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Sectoral Innovation System Foresight in Brazil and Korea

Competences for innovation system transformation

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Contents

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1 Introduction

For long it has been argued that foresight has a potentially important role in relation to policy making on national innovation systems (Martin & Johnston, 1999). The field of foresight has recently undergone a two-tracked transformation. Firstly, foresight is in a process of developing theoretical foundations as the field moves from being practice-oriented towards increasingly also becoming a scientific discipline. Secondly, foresight is in a process of implementing a systemic and evolutionary understanding of innovation into its conceptual and applied methodology. Andersen and Andersen (2014) have suggested the concept of 'innovation system foresight' (ISF) as a tentative framework that can bring forward this two-tracked transformation. Here we argue that this transformation can be aided by an increased focus on sector level foresight because it facilitates taking into account necessary contextual factors and the broad participation of stakeholders essential to ISF. Both ISF in general and sector level foresight in particular are conceptually underdeveloped and empirically under-researched (see section 2). Advancing our knowledge in this area is important for better understanding the issues involved in strategic innovation system (IS) transformation.

This paper seeks to address the latter research gaps by exploring sector foresight in Brazil and South Korea (henceforth Korea). Though very different, both countries face challenges of IS transformation. In both countries sector level foresight initiatives have been launched to complement and/or to address the lacking impact of national and technology oriented foresights. We analyze these sector foresights by looking at the presence of core features of ISF in foresight design and on how these influence the foresight process. The focus of the paper is thus on conceptualization and design of foresight. The key propositions of this paper are: (1) adhering to the principles of ISF will improve impact of foresight for innovation; (2) the principles of ISF are particularly relevant for sector level foresight. The paper is theoretically motivated and it is empirically explorative. Though generalization potential is limited, the case studies hold lessons for our theoretical suggestions that in turn serve for pointing towards other research challenges. The paper contributes to foresight research on two points. First, it further explores the notion of ISF and advances fruitful integration between the two academic fields of Innovation Studies and Foresight. Second, it highlights the need for, and explores the practice of, foresight at the sector level. The latter is a gain for practitioners and policy makers – especially those interested in innovation policy in emerging economies as Brazil and Korea.

Chapter two will outline the basic principles of ISF that will be translated into indicators for our measuring of ISF. Also, it will illustrate why the sector-level approach is necessary. Chapter three presents sector foresight cases from Brazil and Korea. Chapter four is the conclusion.

2 Sectoral Innovation system foresight

2.1 Innovation system foresight

The notion of Innovation System Foresight (ISF) essentially reflects acceptance of an evolutionary and systemic understanding of innovation. The main implications of the latter are: (i) the dimensions of science, technology and innovation are interdependent and equally important wherefore foresight must be able to embrace all three dimensions and especially their interactions; (ii) innovation is a distributed, open-ended and evolutionary process which implies that innovation essentially cannot be planned. Consequently, innovation policy cannot be developed or implemented in a top-down manner; (iii) innovation processes are socially embedded and thus context-dependent; (iv) producers, users and regulators of knowledge are equally important and interactions between them are of core importance. ISF entails that innovation system transformation is the central purpose of foresight. See Andersen and Andersen (A. D. Andersen & Andersen, 2014) for a more elaborated account of ISF.

2.2 The sector level[1]

The broad participation in foresight exercises implies that high levels of aggregation (e.g. on national level) are problematic. Even though national level foresight is important for innovation via its function of building shared visions and strategies it seems extremely difficult to manage a National ISF due to the complexity and number of stakeholders involved. The latter is supported by Keenan (2003) who argues that national foresights are too superficial with respect to analyzing the system of interest, and consequently the resulting action plans are too generic to be meaningfully implemented. There is a trade-off between level of aggregation of foresight and implementability of results (Georghiou, Harper, & Scapolo, 2011), and ultimately usefulness of foresight. There is a need for complementing nation level foresight with foresight at lower levels of aggregation.

Because innovation is a systemic and localized process it is crucial to integrate contextual factors (Barré, 2002; Cariola & Rolfo, 2004) and the demand for knowledge in foresight (Georghiou et al., 2011). The latter implies that technology-focused foresight has some limitations. A technology often feeds into a number of different sectors whose context specificities cannot be accounted for in detail. Also, it is often complicated to enroll the demand side either because demand doesn't yet exist for new technology or because potential users are scattered thinly across many sectors. On the other hand, with a sector focus the demand side and context factors are relatively easier to identify and thus enroll.

