are categorized.

Policy instruments

Policy instruments are the carrier of policy. 'The choice of policy instruments constitutes a part of the formulation of the policy, and the instruments themselves form part of the actual implementation of the policy' (Borrás and Edquist, 2013, p1513). Bemelmans-Videc *et al.* (1998) present examples of studies of the three categories of policy instruments: regulation (sticks), economic means or subsidies (carrots), and information campaigns (sermons) (ibid, pp10-12). Rothwell and Zegveld (1981) classify policy instruments into three types, namely, supply side, environmental side, and demand side instruments. These have been classic in the literature of typologies of policy instruments, in contrast to the bipolar approach to categorizing policy instruments into two seemingly opposite types, with the emphasis on the demand side or the supply side changing over time. 'Environment side policy fortifies the national innovation system' (Shyu and Chiu, 2002, p372). The introduction of an environmental dimension clears the ambiguity between and on the boundary of demand and supply sides stemming from the bipolar approach. However, the emphasis on the demand side policies is on the rise in recent years. Demand side innovation policy tools and measures complement supply side innovation policy tools; therefore, effective links between them should be established, maintained and developed. Taking these factors into consideration, we adopt demand side, supply side, and environmental side policy instruments as the three major policy instrument categories in this paper.

Policy implementation

It is revealed that, given the complexity in policy implementation and the need for reducing ambiguity and conflict in policy implementation, the institutional and policy characteristics have been considered to be paramount in theory and practice, with which we examine policy implementation in this study. Policy implementation 'is what develops between the establishment of an apparent intention on the part of government to do something, or to stop doing something, and the ultimate impact in the world of action' (O'Toole, 2000, p264). 'Policy implementation as a field of scholarly inquiry and practical recognition has come and gone like an elusive sprit' (deLeon and deLeon, 2002, p467), because 'it was either too difficult to study or, conversely, too simple (ibid, p469). Thus, the implementation issue or dimension is either circumvented – being too difficult, or ignored – being too simple, in much of actual policy research. Reviewing the OECD science policy-making model, Henriques and Larédoc (2013) stress that the OECD model 'is centred on the creation of structures, actors and functions that enable the policy cycle to deploy in the field' (p804). Thus, the institutional and policy characteristics have been considered to be paramount. At national level, these are translated into the authorities of policy issuers and the degrees of enforcement, with which we examine policy implementation in this study.

3. STI policy and S&T foresight and planning in Russia and China

We study STI policy of Russia and China in this paper from S&T foresight perspectives and with regard to policy instruments, policy objectives, and policy implementation. Technology foresight has long been taken on ardently in Russia and China for developing STI policy tools and implementing STI policy instruments. This is due partly to their heritage in comprehensive planning systems for economic development and industrial upgrading. 'Researchers have determined several avenues for the most considerable Foresight impact, including a knowledge society; the emergence of science, technology and innovation (STI) system; business and policy decision-making processes; and public understanding of science and technology' (Sokolova, 2015,

p216). In one of the Foresight projects conducted by Sokolova, 'The position of the client (Ministry of Education and Science of the Russian Federation) was characterized as strong in the national innovative system because this ministry has a direct influence on the formation of science, technology and innovation policy in Russia' (ibid, 222). Reviewing a list of the most remarkable Foresight evaluation projects, Sokolova (2015) indicates that '[all] these studies evaluated belong to Foresight at the national level … focus on outputs and stronger links to science, technology and innovation (STI) policy' (p217). In Russia, '[a] number of policy instruments have been introduced to increase the efficiency of STI policies. One of them is S&T Foresight' (Sokolov and Chulok, 2016, p17). Whereas in China, 'technology foresight is not only an essential instrument, but is also widely applied in China to develop planning and policies regarding science, technology, and innovation activities' (Li *et al.* 2017, p246). In a recent study, Wang and Li (2019) demonstrate that 'China's innovation policy is the instruments to implement the national medium to long-term planning for S&T, projecting the long-range prospects of S&T development, and setting guiding principles, development goals and overall deployments' (ibid, p308).

'The first attempts of systematic Foresight of long-term S&T development go back to the 1950s (Sokolov and Chulok, 2016, p17). 'First STI Foresight studies at the national level refer to 1970s when Japan started its Delphi surveys which then were repeated every 5 years' (ibid, p18). '"Technology Foresight" took off in the 1990s, as European, and then other, countries sought new policy tools to deal with problems in their science, technology and innovation systems' (Miles, 2010, p1448). Foresight activities were defined in 1984 in SPRU[2] as 'the techniques, mechanisms and procedures for attempting to identify areas of basic research beginning to exhibit strategic potential' (Martin, 2010, p1440). This definition 'was to evolve over time', and by the 1990s, to 'the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and

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the emerging generic technologies likely to yield the greatest economic and social benefits' (ibid, p1440). ""Technology foresight" is a term now widely used by academic researchers, policy-makers, industrialists, consultants and others round the world' (ibid, p1438).

Gokhberg and Sokolov (2017) have reviewed the evolution of forward-looking activities and technology foresight in Russia vis-à-vis science, technology and innovation policy challenges and its development over the last century. They have evaluated long-term planning under the Soviet system first, and then the evolution from long-term planning to technology foresight in post-Soviet Russia. The latter has begun with transition to a market economy in the 1990s, and then towards innovation development since the 2000s. Specifically, Sokolov and Chulok (2016) focus on the latest exercise – Russian S&T Foresight 2030. According to them, the first large-scale study at the national level was the S&T Foresight 2025 initiated in 2007 by the Russian Ministry of Education and Science. Higher School of Economics (HSE 2013) indicate that 'Russian S&T Foresight is aimed at identifying the most promising areas of science and technology development in Russia towards 2030 to ensure the realisation of the nation's competitive advantages' (p2). More than 2,000 experts in 15 countries were surveyed in formulating S&T Foresight 2030. 'The process resulted with a set of global challenges, windows of opportunities and threats for Russia, with breakthrough future technology along with a list of priority S&T areas' (ibid, p2). 'Particular S&T goals and priorities have been set in a number of high-level strategic documents including the S&T Policy Framework, the Concept of Socio-Economic Development until 2020, and S&T Foresight 2030' (Gershman *et al.*, 2018, p136). S&T Foresight 2030 includes three large sections, covering macroeconomic issues and development prospects while putting emphasis on S&T. The framework of the Russian S&T Foresight is similar to the Planning Framework for National Medium to Long-Term S&T Development of China to be introduced next.

Likewise, Wang and Li (2019) provide an overview of economic and social planning in the People's Republic of China (PRC) – the consecutive Five-Year Plans with the first being launched in 1953. Soon after, 'there has been S&T planning since as early as 1955, because the attainment

of economic goals is considered to be dependent on the development in S&T' (ibid, p308). The PRC State Council set up a Science Planning Commission and assembled over six hundred scientists in 1955 to compile the first such planning, Planning Framework for Long-Range Prospects in S&T Development (1956-1967), or The Twelve-Year S&T Planning (Science Planning Commission, 1956). The latest was Planning Framework for National Medium to Long-Term S&T Development (2006-2020) (State Council, 2006a). On September 30, 2019, Ministry of Science and Technology of the PRC (MOST) released a proclamation requesting for tender for conducting research on major areas and tasks for the next 2021-2035 Planning Framework for National Medium to Long-Term S&T Development (MOST, 2019a). Eligible tenders included higher education institutions, research institutes, corporations, professional associations, and international organizations. 'Recommended research tasks would be focused on key, hot and challenging themes and issues. It is required to put forward profound ideas and outstanding measures that meet the requirements for achieving the long-term goals, and that can be advanced and implemented in the next 15 years (ibid, p1). 20 tender institutions were chosen out of 189 tender applications to undertake tasks in 15 research areas (MOST, 2019b).

