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Context appropriate technologies for development: Choosing for the future[☆]David Feige^a, Nicholas S. Vonortas^{b,c,d,*}^a Center for International Science and Technology Policy, The George Washington University, United States^b Center for International Science and Technology Policy and Department of Economics, The George Washington University, USA^c São Paulo Excellence Chair, University of Campinas, Brazil^d National Research University Higher School of Economics, Russian Federation

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ABSTRACT

Technology foresight has been increasingly undertaken by developing countries to identify technologies whose adoption might serve as a platform for future economic growth. However, foresight activities have not, by and large, resulted in well-developed policy initiatives. Three factors are relevant for improvement. First, foresight activities would benefit from being more informed by the convergence literature and global convergence experience over the past several decades, and should therefore incorporate organically the concepts of absorptive capacity and technology gap into foresight exercises. Second, certain preconditions – in particular the existence of a functional national innovation system – enhance the likelihood that foresight exercises will be successful. Third, in order to achieve wide buy-in and promote the sustainability of initiatives generated by the foresight activity, developing countries are advised to consult widely in the foresight process. Policies emanating from foresight activities should additionally address two core challenges: a) a clear definition of those technologies that should be developed internally vs. those that should be sourced from abroad and b) identification of the internal capabilities to be developed in conjunction with those technologies targeted for acquisition from abroad.

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1. Introduction

This paper explores technology foresight in developing economies. Technology foresight is the incorporation of projected future technology scenarios in the policy-making process. Despite the extensive body of literature on foresight in developed countries, relatively little exists with respect to its application in developing economies; and what does exist is largely case-study based. This paper addresses this shortcoming.

Foresight activities have, by and large, yet to be translated effectively into policy initiatives in developing-country environments. Three factors are relevant for improvement. First, many developing countries have focused their efforts disproportionately on leading-edge technologies, an approach borrowed from the leading economies; when they would be better served by targeting proven technologies that can be adapted to their local environments. This suggests important, as yet unexplored, links to convergence theory. Second, many developing countries lack the preconditions necessary to conduct effective foresight activities; principally the existence of a functional national innovation

system. Finally, over-reliance on expert opinion at the expense of mobilizing large segments of society in foresight exercises has often resulted in narrow buy-in and limited traction in implementation.

Policies emanating from foresight activities should also address two core challenges: a) a clear definition of those technologies that should be developed internally vs. those that should be borrowed from elsewhere; and b) identification of the internal capabilities to be developed in conjunction with those technologies targeted for acquisition from abroad.

The paper is organized as follows. We open by defining technology foresight and providing an overview of its historical evolution and principal methods, followed by a review of its application in developing countries. The third section treats some special policy problems that arise in conducting foresight activities in developing countries, followed by a case study on Panama's technology foresight experience. We then make a few concluding remarks and explore opportunities for further research.

2. Technology foresight: definition, historical evolution, and methods

2.1. Definition

Foresight is one type of future-oriented technology analysis, or technology futures analysis (TFA), a term coined in 2004 by the Technology Futures Analysis Methods Working Group (Cagnin, et al. 2008), although the application of the principle pre-dates the term itself. TFA

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refers to all kinds of technology-oriented projections; but principally refers to technology *forecasting* as well as technology *foresighting*.

The classical definition of technology *foresight* is “a process by which one comes to a fuller understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning, and decision-making...Foresighting involves qualitative and quantitative means for monitoring clues and indicators of evolving trends and developments and is best and most useful when directly linked to the analysis of policy implications” (Coates, 1985). Foresighting has also been defined as “a deliberative process that involves the identification of not the most probable scenario but the evaluation of many possible, desirable, or feasible scenarios” (Wehrmeyer et al., 2002). Miles (2008) argues that “foresighting is a set of approaches to bringing longer-term considerations into decision-making, with the process of involving informed stakeholders in analysis and dialogue being important alongside the formal products that can be codified and disseminated”. Georghiou et al. (2008) suggest that technology foresight activities are *participative* (involve the interaction of a wide range of stakeholders and experts), *prospective* (incorporate traditional forecasting efforts, using systematic methods to explore future dynamics and enabling the development of coping strategies); and *contain a policy-making element* by embracing approaches that adopt a long-term perspective in the form of strategic planning.

While *foresighting* identifies a range of future possibilities, *forecasting* attempts to identify a single, most probable, technological outcome. Foresighting is, therefore, most useful in contexts in which the future is unknown and not highly dependent on past technological trajectories; while forecasting is more useful when the past is likely to be a useful guide to future technological developments (Wehrmeyer et al., 2002). As such, foresighting is more closely related to scenario planning than is forecasting.