The sector level is moreover relevant because innovation dynamics differ significantly across sectors (Dosi, 1988; Malerba, 2002, 2004; Pavitt, 1984). Such differences are caused by differing: (i) technological opportunities; (ii) technological and innovation capabilities; (iii) quality and volume of demand which results in diverse demand-pull effects (Dosi, 1988). Moreover, institutions, patterns of interaction, financial services, competition, and government policies most often have sector-specific traits (Malerba & Nelson, 2011). If foresight is to be a relevant tool for innovation policy making it must be able to account for such sectoral differences (Weber, Schaper-Rinkel, & Butter, 2009). This diversity in innovation dynamics has given rise to the concept of Sectoral Systems of Innovation (SSI). In contrast to other IS approaches, SSI is defined around "*a set of new and established products*" (Malerba, 2004, p. 16) and is composed of elements and relationships which interact in the production, diffusion and use of new knowledge for the creation, production and sale of those products. We will use SSI to set relevant boundaries for sector ISF.

Innovation oriented foresight at the sector level is relatively unexplored and nearly absent when looking for systemic approaches to foresight. Foresight research with a sectoral focus most often concern case studies that do not reflect much upon the concept of a sector and why it is relevant. Still fewer considers innovation dynamics as something particular at the sectoral level (see e.g. Abadie, Friedewald, & Weber, 2010; Antunes & Canongia, 2006; Czaplicka-Kolarz, Stańczyk, &

[1] To define a sector is not necessarily a straightforward exercise. In this paper we understand a sector as consisting of a group of actors related through production and sale of a given set of products. This definition is thus product-based. We do not consider a technology or technological area as a sector (e.g. nano- or bio-technology). Still, a sectoral innovation system (SSI) is different from an economic sector. In an economic sector one traditionally only looks at production linkages while in SSI one looks (primarily) at knowledge and innovation dynamics which tends to involve a broader set of actors and structures.

Kapusta, 2009; Toivonen, 2004; Zappacosta, 1999). The exception is the 'Sectoral Innovation Watch' (SIW) program managed by Europe Innova[2]. SIW was related to the 'Europe 2020 Strategy' targeting smart, sustainable and inclusive growth in Europe. SIW monitored and analyzed differences in innovation performance across nine sectors and identified potential future developments (Montalvo & Giessen, 2012; Weber et al., 2009). The theoretical framework applied in the project is inspired by SSI and foresight. The reports can be seen as an experimental application of a sector ISF approach to foresight. Within this nascent area this paper complements the SIW initiative by (i) further strengthening the argument for why sectoral approaches are needed, (ii) outlining in further detail the links between sectoral innovation systems and foresight, (iii)) SIW mainly contains an 'analyzing the present' exercise (step 4 in figure 1) and not an exploration of conceptual implications for all foresight phases. We mainly focus on the pre-foresight phase which essentially would constitute the theoretical basis for the SIW reports.

For the reasons outlined above we propose that (1) that adhering to the principles of ISF will improve impact of foresight for innovation; and (2) the principles of ISF are particularly relevant for sector level foresight. In the following we explore these propositions empirically.

3 Sector Foresight in Brazil and Korea

3.1 Methodology

A foresight process can be described as consisting of three main phases: pre-foresight, foresighting and post-foresight (Martin & Irvine, 1989) with each phase containing a number of steps. ISF directly affects the pre-foresight phase and due to interdependency between the phases it indirectly affects the foresight and post-foresight phases. Andersen and Andersen (2014) identify four main implications of ISF for design of foresight. These four points will in this paper be used for assessing to what extent a foresight design conforms to ISF. We present them briefly below.

The goal of foresight. In the literature several goals are mentioned such as setting priorities in S&T, guiding innovation systems, shop window for competences, enrolling new actors to S&T debate, and network building (Barré & Keenan, 2008). From our perspective the main purpose, and thus goal, is to 'strengthen' the innovation system. The before-mentioned goals are seen as inputs to this principal goal. This implies that in order to be meaningful these inputs must be understood and designed as serving that goal – that is, they are embedded in a broader system.

System definition and boundary setting. There seems to be no agreed-upon method for setting system boundaries and thus classify factors as external or internal. Boundary-setting influences choice of methodology, data collection and stakeholder involvement in subsequent steps in the foresight process. ISF suggests following the definition of an innovation system as the organizing principle for setting boundaries. The system should thus include the elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge (Lundvall, 1992).

Participation. Innovation-system transformation requires distributed policy which in turn requires (meaningful) participation of all key stakeholders (representing actors, relationships, infrastructure,

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[2] Reports about the nine analyzed sectors can be found at: http://www.europe-innova.eu/web/guest/publications/europe-innova-projects-publications.

institutions, etc.). In this sense the initial system definition, and identification and enrollment of key stakeholders partly define implementation possibilities. It reflects a systemic interdependency between pre and post foresight because if those required to make decisions (gatekeepers) have not been included, there is little chance that they will act according to the foresight action plans. Although necessary, broad participation does not guarantee successful implementation (Cagnin, 2011).