As S&T Planning Framework (2021-2035) has yet to be drafted and worked out, we contemplate S&T Planning Framework (2006–2020) in this paper that remains the latest. New to S&T Planning Framework (2006–2020) was the second part of Section VIII 'Reform of the S&T Governance and the Assembly of National Innovation System', indicating a policy shift that put an emphasis on innovation. Fundamental policy guidelines and measures and their implementation were addressed and stipulated in a separate document Supporting Policies for Implementing 'Planning Framework for National Medium to Long-Term S&T Development (2006-2020)' (State Council, 2006b). These Supporting Policies covered a range of areas, including S&T input, tax incentives, financial support, public procurement, technical absorption, intellectual property, human resources, S&T bases and platforms, coordination between government departments in supporting innovation activities. '[T]echnology foresight achievements can make national S&T

planning more precise and accurate, which is beneficial for decision-makers to understand future trends in S&T and optional policy responses' (Li *et al.*, 2017, p253).

China and Russia share fundamental similarities in the policy making process, inherited from the Soviet Union and featured by centralized top down approaches to governing the country, policy making being one of the centerpieces (Gaenslen, 1986). There are differences though. China has experienced more than two thousand years' Mandarin bureaucratic governance, having formed a comprehensive system of administration and regulation to the detail (Wang, 2017). There are considerably more policies in China than in other countries, issued and amended at high frequencies. Consequent to this, chop and change, which literally means a policy made in the morning can be changed in the evening, is a mocked phenomenon in China in thousand years. Government policy looks like the moon, which is different on the first day (new moon) and the fifteenth day (full moon) in a lunar month, is another description. The nominal legislative process and the procedures for the configuration of executive or administrative regulations and decrees are similar to a large extent in the two countries (*cf.* State Duma, 2018; National People's Congress, 2013; State Council, 2017a,b; Russian Government, 2019). Albeit, the two countries differ considerably in the adoption of legislative measures and executive/administrative regulatory measures in governing the country. China resorts to executive/administrative regulations, decrees and provisions by far than Russia. This way, China looks and is more flexible on the one hand, partly explaining the chop and change phenomenon of policy in China. On the other hand, the less binding attribute leads to the loose implementation and enforcement of policy.

In general, the process involves policy initiation, scrutiny and analysis, drafting, commenting/feedback, further discussion, finalizing, several rounds of reading/deliberation, approval and implementation. The law, approved by the legislature, is signed by the President, published and enters into force within a given period. That given period is 10 days after the official publication in Russia and is designated explicitly in China. There is variation in the process. Russia adopts three rounds of reading for approval of law; whereas China assumes a three deliberations

procedure before the draft law is submitted for vote. The three deliberations procedure is proclaimed to promote democracy fully, which is also reflected in the drafting stage, seeking opinion/comments widely, forums, hearings, repeated discussions and revisions are the frequently used phrases. The President of the two countries is different too – it is a powerful executive head of state in Russia but a nominal head of state in China, though the Presidency of China is usually assumed by the general secretary of the Central Committee of Communist Party of China where the political power resides.

The President of Russia issues presidential decrees or executive orders that are legal acts and have the status of by-laws in the hierarchy of legal acts, along with decrees of the Government of the Russian Federation and instructions and directions of other officials. The President of China signs law for the People's Congress of China and its Standing Committee, not on his own. The procedures for the configuration of executive or administrative regulations are less stringent and without rounds of reading. It is stated that the issue of resolutions and executive orders is one of the main areas of the work of the Government of the Russian Federation. Formulation and implementation of policy is one of the main responsibilities of government departments in both countries. There is the explicit hierarchy of regulations, provisions and measures in China; those made by government departments cannot be called regulations but provisions or measures, similar to instructions and directions in Russia (*cf.* State Council, 2017a,b; Russian Government, 2019). Moreover, China employs joint issues to an excessive degree relative to Russia, as many as 12 on occasions, which entails longer inter-departmental consultations in the policy making process.

4. Research design, samples and variables

Our sample covers the period between 1990 and 2013. There are 339 policy items for China, issued by the People's Congress of China and its Standing Committee, the legislature; the State Council, the executive; the Ministry of Science and Technology, the Ministry of Commerce, the Ministry of Finance, the Ministry of Education and other ministries that form the State Council; and non-

cabinet departments and agencies. There are 79 policy items for Russia, issued by the Federal Assembly of the Russian Federation (Federation Council and State Duma), the legislature; the Russian Government, the executive; the Ministry of Education and Science, the Ministry of Energy, the Ministry of Economic Development, the Ministry of Finance, the Ministry of Industry and Trade and other cabinet and non-cabinet departments and agencies. Efforts have been made to include all pertinent innovation policies. The primary sources of policies are the websites of the PRC Ministry of Science and Technology and the Ministry of Education of the Russian Federation, which gather innovation policies issued by the legislature, the executive, the ministry itself, and other government departments and agencies. The websites of the legislature and the executive have also been explored, where innovation policy is one of many kinds of policies, as well as other government departments and agencies. These have been supplemented by and checked against various published collections of innovation policies.

Innovation policies that are formulated to encourage and nurture innovation activities and processes are deployed in a 3×3^2 framework in this study. It is a structural analytical framework specifically developed in this study for STI policy analysis, consisting of an outer layer of 3 dimensions and the encompassed 3^2 constructs in the inner layer. This analytical framework demonstrates cogently a purposeful policy process that policy makers issue policies by means of policy instruments that are implemented to achieve policy objectives. The policy variables describe policies in three dimensions of policy instruments, policy goals/objectives and policy implementation. Table 1 lists these policy variables with their narratives. The demand side policy instruments include three elements: public procurement, industry-HE institution-R&D institution collaboration, and international collaboration. There are four items included in the supply side: support for small and medium enterprises (SMEs) and micro and small enterprises (MSEs), fiscal support and subsidies, financial support, and human resources. The environmental side instruments consist of six items: administrative support, infrastructure support, information support, enhancement in intellectual property protection, tax incentives, and standards setting.

With regard to policy goals, there is one policy objective of S&T development for the innovation generation goal. There are two policy objectives of technological transformation and technical exports for the diffusion goal. The adoption goal includes two objectives: technical absorption and technical imports. On the policy implementation dimension, institutional characteristics are featured by legislature, executive, ministry and bureau or agency. The legislature is the National People's Congress of China and its Standing Committee, and Federal Assembly of the Russian Federation (Federation Council and State Duma); the executive is the State Council of China and the Russian Government; ministries are departments that form the executive; bureaus or agencies are non-cabinet government departments. Policy characteristics are reflected by the degrees of enforcement in two variables: whether it is a law and whether it is jointly issued by more than one entity.

