Technological Forecasting & Social Change 115 (2017) 338–347

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

A portfolio analysis methodology to inform innovation policy and foresight

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ARTICLE INFO

Article history:
Received 30 September 2015
Received in revised form 29 January 2016
Accepted 28 June 2016
Available online 7 July 2016

Keywords:
Innovation
Portfolio optimization
Foresight

ABSTRACT

This paper describes a new method for combining innovation foresight, country's innovation indices, and decision analysis to identify the best combination of investments to improve national innovation systems, using Brazil as the example. The sub-pillars for human factors for innovation of the Global Innovation Index (GII) (Cornell University, INSEAD, and WIPO, 2014) are used to develop a gap coverage matrix that is analysed using the Portman method (Chow et al., 2011), to enable the identification of an optimum portfolio of investments, taking into account the level of funding for each program and any interrelationships between them. The methodology could either be refined through a foresight exercise or provide inputs to a foresight study for innovation policy that would generate threshold values for the gaps and describe their relative importance. The latter could provide an explicit and quantitative guide to decision-makers in the implementation of the foresight results. The implications of the method for FTA practice are discussed.

1. Introduction

For many years innovation foresight (Georghiou, 2007) has been an exercise typically circumscribed to technology assessment areas. Foresight has evolved beyond technology-driven scenarios. More recently, its focus has shifted from specific future economic and technological targets to an in-depth understanding of the ways in which one can operate and interact in known and in unknown systems (Miller, 2007, 2011a, b; Loveridge, 2009). Hence, future-oriented discussions have been based on reframing the future in order to collectively identify and invent anticipatory assumptions and make choices in the present (Miller, 2007, 2011a, b).

Many are the challenges in attempting to characterize innovation ecosystems. Cagnin et al. (2012) highlighted the contributions that FTA might make to orient innovation systems towards grand challenges by considering structural and functional aspects of a 'systems of innovation' approach. This should be the departing point for any foresight exercise aimed at understanding the dynamics of a given innovation ecosystem and its associated indicators. In this paper, we propose a methodology that could generate inputs for any innovation foresight exercise. In order to bring abstraction down into an operational level, the proposal will look at such a foresight study that would address shortcomings of the Brazilian innovation ecosystem as a case study.

The Global Innovation Index, hereafter GII, considers the performance of a broad range of countries in seven areas ("pillars") critical to building, maintaining and strengthening national innovation ecosystems. In this paper, we describe and execute an example application of a methodology to optimize a portfolio of investments to address a country's shortcomings in specific GII pillars and their 81 sub-pillars. The application example is Human Factors in Innovation, for which we apply our method to nine sub-pillars in Brazil. The portfolio of investments that we consider is restricted to fifteen programs of the Brazilian Ministry of Education for which we were able to obtain sufficient data for the analysis. Accordingly, the portfolio that we identify is optimized only within these possible investments, and does not include many likely important programs of other federal, state and local agencies and even those of the Ministry of Education for which we did not have sufficient data for analysis. Thus, we present these results solely as an illustration of the method and not with the intent to support investment decisions.

For a country aspiring to improve its ranking in the GII, its position in each pillar and sub-pillar illustrates shortcomings that need to be addressed in its innovation ecosystem. We treat these shortcomings in our method as "gaps" to be addressed by portfolio investments, and develop a supply-demand matrix in which the "supply" is the investments or programs aimed at improving the innovation ecosystem and

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http://dx.doi.org/10.1016/j.techfore.2016.06.032

the gaps are the "demand." Following that, we show how to estimate the expected value for each investment or program that addresses each gap. We use the expected value matrix, together with estimates of the cost of each program and the number of individuals it benefits, to find an "optimum" portfolio for any given total investment, i.e., the portfolio of investments that provides the highest total expected value per individual benefitted. We then measure gaps either relative to some objective requirement or to the best value achieved by another country.

Every country, regardless of its GII ranking, will have its own characteristic innovation ecosystem, with its own specific shortcomings to be addressed. Foresight taking into account the current state of innovation and the country's aspirations is necessary to understand whether filling the gaps defined in terms of shortcomings of the GII pillars and sub-pillars will be sufficient to achieve these aspirations. Such foresight can also provide guidance on what constitutes adequate filling of each gap and in which areas new gaps need to be defined. Lacking such guidance, we have treated all the gaps as of equal importance and used as our objective function for portfolio optimization the total expected value across all gaps. However, the methodology was designed to be used with foresight approaches, and when applied as a support for decision-making will incorporate foresight tools and outputs to define appropriate thresholds for filling each gap as an integral part of its objective function for optimization.

The paper is organised as follows: the next section discusses the methodological approach, followed by a section on results, discussion and implications, including assumptions and limitations of the present work and future recommendations. The paper ends with a brief conclusion.