Mapping the present. There is no agreed-upon method for analyzing the present system situation. SWOT and STEEP(V) analyses are often used but they are not based in a coherent theoretical framework nor do they give explicit guidelines for analysis[3]. Moreover, these frameworks are not developed with a specific focus on innovation and dynamics, and may thus be weak in this respect. The quality of any foresight will depend on the quality of the mapping exercise because it will serve as a basis for the following foresighting steps. We suggest an IS-framework for such analysis which is in line with the work done in SIW and implies analysis of context-specific innovation dynamics.

The case analysis will contain three main elements. The first element is a description of innovation policy context and challenges with relevance for foresight. Second element is a description of the foresight context and earlier experiences. The third element is an assessment of ISF content in the design of selected sector foresights, and how this relates to the foresight process. Our data consists of academic publications, foresight reports and eight interviews with main actors in Brazil and Korea conducted in June and July 2012.

We use case studies to grasp the praxis of sector foresight in the concrete projects. In Brazil we look at a single foresight. In Korea we directly look at foresight praxis in two organizations. Although cases differ they are comparable on the level of conceptual understanding and design of foresight. All objects of study were chosen due to empirical uniqueness as sector foresight is rare. The countries were chosen because the face similar challenges of transforming their innovation systems.

3.2 Sector Foresight in Brazil

We focus on 'Plano Estratégico Setorial' (strategic sector plan – PES) as a case of sector foresight. PES was managed by the Brazilian Agency for Industrial Development (ABDI) and the Center for Strategic Studies and Management in Science, Technology and Innovation (CGEE) between 2004 and 2008.

3.2.1 Innovation Policy in Brazil

After a period of 'deregulation' and absence of innovation policy from 1990 onwards, it gradually returned during the 2000s. But by then collective competences for public-private dialogue on policy development had deteriorated (Koeller & Cassiolato, 2009). To restore innovation policy, investments increased significantly. An important initiative in this context was the Industrial, Technological and Foreign Trade Policy (PITCE) launched in 2004 by the Ministry of Development, Industry and Trade (MDIC). PITCE aimed at stimulating technological innovation and a pro-innovation discourse. This novel policy initiative lacked coordinating organizations and institutional support.

[3] It has been argued that the SWOT framework pays insufficient attention to the (learning) capabilities of individual firms and to the fact that economic competition is increasingly innovation-based (Zack, 1999). This indicates that the framework isn't developed to study dynamics of the learning economy. It has also been argued that the SWOT framework is theoretically superficial and consequently little informative on the content of the analytical steps involved. The latter has contributed to a SWOT practice that does not go beyond description in the most general terms. Such analysis lacks rigor and analytical content (Hill & Westbrook, 1997). Others have argued that SWOT is derived of theoretical underpinnings and therefore often produces shallow and misleading results (Valentin, 2001).

Consequently, the government created the National Council for Industrial Development (CNDI) to support implementation and monitoring of PITCE. CNDI was to give coherence to actions and proposals, and to strengthen the dialogue between the public and the private sector. The Brazilian Agency for Industrial Development (ABDI) was created as an executive secretariat for CNDI. ABDI also functions as a strategic think tank that interacts with industry on industrial policy. ABDI has institutionalized channels of communication with most Brazilian industries in the form of competitiveness forums, trade chambers, sectoral chambers and working groups[4] (MDIC, 2010a). Thus, ABDI articulates and diffuses needs and wishes of industry in CNDI.

3.2.2 Foresight in Brazil

Brazil's first foresight (national) was 'Brazil 2020' (1998). It was an attempt of 'integrated governmental planning' by use of scenarios. It didn't produce priorities for public investments, and can best be understood as an exercise that developed capability in Brazil for long-term thinking (Santos & Filho, 2007). The second foresight exercise (national), the 'Prospectar Programme' (2000-2003), focused on impact of science and technology trends for industry and society. It mobilized more than 10,000 researchers and raised awareness of Brazil's future challenges. Problem identification and formulation was the main outcome (R. Popper & Medina, 2008). In 2000 MDIC launched the 'Brazilian Technology Foresight Program' with support from UNIDO[5]. It had an explicit sectoral focus in the form of production-chain analysis which was considered as novelty in itself[6] (R. Popper & Medina, 2008). Several reports were published (Castro, 2001; MDIC, 2002) but none reflect on the choice of sector focus[7]. The production-chain perspective reflects a systemic approach but the foresights were not participatory. Policy makers struggled to transform the results into implementable policies. Aulicino & Kruglianskas (2008) argue that this was due to difficulty in enrolling stakeholders in the foresight processes. As a consequence, the pre-foresight process should involve key stakeholders to improve their understanding of and participation in the process. This point illustrates the interdependency between pre and post foresight. In 2004 the program 'Brazil 3 Moments project: 2007, 2015 and 2022**'** was launched**.** It aimed at defining long-term national strategic objectives but wasn't particularly focused on Science, Technology and Innovation (STI) (R. Popper & Medina, 2008; Santos & Filho, 2007). It was created for (re)building a dialogue between the State and the Brazilian society for reaching strategic goals (Santos & Filho, 2007).