{Table 1 about here}

The coding of the policies and their representative variables is as follows. Dummy variables are adopted for all policy instruments and policy objectives. For example, the public procurement variable is 1 when a policy instrument is concerned with public procurement, 0 otherwise; the technological transformation variable is 1 when a policy instrument addresses technological transformation, 0 otherwise. For institutions, legislature, executive, ministry and bureau are coded as dummy variables; the legislature variable is 1 when the policy is issued by the legislature, 0 otherwise; the same coding is adopted for the executive, ministry and bureau variables. For policy characteristics, the value of the variable of joint issues is 1 when the policy is jointly issued by more than one entity, 0 when it is issued by one entity; the law variable takes the value of 1 when a policy is issued by the legislature and passed as law, 0 otherwise.

Policy instruments are not mutually exclusive; e.g., a policy item for financial support can, at the same time, be on infrastructure support within the supply side. A policy item can also contain

two or more instruments on different sides; e.g., a policy item for infrastructure on the supply side can also involve administrative support on the environmental side. The sum of such percentages, where the denominator is the number of total policies, can therefore be over 100 percent and each percentage figure can be overstated. Therefore, adjusted percentages are provided where the denominator is the number of total instruments, producing the sum of adjusted percentages that is 100 percent. Similarly, a policy item can be issued to achieve more than one objective; it can also be issued by more than one entity. Accordingly, adjusted percentages that sum to 100 percent are likewise provided for policy objectives and policy implementation. Since every policy item has three dimensions, it must take the value of 1 in at least three dummy variables, e.g., it is a supply side instrument of financial support, its policy objective is technical transformation and it is issued by the executive. In addition, a policy item is reflected by a non-dummy, the number of entities involved in the issue of the policy.

5. Mapping and comparing countries in instruments, objectives and implementation

This section maps and compares the two countries in STI policy instruments, goals/objectives and implementation. It attempts to differentiate Russia from China in their choice of policy instruments, their devotion to policy objectives and their approaches to policy implementation. To this end, state (Russia and China) is the dependent variable, and policy variables of policy instruments, objectives and implementation are the independent variables or determinants. A statistical summary of policy variables is presented in the next sub-section, prior to formal estimation and analysis that follows.

5.1. Overview

Table 2 reports the summary statistics of the variables for both China and Russia. The first column under each country is the number of policies in each category, the second column is the percentage

of the policy instrument, the policy objective or the type of issuer in that category, except average number of joint issuers, and the third column is the adjusted percentage.

In terms of distributions of policy instruments, both Russia and China valued the importance of environmental side instruments and supply side instruments were used predominantly relative to demand side instruments. Transitioned from planning economies, fiscal support and subsidies were heavily exercised in both countries. Being the first planning economy who endured the longest period of the planning system in the world, Russia resorted to fiscal support and subsidies more than China; over 30 percent policy instruments were for fiscal support and subsidies in Russia, while the figure for China was 18 percent. The human resources instrument accounted for approximately 13 percent of policy instruments in both countries. For environmental building, Russia paid attention to infrastructure and administrative support while China resorted to administrative and tax incentives measures. These features also reflected their respective historical heritages as the paramount investment driven planning economy and the oldest bureaucrat in the world.

China and Russia differed in policy implementation. On the institution side, the degree of authority in Russia was higher than China. Policies were issued predominantly by ministries and bureaus in China, the former accounting for nearly 70 percent of total policies. The share of ministries in policy issuance was the largest, accounting for nearly 58 percent, followed by a share of over 32 percent for bureaus. The legislature's share in policy issuance was less than 2 percent and that of the cabinet accounted for around 8 percent. In contrast in Russia, the legislature, executive and cabinet ministries issued comparable numbers of policies and their shares in policy issuance were also comparable. The legislature had a quarter of share in policy issuance, while the executive and ministries took approximately a one third share each. Unlike China, non-cabinet bureaus or agencies played little role in policy issuance. On the policy characteristics side, the degree of enforcement in Russia was higher than that in China, i.e., considerably more policies were laws in Russia than in China. In contrast, China resorted to joint issues to strengthen policy

enforcement. There were 109 policies that were jointly issued by two or more entities in China, accounting for nearly one third of total policies issued; while six policies were jointly issued in Russia, accounting for less than 8 percent of total policies. The average number of government entities involved in joint issues of policies was 1.61 in China; whereas the average number of government entities involved in joint issues of policies was as low as 1.13 in Russia.

{Table 2 about here}

Both China and Russia paid great attention to S&T development for the fulfilment of the goal of innovation generation, accounting for half of all policy objectives. This corresponds to the Russian S&T Foresight literature that 'Russian S&T Foresight is aimed at identifying the most promising areas of science and technology development in Russia towards 2030 to ensure the realisation of the nation's competitive advantages' (HSE 2013, p2). Whereas in China, recommended research tasks would be focused on key, hot and challenging themes and issues (MOST, 2019a, p1). Transitioned from the planning economy and system, fundamental research traditionally enjoyed higher priorities, being dominated by the state sector. In contrast, technical diffusion and adoption of innovation were regarded less important, at least from the point of view of policy formation. These objectives were largely left for enterprises and R&D establishments to achieve for themselves. Nonetheless, both countries were keen on the commercialization of military technologies - transforming military technologies for commercial utilization to generate earnings. As such, technical transformation accounted for around 27 percent among all policy objectives in the two countries.

{Figure 2 about here}

{Table 3 about here}

Preliminary summary statistics are compared and contrasted in Figure 2 and Table 3. Figure 2 illustrates and contrasts graphically the adjusted percentages of the policy instrument, the policy objective and the type of issuer in that category. The top pane is for policy objectives, the middle pane for policy instruments and the bottom pane for policy implementation. Paired *t* tests are performed to examine these differences, with the test results being reported in Table 3. Visually observed from Figure 2 and regarding policy instruments, there was little difference between China and Russia in support for SMEs and MSEs, human resource support, intellectual property protection and international collaboration. Fiscal support and subsidies remained the most employed instruments in both countries, where Russia outpaced China significantly, demonstrating the overwhelming dominance of fiscal support and subsidies in Russia. In contrast, China utilized financial support and tax incentives noticeably more than Russia. Considerable difference was also evident in infrastructure support, administrative support, collaboration between R&D institutes, HE institutions and industry and information support. While Russia devoted more to infrastructure support, China tended to resort to administrative support, fostered industry-HE-R&D collaboration and valued information support. Although on tiny scales, China paid more attention to standards setting and public procurement in facilitating innovation.

Both countries prioritized 'higher end' innovation objectives for innovation generation and technical transformation, typified by the planning economy on transition to the market economy, with which Russia was slightly higher on the topmost, given its longer history in the planning system. China was keener on learning from the west, which was reflected in the difference between the two countries in technical import. There did not seem to be noticeable difference in technical absorption and technical export between the two countries. Clearly, there were striking differences between the two countries in approaches to policy implementation. Most innovation policies were issued by higher level authorities in Russia and in contrast, lower level authorities got involved more in issuing innovation policies.

These visual differences and similarities are validated by the test for difference statistics in Table 3, where the mean statistic is formulated as China's figure minus Russia's figure. Confirming that Russia outpaced China significantly in fiscal support and subsidies, the statistic is highly significantly negative at the 1% level. Similar highly significant difference was found in infrastructure support. On the other hand, China employed significantly higher portions of instruments for financial support, administrative support, information support, industry-HE-R&D collaboration, and tax incentives. The statistics confirm that the two countries had virtually no difference in achieving the policy objective of S&T development, and China was slightly more active in promoting technical transformation. Apparently, China was keener on technical import. The differences in policy implementation cannot be more striking. The statistic is highly significant at the 1% level for all. It is highly significantly negative for the first two types of authorities and highly significantly positive for the rest, confirming the above conclusion that the degree of policy enforcement was considerably higher in Russia than in China.

