



# The effect of innovation activities on innovation outputs in the Brazilian industry: Market-orientation vs. technology-acquisition strategies



Alejandro Germán Frank<sup>a,\*</sup>, Marcelo Nogueira Cortimiglia<sup>a</sup>, José Luis Duarte Ribeiro<sup>a</sup>, Lindomar Subtil de Oliveira<sup>b</sup>

<sup>a</sup> Department of Industrial Engineering, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil

<sup>b</sup> Department of Business Administration, Universidade Tecnológica Federal do Paraná, Curitiba, Brazil

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## ABSTRACT

This research investigates innovation in Brazil, one of the largest emerging economies in Latin America. More specifically, we aim to understand how innovation activities conducted in Brazilian industrial sectors (innovation input) are related to and affect innovation results (innovation output). The paper presents a quantitative analysis of a comprehensive nation-wide, government-sponsored innovation survey (PINTEC), covering more than 30,000 companies and 34 industrial sectors. Data from PINTEC reports were analyzed by means of PCA and 2SLS regression. Our results show that Brazilian industry tends to adopt two main opposite innovation strategies: market-orientation or technology-acquisition. The market-orientation strategy prioritizes internal and external R&D activities as well as commercialization and product launch activities; these activities showed a positive effect on innovation output. On the other hand, a technology-acquisition strategy based on industrial machinery and equipment acquisition showed a negative effect on innovation output. Moreover, our results show that innovation efforts that concentrate investments on software acquisition also generate negative results on innovation outputs. Our results shed light on critical aspects of innovation in the Brazilian emergent economy that provide insights and contributions for both managers and policy makers.

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## 1. Introduction

Nowadays, innovation is touted as the defining attribute for competitiveness, be it at the firm, industry, region, or nation level (Lawson and Samson, 2001; Miozzo and Walsh, 2006; Ireland and Webb, 2007). Over the last decade, an aspect of innovation research that gathered steam regards the empirical investigation of innovation inputs and outputs (and consequent economic and market performance) at the firm and industry levels (Schwartz et al., 2012; Hashi and Stojcic, 2013; Santos et al., 2014). This stream of research aims to understand which are the specific innovation activities conducted by firms or industrial sectors and what are the results of

such activities. Given the wide availability of standardized innovation surveys in many countries since the early 1990s, several works have addressed this issue (e.g., Courvisanos, 2009; Hashi and Stojcic, 2013; Marxt and Brunner, 2013), usually employing variations of the linear framework of innovation proposed by Crépon et al. (1988).

Most of this research addresses developed economies, characterized by favorable environments for innovation in the form of well-structured and mature national innovation systems (Filippetti and Archibugi, 2011), stable economic, social and political scenarios, and availability of private venture capital and large pools of qualified knowledge workers (Furman et al., 2002; Faber and Heslen, 2004). More recently, however, there has been a growing body of literature dealing with innovation activities in emerging economies (e.g., Raffo et al., 2008; Goedhuys and Veugelers, 2012), where determinants and preconditions to innovation are remarkably different. According to the technology gap approach to development and growth, there is a close relationship between economic and technological development (Fagerberg, 1987, 1994, 1996; Kemeny, 2011). In light of this approach, it can be argued that innovation

\* Corresponding author at: Av. Osvaldo Aranha 99—Sala LOPP 508–5° andar. Escola de Engenharia. Universidade Federal do Rio Grande do Sul, Centro, CEP 90035190 Porto Alegre, RS, Brazil. Tel.: +55 51 3308 3490; fax: +55 51 3308 4007.

E-mail addresses: [frank@producao.ufrgs.br](mailto:frank@producao.ufrgs.br) (A.G. Frank), [cortimiglia@producao.ufrgs.br](mailto:cortimiglia@producao.ufrgs.br) (M.N. Cortimiglia), [ribeiro@producao.ufrgs.br](mailto:ribeiro@producao.ufrgs.br) (J.L.D. Ribeiro), [lindomar@utfpr.edu.br](mailto:lindomar@utfpr.edu.br) (L.S.d. Oliveira).

is essential to the development of emergent economies (Metcalf and Ramlogan, 2008; Fagerberg and Srholec, 2008). How firms in developing countries innovate and which results derive from such innovative behavior impact such countries' absorptive capacity and innovative capability, a key aspect of the literature on technologic and economic catching up (Castellacci and Archibugi, 2008; Castellacci, 2011; Castellacci and Natera, 2013).

In this context, Latin American countries stand out as a particularly intriguing case. Overall investments in R&D in these countries have always been low, even when compared with other emerging economies in Asia and Eastern Europe (Olavarrieta and Villena, 2014). Particularly, private investments in R&D are hindered by a mixture of economic and political macro volatility, low quality of education and research institutions, financial constraints, and a weak intellectual propriety enforcement regime (Hall and Maffioli, 2008; Crisóstomo et al., 2011). Moreover, Latin American countries are highly heterogeneous in terms of their innovation environments (Crespi and Zuniga, 2012; Olavarrieta and Villena, 2014). This heterogeneity is reflected in findings of previous research dealing with innovation activities in Latin America. Crespi and Zuniga (2012) reported that determinants of innovation activities and innovation intensity are highly variable across the Latin American countries studied. Similarly, Raffo et al. (2008) found out that in some Latin American countries the innovative behavior of firms and industries is similar to selected developed nations, while in others firms struggle to innovate.