In 2001 foresight was institutionalized with the creation of CGEE. CGEE is a public non-governmental organization created to conduct foresight activities and promote national planning for STI. CGEE explicitly considers foresight as a coordinating activity that connects actors in science, policy and industry (CGEE, 2012). The methodological approach was gradually developed in-house with

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[4] Plastics; Civil Construction; Leather and Shoes; Agribusiness; Biotechnology; Meat Industry; Wood and Furniture; Steel; Hygiene, Perfumery and Cosmetics; Software and Electronic Goods; Textile and Clothing; Automotive; Aeronautic; Capital Goods; Ship-building; Service Sector; Paper and Cellulose Industry; Defense Industry; Bioethanol Industry; and Forum for Permanent Articulation with Civil Society.

[5] UNIDO has been instrumental for developing and spreading a foresight culture in Latin America but mainly with a national focus (R. Popper & Medina, 2008)

[6] According to Lelio Fellows (Filho, 2012) the production-chain perspective was applied because the people hired to carry out the foresight mainly had experience from the Brazilian Agricultural Research Corporation (Embrapa) where it as widely applied.

[7] The production-chain analysis in these studies implied: (a) describing the production chain; (b) analyzing it's institutional and organizational environment; (c) identifying the needs and aspirations of the production chain partners; (d) analyzing their performance and identifying critical factors; (d) forecasting the behavior of critical factors and visualizing the future performance (Rafael Popper, 2003).

inspiration from 'European foresight' (R. Popper & Medina, 2008). Due to diversity in clients CGEE has developed a conceptual foresight model with flexibility to allow for different objectives, application areas, and methods (Santos & Filho, 2007).

3.2.3 Sector Foresight: Plano Estratégico Setorial

PES was launched under PICTE to analyze and support sector-specific needs and competitiveness in a 15-year time horizon (ABDI, 2012). PES contained three steps. First, a panorama analysis (Status quo) was done for each sector. Second, a foresight study identifies trends, issues and perspectives relevant to a (selected) segment of the industry. Third, building on the first two steps a sector competitiveness agenda is developed to support formulation and implementation of public policies to strengthen competitiveness and innovation (Arcuri, 2009). PES was partly initiated and managed by ABDI. It resulted in 11 sectoral foresights that were used as inputs to discussions in CNDI on the Productive Development Policy program (PDP). PDP was launched in 2008 to improve national long-term competitiveness. PDP aimed at promoting a constructive dialogue with the private sector and consolidating a shared, strategic vision (MDIC, 2010b). ABDI contracted CGEE to carry out the foresights in PES. In the process, CGEE developed a sectoral foresight approach which includes stakeholders from industry (and not only experts), and focus on industrial competitiveness (not only science planning) (Nehme, Galvao, Vaz, Coelho, & Fellows, 2011).

Goal of foresight: Although PES was intended to enhance 'traditional' competitiveness, ABDI and CGEE acknowledged that development of industrial and innovation policy for the longer term is a distributed process. PES embodies the notion that industrial performance is a systemic phenomenon and that (innovation) system transformation hinges on the acceptance from key stakeholders that must be enrolled in strategy-development processes. PES thus goes beyond setting research agendas and expert-based foresights by focusing on realizing structural change via participatory processes. In consequence, the main goal of PES can be said to be innovation system transformation.

System boundaries: ABDI selected the industries to be analyzed according to national priorities set by government. The boundaries of these industries were defined in interaction and negotiation between ABDI, CGEE, industry and external consultants hired by ABDI. Each sector foresight had a steering committee with representatives from BNDES[8], MCTI[9], FINEP[10], sectoral organizations (national level industry unions[11]), CGEE, ABDI, and others. Committees decided guidelines and followed the process closely. They decided industry boundaries and who would be relevant actors to include, and chose sub-sector foci points within the production chain (Campanhola, 2012). In the pre-foresight phase ABDI insisted on using private business consultants to avoid CGEE's 'usual reliance' on university researchers only. Consultants would be more pragmatic and focus more on 'market aspects', it was believed. ABDI wanted to reorient CGEE towards a more industrial focus in foresight (Campanhola, 2012). The decisions made in the committees on boundaries, focus areas and hence key actors formed the basis for CGEE to develop its sector model. Thus, it seems that there was no systematic methodology or underlying theory for setting boundaries of industries and for prioritizing

8 Brazilian Development Bank.
9 Ministry of Science, technology, and Innovation.
10 National Agency for Financing Studies and Research.
11 In Brazil there are both state-level and national-level unions, and they do not always agree nor represent the same firms.

industry segments of particular interest – except they were conceived as important. Still, the negotiation process reflects that ABDI insisted on avoiding an (top-down) expert-based foresight.