2. Methodological approach

The proposed methodology is depicted in Fig. 1. The PortMan decision-making process provides tools to optimize portfolios and fill in gaps (Chow et al., 2011), which was originally developed for Research and Development (R&D) projects. The novelty of the present work is to connect innovation indicators and educational programs within the PortMan framework. For the current work, gaps are shortcomings in the GII sub-pillars, i.e. innovation indicators. The process concludes with recommendations for a foresight exercise to establish thresholds for gaps and their relative importance based on future scenarios. As a result, one can design programs that will fill in gaps and inform decision makers on choices for a portfolio of programs to effectively execute a country's innovation strategy.

In order to select innovation indicators and identify countries of reference one should compare innovation studies to identify common metrics and countries that score consistently high irrespective of the metrics employed. It is not uncommon to find innovation indicators associated with GDP expenditures and these should be removed from the study, since it is a central government decision to define and achieve GDP targets, rather than objectives of the portfolio of programs under evaluation. Once indicators, i.e. gaps, have been identified, one should develop a method to rank or categorize their relative importance since they can be used as inputs for foresight studies.

2.1. Innovation indicators and countries of reference

We performed a brief comparison of innovation reports aiming at identifying reference countries and innovation indicators for Brazil, which is the country under study. The following reports were used: The Global Innovation Index, GII, (Cornell University, INSEAD, and WIPO, 2014), The Global Competitiveness Report, GCR, 2013–2014 (Schwab et al., 2013), The Global Innovation Policy Index, GIPI, 2012 (Atkinson et al., 2012) and the Innovation Union Scoreboard, IUS (European Commission, 2014). Two reports were selected due to their importance for organizations that address global issues: GII for World Intellectual Property Organization and CGI for the World Economic Forum. Europe has a number of representatives in the top innovative countries. This motivated the use of the IUS, which is widely adopted by the European Commission. The GIPI was used to broaden the spectrum of the assessment of innovation beyond competitiveness and usual indicators since it deals mostly with public policies for innovation.

The Global Innovation Index, hereafter GII, was the report selected for the present case study. The GII has continuously evolved since 2007, and in 2011, the World Intellectual Property Organization adopted it. It contains one of the most complete set of studies with data from 143 countries. It also includes trends, for example, sustainability, and paradigm changes such as creative outputs in the economy as part of the calculation of the overall innovation score. Another advantage of the GII is that most of its data are recent (2012 − 2013); only 37% comes from previous years (Cornell University, INSEAD, and WIPO, 2014). The GII defines pillars under which indicators are grouped and provides four indices: the input sub-index, the output sub-index, the efficiency ratio (output/input) and the overall GII score (simple average of input and output indices). It also contains a conceptual and statistical coherence analysis for its composite indicators (Cherchye et al., 2008).

Since the present study focuses on the proof-of-principle of a methodology, not all GII indicators were used. There were a couple of reasons for selecting only those related to human factors behind innovation. First, these are recommended by the GII and characterized by the

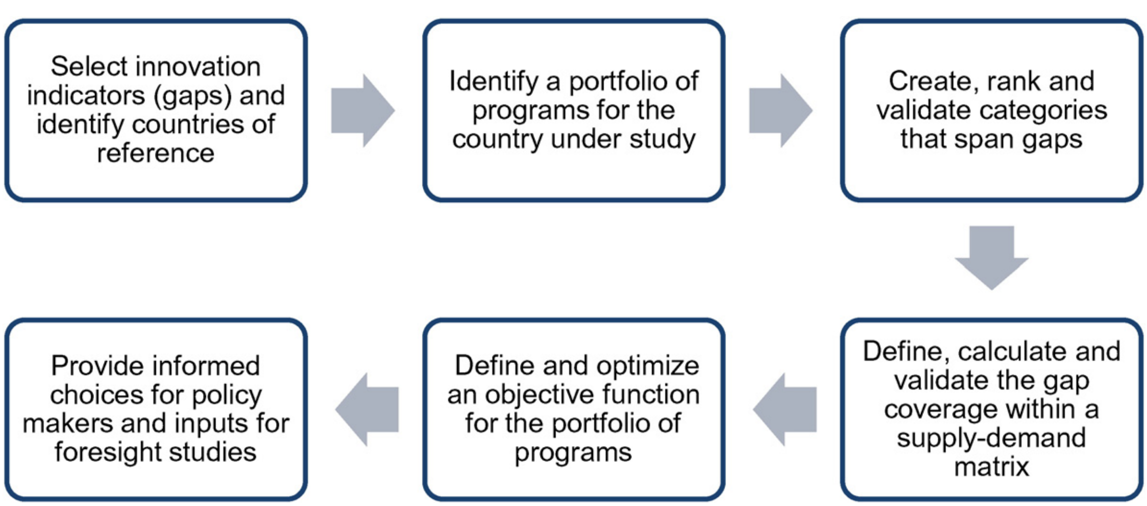

Fig. 1. High-level description of the proposed methodology.