2.2. Historical evolution and current issues

Technology foresighting originated in Japan in the 1970s; then spread in the 1980s to France, Canada, Australia, and Sweden before being adopted in Germany, the U.S., the U.K., and other countries in the 1990s (UNIDO, 2005). Diffusion followed swiftly to the point where most developed countries had adopted the practice by the end of the decade; in addition to several emerging countries. Georghiou (2001) has argued that technology foresight activities have passed through three generations; the first characterized by technological forecasting by experts; the second with a greater market orientation; and the third and final with more of a social/user orientation. Many of the efforts initiated by developing and emerging economies remain “stuck” in the first generation.

Foresight activities began to spread rapidly beginning in the 1990s, for four reasons. One was the widespread recognition of the centrality of technology and innovation to national competitiveness. Second, constraints on public expenditures forced governments to focus their efforts on a more limited set of technologies to invest. Third, foresight activities provided societies with a systematic way of approaching problems in an ever-more complex world. The last was the acceptance of the importance of scientific and technological competencies and their role in generating national wealth (Martin, 2001). Keenan (2003) adds to these 1) the emergence of new styles of policy-making, whereby policy interventions had become more widely distributed across a wide number and types of actors; 2) an increased desire for anticipatory intelligence; 3) the ability of foresight activities to drive advocacy coalition-building; 4) bandwagon effects; and 5) the “millennium effect” whereby countries aspired to prepare for the turn of the millennium. As emerging countries observed the widespread use of foresight activities in developed countries, they began copycatting the process. Most of their efforts, therefore, are more or less nascent relative to more developed places.¹

¹ For an excellent and comprehensive review of technology foresight, including its historical evolution, common approaches and methods, and policy transfer, we refer the reader to Georghiou et al. (2008). See also Miles (2010).

Technology foresight is most commonly associated with technologies that contribute to economic growth and has historically been a developed-country phenomenon. However, developing countries – especially emerging economies – have increasingly adopted foresight processes to benefit from the next technological “wave” to drive economic growth. This can be important to developing countries in a growth trajectory due to their need to focus scarce resources to maximize impact. By throwing their weight behind a pre-defined (limited) set of technological trajectories rather than by spreading resources widely across a number of different ones, governments hope to make a meaningful impact on the adoption, adaptation and further development of the technologies they “champion”.

Many observers have taken issue with the practice of “picking winners” – the targeted selection of and support to specific firms, industries, or technologies. Yet, while targeted selection of firms (and often industries) is frequently misguided,² the targeted selection of technologies is said to be fundamentally different as governments alone offer the reach and resources to create the technology “platforms” upon which future technological solutions can be built. While there is inherent risk in any foresight activity that governments will identify the “wrong” technologies (or a sub-optimal set), this risk is substantially mitigated in developing countries as targeted technologies are often fairly mature and well developed and are not characterized by the technological or market risk associated with radically new approaches. Further, the benefits of foresight activities – allowing for the concentration of scarce resources – generally outweigh this risk.³

Current discussion is dominated by the need for better prospective analysis in the leading economies and for better diffusion of knowledge regarding the benefits of technology foresight in developing and emerging economies. According to Popper (2008a, 2008b) and Havas et al. (2010), more effective analysis would mitigate the tendency toward what they refer to as “hype-disappointment cycles” whereby potentially promising technologies are overhyped to the point that they inevitably lead to disappointment when the hype is not fulfilled.

One final point should be emphasized here. While governments often facilitate foresight activities and are generally responsible for the final “selection” of technologies to be backed, in its optimal form foresighting is a largely consultative process that draws on a wide range of expertise from government, the private sector, and civil society actors. Foresight activities can draw on a variety of participants ranging from technology experts to communities that will be affected (either positively or negatively) by technologies that are adopted (Saritas, 2006). Foresighting exercises conducted by governments in a vacuum are unlikely to be accorded the legitimacy necessary to ensure their sustainability.

2.3. Methods⁴

Numerous methods can be employed in conducting foresighting activities. Popper (2008a, 2008b), for example, lists 33 different foresight methods, which can be categorized as qualitative (subjective judgments that attempt to attach meaning to events and perceptions); quantitative (which use statistical methods or use or produce data); or semi-quantitative (which use mathematical models to quantify subjective judgments). Most foresighting exercises employ multiple techniques. UNIDO's *Technology Foresight Manual's* (2005) draws on

² The World Bank Commission on Growth and Development's “The Growth Report: Strategies for Sustained Growth and Inclusive Development” (2008), for example, which convened 22 leading practitioners from government, business, and the policymaking arena, came to the conclusion that identifying specific sectors for support is only infrequently a successful strategy.

³ A number of authors have argued that market failures justify the identification of specific technologies around which a country's resources may be concentrated, including Tassey (2007).

⁴ For a more comprehensive treatment of foresight methods, we refer the reader to UNIDO's *Technology Foresight Manual's* (2005).

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