Among Latin American countries, Brazil stands out as a *rara avis* that deserves further investigation regarding innovative behavior. A regional economic power, one of the world's leading destinations of direct foreign investments and the largest recipient of foreign investment in Latin America (Franco et al., 2011), Brazil leads Latin America in many indicators of manufacturing and innovative activity (Olavarrieta and Villena, 2014). From an institutional perspective, Brazil implemented a number of rather successful large-scale policies and investment programs aimed at fostering innovation in Brazil, particularly in the last decade (Hall and Maffioli, 2008; Dantas and Bell, 2011; Fleury et al., 2013). Indeed, its national innovation system evolved constantly between 1980 and 2008 (Castellacci and Natera, 2011). However, compared to the country's regional prominence and its role among developing economies, there are relatively few comprehensive studies about innovation activities in Brazil. From a developmental perspective, it is critical to understand the inner workings of such innovation activities, as it has been argued that emerging economies' capacity to catch up with more technologically advanced countries will be greatly expanded as their innovation intensity improves (Castellacci, 2011; Castellacci and Natera, 2013). Additionally, previous research about the innovative behavior of Brazilian firms used rather outdated or narrow temporal data (e.g., Goedhuys and Veugelers, 2012; Resende et al., 2014) that may have not captured the dynamicity of the Brazilian innovation landscape.

Based on these considerations, this work contributes to the understanding of innovation in emerging economies (Crespi and Zuniga, 2012; Bogliacino et al., 2012; Santos et al., 2014) by addressing innovation behavior of Brazilian firms. Particularly, we explore how two of the three constituting elements of the innovative capability dimension of the Brazilian innovation system relate to each other (Castellacci and Natera, 2013). Thus, our research question can be stated as follows: *how innovation input in the Brazilian industry influence the so-called innovation outputs?* More specifically, our main objective is to analyze the relationship between nine innovation activities (innovation inputs) and the innovation results obtained (innovation output). This is done by means of a quantitative analysis of the results of a comprehensive nation-wide, government-sponsored survey on innovation (PINTEC) covering more than 30,000 companies. Specifically, we focus

on the economic characteristics of innovative firms, innovation activities performed by these firms, and perceived benefits accruing from innovation across 34 industrial sectors. Our results help to understand the characteristics of innovation in the Brazilian emergent economy. A key finding of this work is the identification of two opposite innovation strategies adopted by Brazilian innovative firms: market-orientation or technology-acquisition. Contrarily to previous research, our results suggest that one of these strategies lead to negative innovation output results in the Brazilian industry.

The paper is structured in six sections. Section 2 presents a brief literature review contextualizing the evolution of the Brazilian innovation landscape and previous research that employs PINTEC data. Section 3 addresses the research method, while in Sections 4 and 5 the results are presented and discussed. Finally, Section 6 brings the final considerations and limitations of the study.

## 2. Theoretical background

### 2.1. The Brazilian innovation landscape

The outlook of innovation in Brazil has improved in the last few decades (Castellacci and Natera, 2011; Rocha, 2015). Dutta and Lanvin (2013) and Olavarrieta and Villena (2014) report that the rate of R&D investment and intellectual propriety production in Brazil has increased in recent years. In fact, Brazil currently leads Latin America in many innovation input and output indicators. The internal market has expanded in the wake of improving macro-economic conditions, and the growing pressure for increased quality and lower prices from more educated and connected customers fostered demand for innovation (Sampaio et al., 2011). The diffusion of information and communication technologies (ICT) allowed Brazilian companies to improve productivity and competitiveness, creating a starting point for innovative efforts (Mendonça et al., 2008, 2009; Cortimiglia et al., 2012).

In recent years, Brazilian education also got better. The number of science and technology (S&T) graduates has increased (Helene and Ribeiro, 2011), as has the performance of Brazilian S&T institutions, both in terms of publications, visibility and innovation (Regalado, 2010; Leite et al., 2011; Olavarrieta and Villena, 2014). Toivanen (2013) argues that Brazilian research is consistently shifting from theoretical to more practice- and innovation-oriented fields. As global demand for Brazilian technologies increases (Silvestre and Dalcol, 2009; Regalado, 2010; Hall et al., 2011; Salerno, 2012), even the composition of the export portfolio has been gradually changing towards more technology- and knowledge-intensive goods and services, with potential positive consequences for the constitution of innovative capabilities by Brazilian firms (Cirera et al., 2015).

Institutional support for innovation has also become more structured and well-coordinated in recent years (Hall and Maffioli, 2008). Innovation policy is guided by the Ministry of Science, Technology, and Innovation (MCTI), but the Ministry of Development, Industry, and Commerce (MDIC) and the Ministry of Education (MEC) also play important roles. Resources for innovation are provided by government institutions like BNDES (Brazilian Development Bank) and FINEP (Funding Authority for Studies and Projects) as well as international institutions like the Inter-American Development Bank. BNDES is a state-owned bank that operates under the MDIC and provides funding for Brazilian long-term development projects, such as innovation and infrastructure projects. FINEP is a funding agency under the MCTI that promotes science and technology in private and public companies, universities, and research institutes through loans and grants. Under the MCTI, the main agency is CNPq (Council for Scientific and Technological Development), responsible for assigning grants to

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