Participation: Identification and enrollment of actors was a crucial aspect of PES. ADBI carefully chose participants from each industrial sector. ABDI's goal was to persuade and gain commitments from committee representatives from industry that enjoyed respect and credibility among businesses (Nehme et al., 2011). Still, firms insisted on solving short-term problems (e.g. interest rates, exchange rates, infrastructure) and were not interested in or accustomed to long-term strategic thinking. ABDI invested significant resources in gradually trying to convince them (and government officials) about the usefulness of foresight via training and workshops. ABDI succeeded due to a combination of factors. First, the creation of ABDI and other policies (e.g. PITCE) reflected the government dedication to STI oriented industrial policies Industry perceived the latter as a business-friendly agenda and as a window of opportunity for actually influencing the political agenda (Alvarez, 2012). Second, ABDI was determined to initiate programs focusing on the longer-term policy and development strategies instead of indulging industry's obsession with short-term urgent problems. According to Alvarez, ABDI's team was hungry to prove itself and desperate to commit industry in the project (Alvarez, 2012). Third, ABDI financed a number of consultancy projects focusing on short-term problem-solving for industries. Seen in the total budget of PES, these short-term investments were insignificant but they reflected a compromise between short and long-term issues. These projects made industrial actors feel respected which in turn earned ABDI and PES legitimacy (Alvarez, 2012). Hence, PES intentionally crafted broad participation from industrial actors (demand-side) in order to facilitate industry transformation. Even though it doesn't appear explicitly from our data we may say that the design of PES had strong links between pre-foresight and post-foresight phases. ABDI/CNDI's mandate ensured political awareness/will and extensive interactive participation of industry actors facilitated their cooperation. In consequence, key stakeholders were conducive to behavioral change.

Mapping the system: Mapping the system created challenges for CGEE because sectors differed significantly regarding maturity, ambitions, and competences. In some sectors the main obstacle for competitiveness was infrastructure; in others collective coordination, technology development or tax structure. This diversity was met with pragmatism from CGEE which developed a sector foresight model (Filho, 2012). It looks at each sector in six dimensions (general views) of society (Market, Social, Economic, Technological, Innovation, Competitive strategies). The latter external and general trends are combined with a sector-specific analysis where focus is put on new players, main competitor countries, leader companies, Brazil, and the production chain. The production chain analysis looks at talent, infrastructure, investments, policy and institutions, design, other 'specific' dimensions. It furthermore emphasizes the relationships between suppliers, producers and users in the chain as important for understanding needs (Filho, 2010). The dimensions are chosen on basis of SWOT, STEEPV, or general experience and are thus not anchored explicitly in any theoretical discipline. The system-mapping framework is an ad-hoc outcome of interaction between goal of foresight, setting system boundaries and choosing participants. The framework is systemic even without a theoretical platform that would explain and justify the choice of parameters. It is not innovation-oriented but capable of catching much sector diversity, and constitutes an ambitious attempt to develop systemic sector foresight.

3.2.4 Conclusion

PES and previous foresight activities in Brazil can be seen as attempts to develop systemic innovation policy tools and institutionalize them. The main lesson from PES is that systemic and participatory (demand-side enrollment) foresight at the sector level is viable. That it is possible to take sector differences into account, and that collective sector strategies can form the basis for policy-making for system-transformation at both sector (PES) and in turn national level (PDP). PES indicates that sector level is more suitable than national when you want a public-private dialogue as basis for policy development. This is also indicated by impact failures in earlier national foresights. The advantage of sector level is that key stakeholders are easily identifiable, limited, and can be enrolled in practice – which can be more complicated in national and technological foresights.

We can draw four lessons from PES on the topic of enrollment of industrial actors which is an important for foresight in general. First, meaningful participation requires that industry representatives have knowledge about foresight and consider it important. Second, the latter point is necessary but insufficient. PES indicates that trust and dialogue between industry and government is a premise for enrollment and in turn meaningful participation. Third, a unique feature in PES was the strategic management of trade-offs between short-term problem solving and strategy development for the longer-term. This may hold a key lesson for sector foresight in general. Fourth, PES indicates that both the institutionalized dialogue which ABDI had with industries and the dialogue taking place during PES were very important for identifying and articulating the needs of industries. This is relevant for information gaps in the short-term but especially for strategy development in the longer term. PES was an experiment in identifying and formulating future needs for 11 industries that companies alone would probably never have initiated (Filho, 2012). ABDI thus functioned as a 'bridging organization' (Bessant & Rush, 1995; Boon, Moors, Kuhlmann, & Smits, 2011) between industry, government and research. Such organizations seem indispensable when going beyond expert-based.