5.2. Estimation, results, analysis and discussion

Having gained general intelligence in innovation landscapes in Russia and China and presented the summary descriptive statistics in the three policy dimensions for the two countries, we implement the model and execute its estimation in this part. Binary logistic regression is adopted for empirical estimation in this study, given the property of the data. The logit model is based on the odds of an event taking place. The logit of a number P between 0 and 1 is defined as $logit\ (P) = Ln[P/(1-P)]$. If $P = P(Y = 1|\mathbf{X\beta})$ is the probability of an event taking place, then $P/(1-P)$is the corresponding odds and $Ln[P/(1-P)]$ is the corresponding log odds. The logit model states that the log odds of an event taking place are a linear function of a given set of explanatory variables, i.e.: $Ln[P/(1-P)] = \mathbf{X\beta}$. The regression based on this logit model is

logistic regression. The probability $P = P(Y = 1|\mathbf{X\beta})$ can be solved as $P(Y = 1|\mathbf{X\beta}) = \frac{exp(\mathbf{X\beta})}{1+exp(\mathbf{X\beta})}$.

Estimation and analysis are conducted in three parts or dimensions of policy objectives, policy instruments and policy implementation. Table 4, Table 5 and Table 6 report the estimation results for the three dimensions respectively. China is coded 1 and Russia 0. Therefore, a significantly positive coefficient estimate indicates that China was in favor of the instrument, objective, institution or characteristic associated with the coefficient. With a logarithmic operation involved, the exponential of the coefficient that is always positive is also reported, which has more straightforward quantitative meanings. This is in the last column headed by Exp(Coef) in Table 4, Table 5 and Table 6. e.g., a figure of 2 for an exponential coefficient indicates that China is twice likely to issue that type of policy instrument than Russia, or set a particular policy objective, and so on; while an exponential coefficient of 0.5 indicates that Russia is twice likely to be the case than China.

Goals/objectives

Table 4 shows the differences and similarities between the two countries in policy goals/objectives. Relatively less developed, China was 3 times more likely to implement policies aiming at technical import (3.206) than Russia, with the coefficient being positively significant at the 5 percent level. China was more commercialized and keener on the commercialization of military technologies than Russia – transforming military technologies for commercial utilization to generate earnings. As such, China was nearly 2 times more likely to implement policies for promoting technical transformation (1.766) than Russia, with a positive coefficient modestly significant at the 10 percent level. In contrast, Russia was twice more likely to issue policies to promote and encourage the absorption of new techniques (2.023 = 1/0.492) than China. Russia and China did not differ significantly in policy objectives for S&T development and technical export. This has reflected

their strategy to deal with global challenges with breakthrough future technology along with a list of priority S&T areas' (HSE, 2013, p2). The framework of the Russian S&T Foresight the Planning Framework for National Medium to Long-Term S&T Development of China are similar in strategy and priorities (Gershman *et al.*, 2018; MOST, 2019a). So they take similar postures in grand goals while differ in less prioritized fields.

{Table 4 about here}

Instruments

China and Russia differed significantly in the issuances of policy instruments of infrastructure support, tax incentives, administrative support, and industry-HE institution-R&D institution collaboration, revealed by the results in Table 5. Russia was 5 times (5.319 = 1/0.188) more likely to adopt a policy instrument for infrastructure support, with the corresponding coefficient being highly negatively significant at the 1 percent level. On the other hand, China was over twice more likely than Russia to adopt policy instruments for administrative support (2.409) and financial support (2.436); and 3 times more likely to adopt policy instruments for industry-HE institution-R&D institution collaboration (3.049) and tax incentives (2.979), all at the 5 percent level of significance. There are no significant differences in the adoption of the rest of policy instruments. That being said, Russia was more inclined to implement policy instruments for fiscal support and supporting medium, small and micro firms; whereas China showed more interest in international collaboration and public procurement. The contrast between them has reflected that 'The choice of policy instruments constitutes a part of the formulation of the policy, and the instruments themselves form part of the actual implementation of the policy' (Borrás and Edquist, 2013, p1513), as the two countries, though similar, are not all the same in policy formulation and differ noticeably in policy implementation.

{Table 5 about here}

{Table 6 about here}

Implementation

Policies issued by the legislature in Russia and China are passed as laws, so the law dummy is excluded from estimation here. The most striking difference in policy implementation between the two countries is the involvement of legislature, highlighted in Table 6. As previously noted in Table 2, only a tiny portion of policies were issued by the People's Congress of China or its Standing Committee, while a quarter of policies were issued by the Federal Assembly of the Russian Federation (Federation Council and State Duma) as law. Consequently, Russia was 13 times more like to implement policies by the legislature (12.821 = 1/0.078) than China. There was the tendency for the cabinet, the highest executive organ, to issue policies in Russia compared with China; and there were also the tendencies for ministries and non-cabinet bureaus, the low level executive and administrative organs, to issue policies in China compared with Russia. China had a striking habitat to issue a policy jointly by several government entities, as many as 12 on occasions. With the average number of issuers being 1.71, China was twice more likely to adopt the practice of joint issues (2.215) than Russia, to fortify the authority of issuers and strengthen policy enforcement. In a sense, this has revealed the complexity and ambiguity in policy implementation, because 'it was either too difficult to study or, conversely, too simple (deLeon and deLeon, 2002, p469). Thus, the implementation issue is dealt with casually for being too difficult or too simple as in the prior literature.

6. Implications and further discussion

China and Russia shared many similarities while demonstrated considerable differences due to historical reasons that influenced their institutional settings, which was also reflected in STI, national STI systems as well as in STI policy design and implementation. We further reflect on

these results and their implications by reviewing the planning systems, exploring the causes of differences and the foundations for similarities between the two countries. Although both Russia and China adopted the planning systems, the time period of China in an orthodox planning system was much shorter. Russia implemented the planning system and operated a planning economy soon after the success of the 1917 Revolution. It lasted for 70 years until the dissolution of the Soviet Union in 1991. In contrast in China, the nationalization of industries started in the mid-1950s, which was almost completed just before the launch of the Cultural Revolution in 1966. So the planning system was disrupted in as early as 1966. It lasted for merely 10 years. In experiencing 70 years' planning system, the Soviet Union had almost accomplished urbanization and industrialization throughout the country. State control was all-inclusive in Russia, covering almost all fields in urban and rural economies. China differed significantly. Further, the plans in the Soviet Union were rigid and plans were laws, whereas China's planning was much loose even at the peak of the planning economy.

The two countries also differed in economic structure, which also contributed to in the two countries' differences in innovation systems. Export structure is identified as one of the major factors. Although China recently became the second largest economy in the world, Russia remained superior to China in top military and defense technologies. Russia was the second largest arms exporter with its share of international arms exports being 21% for the period 2014-2018, second only to the US that had a share of 36% (Wezeman *et al.*, 2019, p2). China was ranked the fifth with its share of arms exports being 5.2%, though the figure is close to the third, France with a share of 6.8% and the fourth, Germany with 6.4% (ibid). Given that weapons employed the most advanced technologies and required constant R&D inputs to gain leading edges against the rivals, they would have an effect on innovation policy and innovation activity. On the other hand, Russia was considered primarily a mineral commodity exporter. Its exports of mineral fuels, oils, distillation products, etc. accounted for 53% of its total exports (UNSD, 2019). The imports of machinery, electrical and electronic products, vehicles, pharmaceutical products and other

manufactures accounted for over 50% of Russia's total imports (ibid). The opposite applied to China, it was scarce in natural resources and had to import them instead; it exported more machinery and other manufactured goods relative to Russia.

