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Technology foresight and industrial strategy

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ABSTRACT

When Technology Foresight (TF) began to be adopted in industrial countries, it tended to be still somewhat a marginal activity in developing countries. Today globalization radically transformed the range of economic activities that developing countries can perform. Production is fragmented and organized along global value chains. Dense flows of knowledge and technology are available, but need to be fully employed in the framework of coherent industrial strategies.

This paper examines how and to which extent TF programs are needed in developing countries given the new prevailing global context. It argues that the TF and industrial strategy are and must be mutually consistent and they need to be taken seriously, coherently designed and implemented in light of their role to shape and economic growth. We provide preliminary support to this argument by discussing the theoretical foundations and justification of TF and industrial strategy, and then reviewing some relevant examples from Brazil, Chile and South Korea.

1. Introduction

Technology Foresight (TF hereafter) represents a systematic exercise aimed at looking into the longer-term future of science technology and innovation (S&T) in order to make better-informed policy decisions (Irvine and Martin, 1984). Since its early inception, pioneered in Japan, TF has tried to help societies and economies to define strategic areas where the future of science and technology would lead.

During the last few decades the practice of TF diffused through a wide range of developed countries as well as regions, large companies and other organizations. A growing number of developing countries have undertaken TF exercises too. But to what extent does TF really reflect their different condition of developing countries trying to catch up with more advanced ones?

Given their scarcity of resources and lower levels of technological development, developing countries are facing remarkable constraints to catch up with developed countries. Industrial and TF strategies are of crucial importance to this aim since they both pursue the same scope which needs to be consistent with and help strengthen the National Innovation System (NIS). Thus, TF needs to go beyond a pure speculation of where the future will lead and instead foster large-scale efforts to align stakeholders' interests towards the common agreed vision of the future.

This paper addresses this central question and analyzes to what extent TF exercises are essential parts of wider industrial strategies in developing countries by first reviewing and discussing the theory and then analyzing three examples from three countries. Firstly, we examine the case of a now-developed country, South Korea, where clever industrial policies combined with a foresighted national vision clearly contributed to achieve a well-defined and unprecedentedly fast economic growth. Secondly, we analyze the case of a developing economy, Brazil, where the fusion and mutual reshaping between industrial strategies and TF exercises is demonstrating the country's ability to fully understand the new dynamics of Global Value Chains (GVC). Finally, we focus on the institutional development in another developing country, Chile. Here the government set up an institutional framework embodied by the National Council for Innovation and Competitiveness (CNIC) that would appear to favor the coherence and close connection between industrial strategy and TF with a long-term perspective.

2. What is technology foresight?

An essential fact characterizing today's economic development is the speed of technological change which brought about unprecedented levels of productivity growth (Baumol, 1986). As a consequence, industrial and trade structures are continuously being reshaped towards

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more complex sets of activities, that often follow a logic of vertical and horizontal fragmentation within global value chains, with room for outsourcing by multinational companies (MNCs) and foreign buyers that drive the process and ensure its internal coherence (Baldwin, 2011, Cattaneo et al., 2013, Gereffi, 1999). This opens up a new window of opportunities in terms of strategic investments that developing countries may follow to move closer to the technological frontier.

TF represents the concrete effort to overcome this emerging complexity since it systematically embodies a set of programs to study innovation plans and priorities to foresee, shape and direct potential future orientation of technological change (Martin, 1995). Its essential feature stems from the active involvement of a variety of actors such as government, experts, industry and civil society that gather together in order to define a joint vision of the future (Miles, 2010). Among TF participants the role of experts from science/academia and the private sector is of crucial importance since they might have better insights on technological issues with respect to policy makers and hence help reduce the uncertainty brought about the unprecedented speed of technological change (Hilbert et al.2009:882). The rationale behind these "exercises" is to generate positive sum games whose outcomes are expected to be more effective in terms of technological advancement, but also more sustainable in terms of socio-economic benefit than those of isolated initiatives taken by each actor.