3.3 Sectoral Foresight in Korea

The main foresight actor on the sector level in Korea is the Ministry of Knowledge Economy (MKE)[12] under which two agencies, mainly the Korea Institute for Advancement of Technology (KIAT) but also the Korean Evaluation Institute of Industrial Technology (KEIT), manage the majority[13]. How these organizations conceptualize and design foresight activities is our main focus.

3.3.1 Innovation Policy in Korea

OECD has recently argued that Korea is faced by a challenge of moving from a catching-up to a 'creative' innovation system (OECD, 2009). One challenge is that innovation policy focusses on technology-push strategies rather than a systemic approach. Moreover, current policy gives preferential treatment to ICT and machinery manufacturing, and struggles with diversification (Oh, 2011). According to OECD, Korea must develop a systematic and evolutionary approach to the promotion of innovation. There is in other a need for *systemic policy tools* for innovation (Smits & Kuhlmann, 2004). This in turn hinges on distributed innovation policy as argued by OECD (2009: 185): "*clearly, governments alone cannot implement national innovation systems; the form and functioning of the latter tend to depend upon the actions of and linkages between a constellation of actors, both*

[12] Under the new administration since 2013, it changes its name to MOTIE(Ministry of Trade, Industry & Energy)
[13] For the energy technology area, there is the third agency called KETEP(Korea Institute of Energy Technology Evaluation and Planning) under the MOTIE http://ketep.re.kr/english/index.jsp

public and private". Still, innovation policy in Korea is hierarchical and centralized (Schlossstein & Park, 2006). Such top-down policy has been effective during the catching-up period but is now less suitable in Korea (Hwang & Choung, 2013). One of the earliest initiatives for addressing this challenge was 'Vision 2025' (1999) which inter alia resulted in the 'Science and Technology Framework Law' (2001) that systematically promotes mid and long-term STI strategies. It furthermore made formulation of '5-Year Science and Technology Plans' mandatory. Each plan 'should' moreover be informed by a national technological foresight. The Korean Institute of Science and Technology Evaluation and Planning (KISTEP), part of Ministry of Education, Science and Technology (MEST)[14], is manages this national foresights program (Park & Son, 2010). There is thus a formal, although not binding, link between the two activities.

3.3.2 Foresight in Korea

With inspiration from Japanese foresight exercises, Korea's first technology foresight was launched in 1993 managed by STEPI. It was based on two rounds of mini Delphi surveys with involvement of thousands of experts. The focus was on identification of future key technologies without taking into account a 'social' dimension. The second Korean technology foresight was initiated in 1998 and similar to the first in design and methodology. Schlossstein and Park (2006) conclude that these first two foresights failed to produce explicit policy implementation as a result of exclusion of key stakeholders and weak government commitment to implement results. The third Korean (national) technology foresight (2003) contained new methodological elements and tried to go beyond S&T by exploring future societal needs. Still, the Delphi technique remained the main tool and the exercise was dominated by experts that were asked about future needs of society. According to Park & Son (2010) the changes reflect a movement towards a systemic understanding of foresight due to the increased focus on social aspects and broader participation[15]. The fourth technology foresight (formally concluded in 2012) has continued the focus on 'social needs' with more elaborate methods such as text mining, network analysis etc. According to Moonjung Choi, manager of the exercise at KISTEP, social participation[16] has not changed from the third to fourth (KISTEP, 2012).

Besides the national technology foresights, Technology Road Mapping (TRM) is a widespread R&D planning tool in Korea. TRM is the main foresight method at the sector level in Korea. It is used as strategic and analytical tool by several private actors and think tanks such as Samsung Advanced Institute of Technology, Korean Economic Research Institute, Korean Institute for industrial economics and trade, and LG Economic Research institute. Park and Son (2006) argue that a sectoral approach is used because it is able to produce focused and concrete outcomes. Ilgoo Cho, Team Leader at KEIT, argues that a sector-level approach is needed because national technology foresights do not supply sufficient details for making the necessary planning and prioritization in sector level R&D. Karpsoo Kim, Professor in Innovation Management at KAIST[17], further argues that Korea must move beyond doing national-level foresights because their outputs are too superficial to be implemented in actual R&D programs. It is this challenge the sector foresights of KIAT and KEIT are intended to address.

[14] Since 2013 under the new administration, MEST is spilt into two, Ministry of Education(ME) and Ministry of Science, ICT and Future Planning(MSIP).
[15] Policy makers, social scientists and citizens were involved in comparison with earlier reliance on natural scientists and engineers only.
[16] The social-need analysis is basically a trend analysis conducted via bibliometrics and data mining and the foresight framework is similar to that used in the third foresight
[17] Korea Advanced Institute of Science and Technology is a public research university created in 1971.