These differences in Russia and China would have an effect on technical imports and technical exports in the two countries. The implications indicate that China would be more pro-active in and keener on technical transformation than Russia in a commercialization process. On the other hand, Russia's supremacy in arms exports meant that there was little need and incentive for Russia to commercialize military technologies. It is interesting to bring in the US for further contrast. In a study on commercializing state R&D in the US and Russia, Sedaitis (1996) remarks: 'The United States and the Russian Federation continue to support the two most militarized state research systems in the industrialized world' (ibid, p294). 'As global conflict shifts from military to economic competitiveness, however, it remains no small task to commercialize the defense-based research establishment in either country' (ibid, p293). By contrast, China would arguably be considered the third in military technologies fairly recently, bearing no such large burden. China tolerated and encouraged commerce and commercial activities by collective and private enterprises much earlier than Russia; such commercial activities outside the state sector started in the 1970s and mushroomed even during the period when China was officially in a planning system with a planning economy. The transformation of military technologies for commercial utilization released the previously protected and utilized R&D outputs to civilian and commercial use by the military equipment and facilities companies themselves, thus generating profits and reducing the reliance on direct state support. It also benefited the non-state sectors in upgrading their research and innovation capabilities. In another sign of difference in commercial attitudes, China was keener on promoting technical exports than Russia to earn foreign revenues.

7. Conclusion

In this paper we have studied STI policy of Russia and China from a policy foresight perspective in a 3×3^2 analytical framework for policy instruments, policy goals and policy implementation. Foresight exercises and planning frameworks, by setting guiding principles, development goals, key tasks and overall deployments, present roadmaps for industries, sectors and fields. The development goals set in foresight and planning frameworks are the grand goals. They will be realized through the implementation of a series of policies rolling out in sequence in perceived future. Our study thus, by mapping STI policy instruments, policy goals and policy implementation, bridges S&T foresight and STI policy research in policy formation and implementation.

Adopting logistic regression for empirical estimation, 418 STI policies between Russia and China have been modeled with 25 policy variables and scrutinized vis-à-vis the three policy dimensions. The differences and similarities in STI policy instruments, goals and implementation have been analyzed, compared and contrasted. China and Russia shared many similarities while demonstrated considerable differences due to historical reasons that influenced their institutional settings, being reflected in STI policy design and implementation. The empirical work carried out in this study has differentiated Russia from China in their choice of policy instruments, their devotion to policy objectives and their approaches to policy implementation.

It has been observed that China and Russia differed significantly in their choice of five policy instruments and the two countries share similarities in the rest eight policy instruments. Transitioned from planning economies, fiscal support and subsidies were heavily exercised in both countries. However, Russia was the first planning economy who endured the longest period of the planning system in the world. As such, Russia resorted to fiscal support and subsidies more than China. The features in the choice and issuances of policy instruments also reflected the two countries' respective historical heritages as the paramount investment driven planning economy and the oldest bureaucrat in the world.

Both China and Russia paid great attention to S&T development for innovation generation. Nevertheless, the two countries did not differ significantly in the policy goal for S&T development, because both of them were very keen and invested heavily in this field. In the last few decades, China was a learner, less developed compared with Russia. Therefore, China took more measures for technical import than Russia. The planning economy in China was not as rigid as in Russia. China started the economic reform, which watered down the planning system and encouraged commerce long before the widely propagated reform and opening up period in the 1970s. As such, China was more commercialized and keener on the commercialization of military technologies and was more likely to implement policies for promoting technical transformation than Russia. In contrast, Russia was more likely to issue policies to promote and encourage the absorption of new techniques than China.

Russia and China differed starkly in policy implementation. Russia issued and implemented policies by the legislature far more than China. Policies in the form of administrative regulations tended to be issued by the cabinet, the highest executive organ, in Russia. They tended to be issued by ministries and non-cabinet bureaus in China. Flexibility in policy implementation tended to be desirable in China, which was rooted in the institution and governance in China in both modern and ancient times. This feature was vividly described by chop and change and the moon. This institutional and customary difference contributed to the difference in policy implementation to a certain extent in the two countries.

This study and its results and findings enrich the literature in STI policy studies. They lessen the imparity between the significance of innovation capacities of Russia and China and the lack of research on innovation and innovation policy of the two countries in the western literature. By examining STI policy in China and Russia and then disseminating the findings, the present paper presents the world with a fuller picture about the global innovation landscape, encompassing both the traditional 'capitalist' economies and in the 'emerging' and former planning economies. The study has also differentiated between Russia and China in STI policy approaches,

demonstrating that emerging economies are as well diverse. Given innovation performance and capacities of the two countries, not only Russia and China can learn from the west, the west can also gain from studying STI policy practice and approaches of China and Russia. Therefore, this study and its results, findings and implications are helpful for further research, providing the substantiated documentation for further comparative studies involving emerging economies and the west. The findings in this study may well impact the world, given the significance of the two countries in innovation – being two of the largest economies included in the Bloomberg top 30 most innovative countries.

With their historical heritages in the planning system and centralization, innovation generation was topmost among all innovation activities in both Russia and China. Being in the 'socialist bloc' then split up, both countries invested hugely in military and defense technologies, against the 'capitalist bloc' and then against each other. Russia and China possessed certain advantages in these fields, and their innovation policy was meant to maintain and further their leading positions. Russia remained superior in top military and defense technologies, being the second largest arms exporter second only to the US. Meanwhile and moving away from the planning system, innovation diffusion and innovation adoption became increasingly important and were encouraged by the governments with policy support and policy incentives. These were featured by the commercialization of innovation generation, in which China led Russia while still catching up with the west. Increasingly assertive following decades of learning from the west and passive engagement with the west in transitions, both countries have been proactively integrating the rest of the world at this stage of development. While Russia endeavors to lead and remain competitive in certain fields and aspects of innovation, China aspires to catch up and overtake the most advanced on all major fronts of innovation. How China and Russia interact with the rest of the world would have yet to be comprehended.

There are limitations in this study nonetheless. Although theoretical analysis has been performed and empirical work has been carried out in this paper to study policy implementation,

the scope in which policy implementation is scrutinized is grand but limited to central institutions. The study has differentiated Russia from China in their approaches to policy implementation at national levels. Future research will benefit from examining local implementation, as well as government-institution interactions in achieving effective policy implementation. Furthermore, while STI policies have been modeled, scrutinized and contrasted between Russia and China in this study, further comparative studies can be carried out between Russia and China and other emerging economies, as well as between emerging economies and advanced countries.