Relevant literature refers to TF as to an exercise encompassing a wide range of activities, including: anticipation, forecasting, systematic looking ahead, forward looking activities, strategic intelligence, futures research, technology roadmapping and prognostic among others (Miles, 2010 and Phaal et al. 2004). The pioneering country in TF was Japan that in the 1970s used to call its national technology planning studies "forecast activity" despite the fact that what it was actually performing was "technology foresight" and perhaps in one of the most refined manners (Miles, 2010). It was later in middle 1980s thanks to Irvine and Martin (1984) seminal work inspired by the long Japanese tradition in S&T and TF, that we now call these "forecasting" activities "foresight". The difference is not trivial. On the one hand, forecasting activities, which are typically performed by closed-circles of experts, provide a mere prediction of future contingencies founded on deterministic precision. Their outcome reflects a specific vision of the world, with a single point of view. On the other hand, TF embraces a broader view of the world that is synergistically integrated with policy strategy. Its outcome sketches insights for forward looking S&T policies that "create" rather than "predict" the future (Miles, 2010) by placing emphasis on the learning processes (van Dijk, 1991) as well as the dialog among different disciplines and actors (Elzinga, 1983).

Irvine and Martin's (1984) work did not only provide the definition and understanding of TF as we conceive it today, but also spurred the proliferation of TF exercises around the world. Right after Japan, France started to perform foresight exercises during the 1980s, followed by Sweden, Australia and Canada (UNIDO, 2005). However, it was during the 1990s that TF gained momentum, expanding also within the UK, the US, The Netherlands and Germany: if one country engaged in foresight activity, others decided to pursue the same exercises too in order to remain competitive (UNIDO, 2005). TF in fact was appreciated as a valuable tool to identify fast, market-oriented and forward-looking innovation policies agreed by the government and the private sector. Recently foresight has also spread to developing countries as a strategic tool to narrow their competitive gap with the technological frontier (see Section 4). The narrow indication that cutting edge technology productions are only a concern to industrialized countries has gradually been overcome, and the literature in this regard has often used the language of "leap-frogging" (Perez, 1983).

From our perspective, the most distinctive features of TF are the following:

1) In its attempt to predict the future, TF has the potential to influence technology direction and hence to "make the future happen" (Miles, 2010). In fact, by fostering a participatory approach and boasting a strong legitimacy which helps building consensus, TF increases awareness, accountability, transparence, predictability of future technological developments and also provide ownership and responsibility (Elzinga, 1983);
2) At the same time, a participatory approach ensures the inclusion of new actors who can expand the range of possible strategies beyond the narrow interests of single individuals. For instance TF can significantly facilitate the strategic decision faced by stakeholders to "make or buy" new technologies considering the local knowledge endowments and organization (Lall, 2004).
3) TF can be pursued at various levels: organizational, local, regional, national or supranational.[1] All these levels of foresight aim to manage both demographic and socio-economic heterogeneity faced by actors involved in the analysis.
4) For its effort to try to link and reorient science and innovation on a national and regional scale, TF is inherently linked with the NIS. TF seeks to foster economic impact by "wiring up" the network between industries, university, governmental bodies as well as the society at large (*e.g.* aging societies, education and training) (Martin and Johnston, 1999, and Andersen and Andersen, 2014).

A number of "failures" intrinsic to innovation activities and S&T policies are usually tackled by TF exercises, such as:

- coordination failures among NIS stakeholders that often have different views on the importance of S&T. The balancing of such interests is crucial to wipe out rent-seeking behaviors and bounded rationality (Schlosstein and Park, 2006);
- communication failures, especially when different actors from distinct disciplines (*i.e.* specialized in different subject-languages and forms of communication) express diverging interests and are convened together in order to define a common strategy;
- market failures, since usually S&T programs require a long-term investment that should be weighed against the possibility of temporary short-term losses; and

political failures since governments too should adopt a long-term perspective on innovation which might not coincide with the political perspective of maximizing consensus in the short-term political interest for the upcoming election (this is often called "dynamic inconsistency").

3. How is technology foresight related to industrial strategy?

Nowadays globalization, increased complexity of manufacturing and services, stronger competition and faster technical change have radically transformed the range of economic activities that developing countries can perform. Production is internationally fragmented and organized along GVCs. Dense flows of knowledge and technology are available, but need to be fully exploited and employed within coherent industrial strategies. A specialization by technology and learning is becoming the dominant paradigm and developing countries need to detect opportunities for future technological and productive specialization in order to catch up and forge ahead.

Therefore individual isolated responses cannot be sufficient to address these complexities and guarantee that countries develop and catch-up. The interdependencies emerging from a globalized competitive setting makes it imperative to devise and follow an appropriate "strategy" to orchestrate responses from the Government, the private sector, and research organizations (Lall, 2004).

However, TF exercises often do not go hand in hand with the concrete identification and design of a policy strategy to promote catch up.

[1] For a comprehensive review of the various methodologies that can combine both quantitative and qualitative methods of TF, see Ciarli et al. (2013).