3.3.3 Sector foresight: KIAT and KEIT

The main public policy foresight actors in Korea are MEST and MKE[18]. MKE's mission is promote industrial development and competitiveness (OECD, 2009). MEST is concerned with setting priorities for long-term direction of S&T development with little industry focus. MKE is closer to industry and more concerned with links between innovation and competitiveness in the shorter run (KIAT, 2012a). MKE is thus the main actor for sectoral foresights in Korea. Foresight in MKE mainly takes the form of TRM. Currently, TRM is done yearly for 35 sectors that cover nearly all sectors in Korea[19]. KIAT[20] is main foresight agency under MKE. It aims to develop and coordinate sectoral innovation systems and facilitate interactive innovation processes among key actors (KIAT, 2012b). KIAT operates TRM for about 20 sectors while the remaining is done by other public agencies[21] (KIAT, 2012a). This makes KIAT the main sector foresight agency in Korea. The conceptual model used to manage foresight in KIAT has an explicit focus on technology development. The framework contains analysis of the sector's strategic environment (phase 1), analysis of sector-internal issues (phase 2), setting goals on basis of SWOT (phase 3 and 4), and developing a strategy plan (phase 5) (KIAT, 2012c; Kim, 2012). KEIT[22] is responsible for sector foresight in the ICT industry where it supports technology planning and implementation (KEIT, 2012b). KEIT's conceptual model for managing foresight contains three main steps: (1) analyze future mega trends to map innovation needs and opportunities for the IT sector (STEEP analysis applied); (2) further analyze technology needs in combination with selected promising future technologies based on expert opinions (Delphi). In 2012, 103 future technology needs were identified; (3) on the latter basis build ICT development scenarios (KEIT, 2011).

Goal of foresight: The overall goal of doing foresight activities in KIAT and KEIT is derived the vision of MKE (new industries and competitiveness) (KEIT, 2012a; KIAT, 2012a). However, both suffer from the institutional structure of being delivery agencies for MKE which only expects a report. There are thus less process benefits by e.g. sharing of vision, facilitation of cross-disciplinary dialogue and obligation of commitment. This structure breaks the links between pre and post-foresight phases and is an institutional weakness from the perspective of Innovation System Foresight.

System boundaries: Neither KIAT or KEIT has an explicit methodology for setting sector boundaries (Kim, 2012). MKE decides sector boundaries, often via industry codes, for both organizations (KIAT, 2012a)[23]. There were several TRM projects for industrial convergence but still room to improve.

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[18] Now changed to MSIP and MOTIE

[19] LED/Optical electronics, Digital TV/ Broadcasting, Next-Generation Mobile, Home Network/Information Appliances, Next-Generation Computing, S/W, BcN , Display Semiconductor, Knowledge and Information Security, Robot, Bio, Next-Generation Medical Devices, Knowledge-based services, RFID/USN (Radio Frequency IDentification / Ubiquitous Sensor Network), NANO Convergence, IT Convergence, Metal Materials, Production Infra, Production System, textiles and clothing, Car Shipbuilding and Marine, Plant/Engineering, Chemical Process Materials, Smart-Grid, Renewable Energy(Heat sector), Renewable Energy(Electricity sector), Energy efficiency Improvement, Greenhouse gas, Nuclear power, Resource Technology, Clean-based technology, Aerospace, Power (KIAT, 2012c).

[20] Established in 2009 under MKE.

[21] such as Korea Institute of Energy Technology Evaluation and Planning (KETEP), Korea Health Industry Development Institute (KHIDI), etc.

[22] KEIT was founded in 2009 under MKE as a merger between six S&T organizations: Korea Institute of Industrial Technology Evaluation and Planning (ITEP); Institute for Information Technology Advancement (IITA); Korea Materials & Components Industry Agency (KMAC); Korea National Cleaner Production Center(KNCPC); Korea Institute of Design Promotion (KIDP); Korea Industrial Technology Foundation (KOTEF).

[23] Considering strong role of government in R&D planning, it is not uncommon in Korea.

Participation: The number of persons participating in KIAT's TRM has been increasing. Now about 700 experts participate in the yearly 35 TRMs. They are organized in expert groups consisting of about 20 persons each and come equally from universities, research organizations and industry (KIAT, 2012a). However, this increasing volume doesn't change that TRM is generally a top-down, expert-driven and technology-focused method for strategy development without broader participation of stakeholders from the Innovation System (Kim, 2012). KEIT stresses that foresight "*activities focus on shaping the future not on just making predictions about the future*" (KEIT, 2011: p. 2)" and thus opens for public-private dialogue. Still, KEIT applies expert-based Delphi surveys as its main tool and the participatory process of vision building includes only a few experts with diverse background. Due to their relation to MKE and dominant foresight design KIAT and KEIT are not involved with pre- or post-foresight (impact).