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Figures

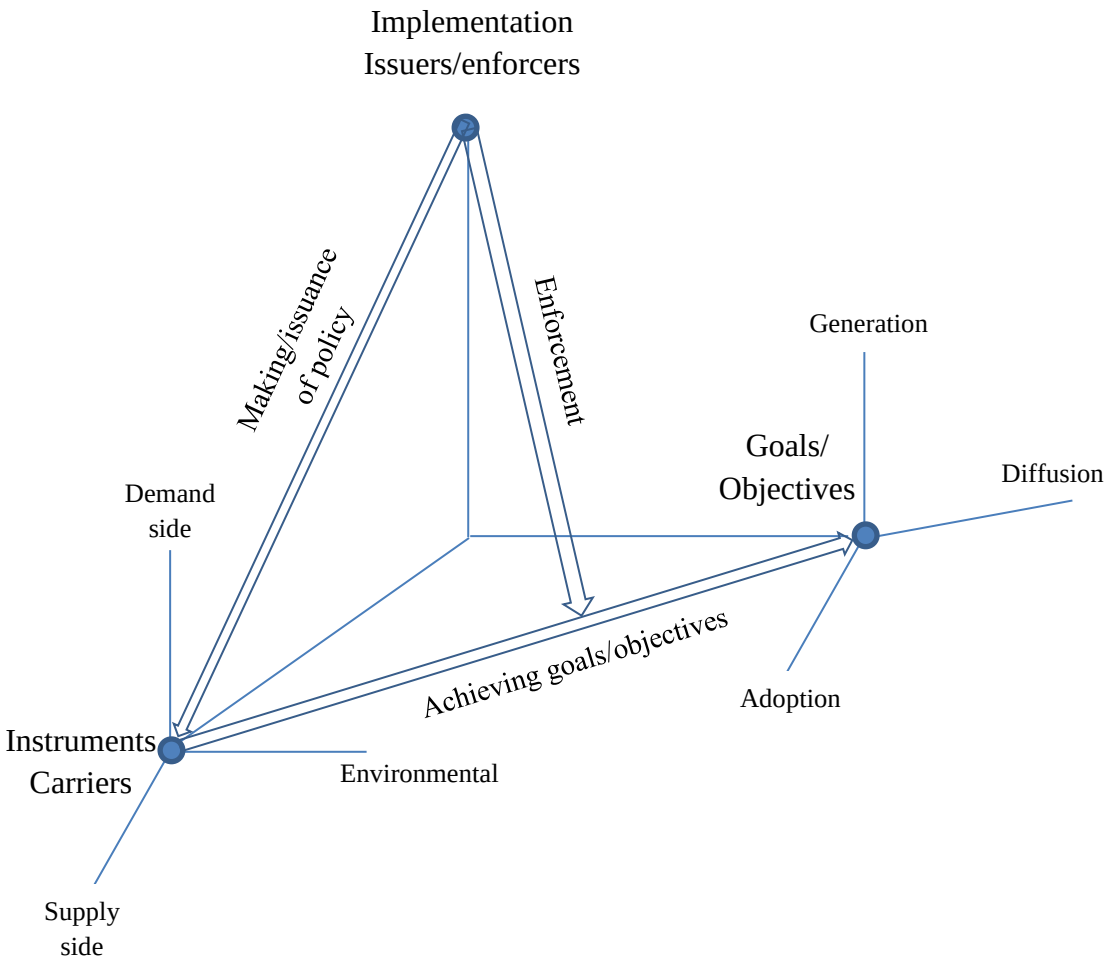
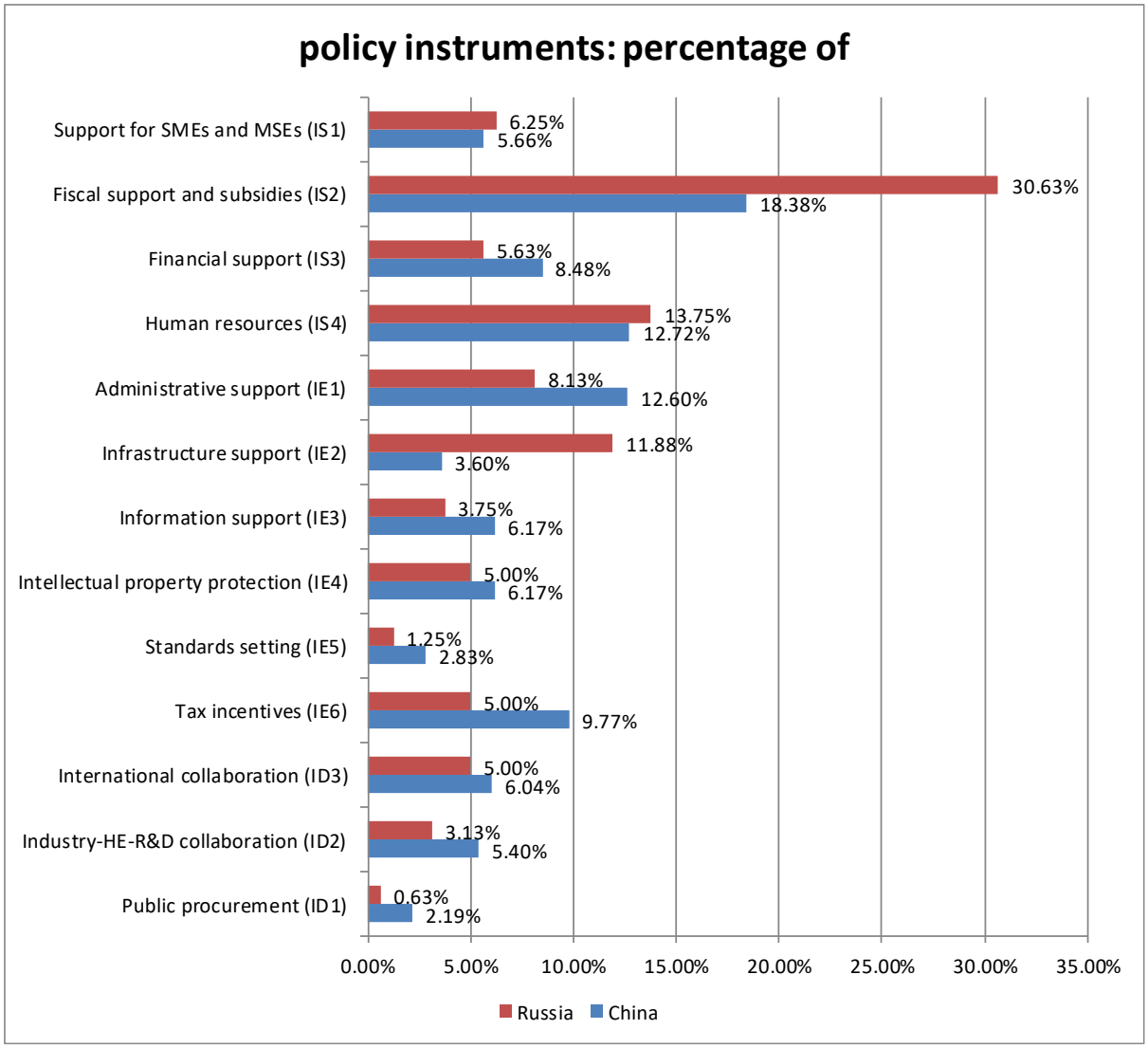
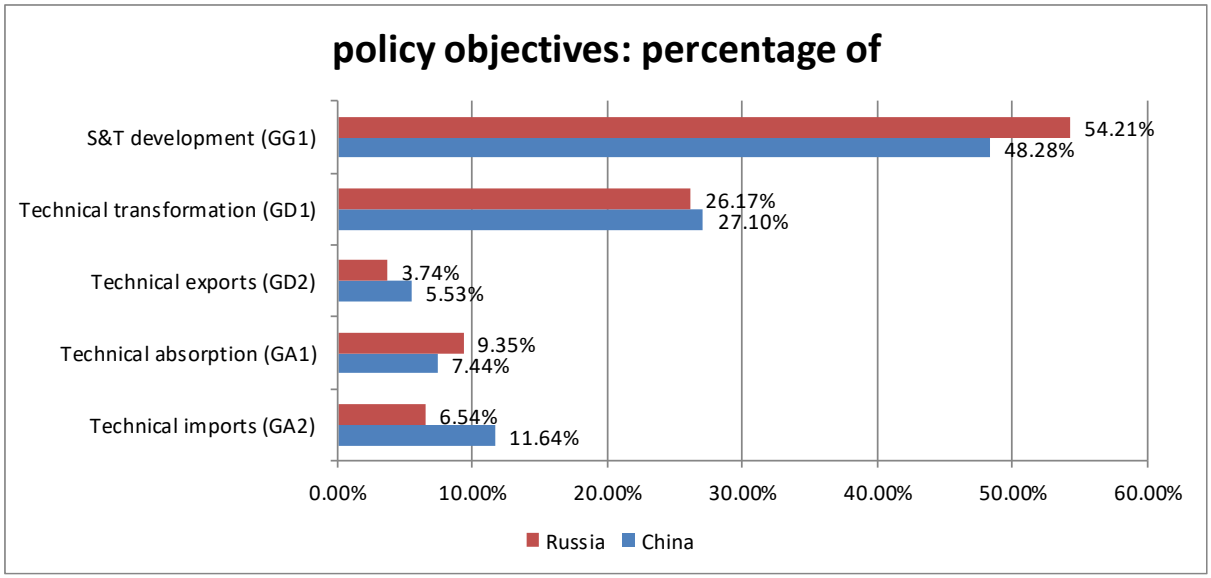


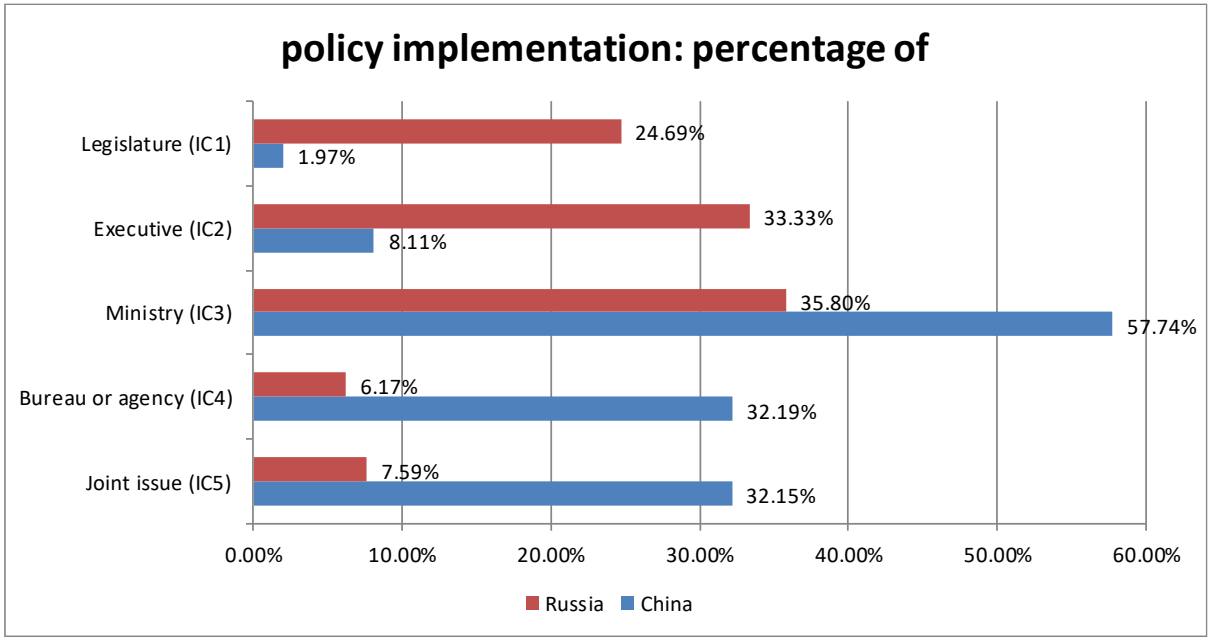
Figure 1. The 3×3^2 framework


policy instruments: percentage of
Support for SMEs and MSEs (IS1)
6.25%
5.66%
Fiscal support and subsidies (IS2)
30.63%
18.38%
Financial support (IS3)
5.63%
8.48%
Human resources (IS4)
13.75%
12.72%
Administrative support (IE1)
8.13%
12.60%
Infrastructure support (IE2)
11.88%
3.60%
Information support (IE3)
3.75%
6.17%
Intellectual property protection (IE4)
5.00%
6.17%
Standards setting (IE5)
1.25%
2.83%
Tax incentives (IE6)
5.00%
9.77%
International collaboration (ID3)
5.00%
6.04%
Industry-HE-R&D collaboration (ID2)
3.13%
5.40%
Public procurement (ID1)
0.63%
2.19%
0.00%
5.00%
10.00%
15.00%
20.00%
25.00%
30.00%
35.00%
Russia
China

(a)



(b)



(c)

Figure 2. Percentages of innovation policy objectives, instruments and implementation means - Russia and China

Tables

Table 1. Policy variables in three dimensions, their names and narratives

	Type	Name	Narrative
Policy instruments	Demand-side	Public procurement (ID1)	Regular and strategic public procurement, shaping innovation directly and indirectly
		Industry-HE institution-R&D institution collaboration (ID2)	Collaboration between industry, HE institution and R&D institution, promoting commercialization of R&D products
		International collaboration (ID3)	International collaboration and exchange programs, boosting R&D capabilities
	Supply-side	Support for SMEs and MSEs (IS1)	Technological training and consultancy for MSEs and SMEs, improving technological infrastructure in MSEs and SMEs
		Fiscal support and subsidies (IS2)	Funding and subsidies for R&D, depreciation subsidies
		Financial support (IS3)	More funding channels, loans on favorable terms, insurance and support for risk control
		Human resources (IS4)	Education and training, favored remuneration, welfare and bonus to attract and reward the talented domestically and overseas
	Environmental	Administrative support (IE1)	Streamlining procedures for approvals, easing restrictions on quotas and licensing, planning, organization, control and supervision of R&D activities
		Infrastructure support (IE2)	Provision of public infrastructure and facilities in the field, including the internet, libraries and databases for information sharing
		Information support (IE3)	Information provision and sharing including networking, libraries and databases
		Enhancement in intellectual property protection (IE4)	Legislation and regulation for intellectual property protection, provision of legal services
		Standards setting (IE5)	Standardization, facilitating diffusion of innovations and market entry
		Tax incentives (IE6)	Tax exemption, tax reduction and other incentives
Policy objectives	Generation	S&T development (GG1)	R&D development, product development and design
	Diffusion	Technical transformation (GD1)	Application and promotion of new scientific and technological achievements, technicalization and commercialization of R&D
		Technical exports (GD2)	Exports of advanced technologies to foreign territories
	Adoption	Technical absorption (GA1)	Encouragement and promotion of absorption of new techniques
		Technical imports (GA2)	Imports of advanced technologies from foreign territories
Policy implementation	Institutional characteristics	Legislature (IC1)	National People's Congress of China and its Standing Committee, Federal Assembly of the Russian Federation (Federation Council and State Duma)
		Executive (IC2)	State Council of China, Russian Government
		Ministry (IC3)	Constituents of, the state executive, or cabinet ministries/departments
		Bureau or agency (IC4)	Non-cabinet departments
		Joint issue (IC5)	Number of departments who jointly issued the policy
	Policy characteristics	Degree of enforcement (PC1)	Law or not