Mapping the system: There is no theoretically anchored method for mapping the sectors (Kim, 2012). The models illustrated apply standard foresight instruments such as SWOT, STEEP, patents/scientific papers and value chain analysis. KIAT uses advanced patent and technology map analyses while KEIT relies more on expert knowledge via Delphi exercises.

3.3.4 Conclusion

Sector foresight in Korea is mainly top-down, expert-based, centralized, short-term, product-oriented, technology-focused and non-systemic which reflects a linear understanding of innovation. In this context it is interesting to observe that the Vice President of KIAT, Yeong Cheol Seok, identifies weak industry impact and analyzing contextual factors as their main challenges. Diffusion of results and impact of TRM is relatively weak and finds interaction with industry difficult (KIAT, 2012a, 2012c). Also Moonjung Choi, KISTEP, is concerned that the Korean technology Foresight has little impact on industry because firms don't appear to be interested and the exercise operates at a rather aggregated level (KISTEP, 2012). One reason may be the industrial structure consisting of few very large companies (Chaebols) that operate independently of MKE and many small companies unable to benefit from results (Kim, 2012). Most of SME have 4-5 employees and are weak in terms of resources and capabilities. In contrast to Brazil, Korea is still weak in wiring of whole industries to develop strategic TRM except some big players.

4 Conclusion and perspectives

The case studies validate our key research propositions: (1) that adhering to the principles of ISF in foresight design will improve impact of foresight for innovation;, and (2) the principles of ISF are particularly applicable in sector level foresight in contrast to national (and) technology foresight. Overall the empirical parts demonstrated the usefulness of our initial theoretical claims about the merits of sectoral innovation system foresight– that performance is systemic and that actors in a system are gatekeepers of change and must therefore be enrolled (and probably also trained).¨

In terms of comparative lessons from the cases, it is clear that Brazil did well to enroll and commit diverse industrial actors. A pronounced structural difference is the absence of organizations in Korea functioning as 'bridging organizations' between industry, science and government. Even though Korea's foresight capacity is more resourceful and institutionalized in general, the foresight design in PES seems better suited for achieving Innovation System transformation. Availability of resources is necessary but not sufficient for inducing (desired) change PES further demonstrated the importance of trade-offs between short-term problem solving and strategy development for the longer-term, trust, and institutionalized channels of interaction between industry and government for enrolling industrial actors. The Korean case illustrated the limitation of top-down, S&T focused and expert-based foresight that once was central to success during the catch-up stage. Korea now faces the challenge of transforming its innovation system through full utilization of systemic and innovation oriented foresight. This paper constitutes a first tentative and exploratory step. To move forward and further exploration of this potential, more conceptual work and case studies are needed.

ISF indicator	Brazil (PES)		Korea (KIAT and KEIT)	
	Characteristic	*ISF compatibility**	*Characteristic*	*ISF compatibility**
Goal of foresight	Effective industrial policy; transforming industrial system	(++)	S&T investment priority lists rather than generating systemic change	(+)
Defining system	Ad hoc and weak innovation focus but with systemic understanding of performance	(++)	Industry codes with a non-systemic understanding of performance and innovation	(+)
Participa-tion	Broad participation and strong policy feed in channel to PDP	(+++)	Narrow participation, and weak/indirect policy feed in channel to MKE	(+)
Mapping method	Ad hoc design based on SWOT and STEEPV	(+)	Ad hoc and S&T focused (linear understanding of innovation)	(+)

Table 1: Summing up

*(+) weak, (++) moderate, (+++) strong

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6 Appendix

Name	When	Where
Lèlio Fellows Filho Senior Foresight Manager and researcher	June 4th	CGEE, Brasilia
Roberto Alvarez International Affairs Manager	June 6th	ABDI, Brasilia
Clayton Campanhola Director (at the time)	June 6th	ABDI, Brasilia
Karpsoo Kim, Professor, KAIST	July 11	KAIST, Daejon
Moonjung Choi Director of technology foresight division Office of Future strategy	July 12	KISTEP, Seoul
Ilgu Cho	July 13	KEIT, Daejon
Yeong Cheol Seok Department of technology strategy KIAT Vice President Kee Nyeong Lee Technology Planning Team Team director	July 16	KIAT, Seoul

Table 2: Overview of Interviews in 2012.

The field of Foresight is currently undergoing a transformation which inter alia involves a process of explicitly implementing a systemic and evolutionary understanding of innovation. The notion of Innovation System Foresight (ISF) has been proposed as a framework for advancing this process. In this paper we empirically explore ISF at the sector level in two emerging economies. We hypothesize that the ISF framework is particularly suitable for foresight analysis at the sector level, because this facilitates inclusion of contextual parameters and stakeholders. By exploring ISF the analysis enhances constructive integration between the two academic fields of Innovation Studies and Foresight. The paper concludes that the principles of ISF improve the impact of foresight for innovation, and that ISF is particularly relevant for sector level foresight.

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