Table 2. Summary statistics of policy variables

	Type	Name	China			Russia		
			No	%	adj %	No	%	adj %
Policy instruments	Demand-side	Public procurement	17	5.01	2.19	1	1.27	0.63
		Industry-HE institution-R&D institution collaboration	42	12.39	5.40	5	6.33	3.13
		International collaboration	47	13.86	6.04	8	10.13	5.00
	Supply-side	Support for MSEs and SMEs	44	12.98	5.66	10	12.66	6.25
		Fiscal support and subsidies	143	42.18	18.38	49	62.03	30.63
		Financial support	66	19.47	8.48	9	11.39	5.63
		Human resources	99	29.20	12.72	22	27.85	13.75
	Environmental	Administrative support	98	28.91	12.60	13	16.46	8.13
		Infrastructure support	28	8.26	3.60	19	24.05	11.88
		Information support	48	14.16	6.17	6	7.59	3.75
		Enhancement in intellectual property protection	48	14.16	6.17	8	10.13	5.00
		Standards setting	22	6.49	2.83	2	2.53	1.25
		Tax incentives	76	22.42	9.77	8	10.13	5.00
Policy objectives	Generation	S&T development	253	74.63	48.28	58	73.42	54.21
	Diffusion	Technical transformation	142	41.89	27.10	28	35.44	26.17
		Technical exports	29	8.55	5.53	4	5.06	3.74
	Adoption	Technical absorption	39	11.50	7.44	10	12.66	9.35
		Technical imports	61	17.99	11.64	7	8.86	6.54
Policy implementation	Institutional characteristics	Legislature	8	2.36	1.97	20	25.32	24.69
		Executive	33	9.79	8.11	27	34.18	33.33
		Ministry	235	69.32	57.74	29	36.71	35.80
		Bureau or agency	131	38.64	32.19	5	6.33	6.17
		Joint issue	109	32.15	32.15	6	7.59	7.59
		Joint issue (avg No of issuers)		1.71	1.71		1.13	1.13
	Policy characteristics	Law	8	2.36	2.36	19	24.05	24.05

Table 3. Tests for differences between Russia and China in three dimensions

(a) *policy objectives*

	Mean	Std Err of mean	Lower 95% CI	Higher 95% CI	*t* - stat	*p* - value
GG1 S&T Development	.009	.035	-.060	.077	.254	.800
GD1 Technical transformation	.062*	.037	-.011	.135	1.659	.098
GD2 Technical export	.038**	.019	.000	.076	1.991	.047
GA1 Technical absorption	-.015	.025	-.064	.035	-.585	.559
GA2 Technical import	.094***	.026	.043	.146	3.595	.000

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

(b) *policy instruments*

	Mean	Std Err of mean	Lower 95% CI	Higher 95% CI	*t* - stat	*p* - value
IS1 Support for SME and MSM	.003	.025	-.047	.053	.117	.907
IS2 Fiscal support	-.189***	.039	-.266	-.111	-4.791	.000
IS3 Financial support	.077***	.026	.026	.127	2.978	.003
IS4 Human resources	.018	.037	-.055	.091	.477	.634
IE1 Administrative support	.127***	.032	.064	.190	3.960	.000
IE2 Infrastructure support	-.153***	.027	-.207	-.100	-5.664	.000
IE3 Information support	.062***	.023	.017	.107	2.714	.007
IE4 Intellectual property protection	.027	.027	-.026	.079	1.000	.318
IE5 Standards setting	.038**	.016	.006	.070	2.350	.019
IE6 Tax incentives	.121***	.026	.070	.172	4.634	.000
ID3 International collaboration	.038	.024	-.010	.086	1.568	.118
ID2 Industry-HE-R&D collaboration	.065**	.022	.021	.109	2.921	.004
ID1 Public procurement	.035***	.014	.008	.062	2.580	.010

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

(c) *policy implementation*

	Mean	Std Err of mean	Lower 95% CI	Higher 95% CI	*t* - stat	*p* - value
IC1 Legislative	-.251***	.025	-.301	-.201	-9.887	.000
IC2 Executive	-.246***	.030	-.305	-.188	-8.265	.000
IC3 Ministry	.345***	.035	.276	.414	9.852	.000
IC4 Bureau/Agency	.327***	.029	.270	.385	11.274	.000
IC5 Joint Issue	.596***	.092	.416	.776	6.504	.000

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Note: China's figure - Russia's figure

Table 4. Mapping in policy objectives with logistic regression

	Coef	Std Err	*t*-stat	Sig	Exp(Coef)
GG1 S&T Development	.564	.344	1.640	.101	1.758
GD1 Technical transformation	.569*	.304	1.872	.062	1.766
GD2 Technical export	.511	.592	0.863	.389	1.667
GA1 Technical absorption	-.709*	.428	-1.657	.098	.492
GA2 Technical import	1.165**	.474	2.458	.014	3.206
Constant	.720**	.361	1.994	.046	2.053

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 5. Mapping in policy instruments with logistic regression

	Coef	Std Err	*t*-stat	Sig	Exp(Coef)
IS1 Support for SME and MSM	-.622	.459	1.355	.176	.537
IS2 Fiscal support	-.467	.319	1.464	.143	.627
IS3 Financial support	.890**	.450	1.978	.048	2.436
IS4 Human resources	.362	.324	1.117	.264	1.437
IE1 Administrative support	.879**	.397	2.214	.027	2.409
IE2 Infrastructure support	-1.672***	.402	4.159	.000	.188
IE3 Information support	.681	.532	1.280	.200	1.975
IE4 Intellectual property protection	.124	.463	0.268	.789	1.132
IE5 Standards setting	.645	.796	0.810	.417	1.906
IE6 Tax incentives	1.092**	.438	2.493	.013	2.979
ID3 International collaboration	.479	.456	1.050	.294	1.615
ID2 Industry-HE-R&D collaboration	1.116**	.569	1.961	.050	3.052
ID1 Public procurement	1.687	1.143	1.476	.140	5.402
Constant	1.115***	.323	3.452	.001	3.049

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 6. Mapping in policy implementation with logistic regression

	Coef	Std Err	*t*-stat	Sig	Exp(Coef)
IC1 Legislative	-2.557**	1.039	-2.461	.014	.078
IC2 Executive	-1.471	.957	-1.537	.124	.230
IC3 Ministry	.066	.960	0.069	.945	1.068
IC4 Bureau/Agency	1.341	.836	1.604	.109	3.822
IC5 Joint Issue	.795	.550	1.445	.148	2.215
Constant	1.609**	.940	1.712	.087	4.996

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.