Development profiles and accumulation of technological capabilities in Latin America

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ABSTRACT

The study of technological capability accumulation processes (TCA) for developing countries is long-standing. The studies tend to adopt a narrow perspective to science, technology and innovation and their policies, which do not seem to be sufficient to understand TCA in countries that face the middle-income trap. This adds to the limited metrics we have to measure TCA. This paper argues that it is necessary to frame the TCA processes at national levels, including the techno-economic and the socio-political spheres (TES and SPS). It is argued that countries' evolutionary trajectory combines these spheres differently and results in different development profiles. This is expected to have an impact on their TCA. The objective is to identify and analyse development profiles of Latin American countries (in terms of TES and SPS), and discuss it relationship with the characteristics of TCA at the firm level. This research departures from descriptive statistics based on Innovation Surveys for the TCA analysis at the firm and country level, and combines different steps and tools to asses country development profiles: (i) a long-term analysis (1980–2010) to verify the existence of cointegration between TES and SPS; and (ii) the identification and estimation of long run paths that determine three different country profiles. Finally, we outline some policy recommendations.

1. Introduction[1]

The study of the processes of technological capability accumulation (TCA) for developing countries is long-standing. Since the early 1980s, there has flourished an extensive literature recognizing the importance of the TCA for technological and economic development (Katz, 1986; Kim, 1997; Lall, 1987, 1992). Several studies have allowed a better understanding of the nature of technological capabilities (TC) and the process of TCA. Initially, the papers focused on proposing ways to approach the study of domestic TC and define the concept (Enos and Park, 1988; Kim, 1992, 1997; Lall, 1993; Westphal et al., 1985). From there, TC was defined as the ability to make an effective use of technological knowledge for production, investment and innovation (Katz, 1987; Maxwell, 1987; Teitel, 1987; Westphal et al., 1985).

Subsequently, an immense arsenal of works based on case study methodology provided evidence of these processes at the firm level (Dutrénit, 2000, 2004, 2007; Figueiredo, 2001, 2003, 2010; Hobday et al., 2004; Vera-Cruz, 2006 among others), drawing largely on the analytical framework constructed by Lall (1992) and Bell and Pavitt (1995).[2] Different bodies of literature have converged on the argument that there is a relationship between the TC of firms and their innovative performance. This firm-level work has also explored the role of technological learning for TC building (Bell, 1984; Katz, 1976, 1986). More recently other studies have explored with quantitative methodologies the levels of TC at country level (Archibugi et al., 2009; Archibugi and Coco, 2005; Fagerberg and Verspagen, 2002, 2007), the nature of technology upgrading and dimensions such as Intensity, Breadth and Knowledge (Radosevic and Yoruk, 2017), and the processes of catching up in Asia, using largely R&D and patent data trajectories in Asian countries (Lee, 2013; Wong and Goh, 2015).

At the micro level, a strong interest was developed to study the processes of TCA of firms, mainly industrial ones, and build taxonomies that classify the capabilities accumulated in different stages (Bell and Pavitt, 1995; Lall, 1992). These taxonomies reflect that the TCA

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processes are gradual, from a stage in which firms have only minimal levels of knowledge (necessary for the operation) to the stage where they have advanced innovative capabilities (which include capabilities for conducting R&D). These taxonomies have been used to understand the processes of accumulation of firms in various countries and industries (Bell and Figueiredo, 2012; Dutrénit, 2000, 2004; Figueiredo, 2001, 2003; Torres, 2004, 2006; Vera-Cruz, 2004).

More recently, there has been a special interest in understanding the factors that promote TCA until catching up, new levels of productivity and improvements in living conditions. However, despite the existence of a large literature on this subject, there is still no consensus on the real possibilities that these countries may have for achieving those objectives, and which would be "good STI policy designs", since several of the proposals made have failed to recommend successful policies. The existence of a group of countries that does not overcome the middle-income trap suggests that we need new metrics to understand the determinants of TCA (Radosevic and Yoruk, 2017). However, we should probably use a different lens, and look at other spheres that transcend the indicators associated with inputs and outputs of domestic science, technology and innovation (STI) capabilities. These studies that adopt a narrow perspective to STI do not seem to be sufficient to understand the problem of the TCA at the firm and national levels, particularly for those countries that are in the middle-income trap.

The use of a broader approach is rooted in other authors. Freeman (2011) argued about the connection between social policy and inequality with technology and growth. According to Katz (1986, 1987), Katz and Astorga (2013), Arza (2013) and Rasiah (2013), macro and micro levels are intertwined and firms respond to changes in the macroeconomic context with changes in their economic and technological behaviour.[3] In this line, Katz (1987:16–17) claims that the rate and nature of technical change, as well as the type of innovations and productivity advances that a given firm can undertake at a certain point in time, strongly depend upon: (i) strictly microeconomic forces emerging from the specific history of the firm; (ii) market variables related to the competitive environment in which the firm operates; (iii) macroeconomic forces characterising the framework conditions; and (iv) the evolution of the knowledge frontier at the international level. In other words, the macroeconomic conditions affect the microeconomic processes of TCA.

In this line, at the height of globalization, Freeman (1995) argued that, despite all its homogenizing tendencies, innovation systems would generate conditions for accumulating TC according to conditions that transcended STI activities. Some recent works have also adopted a broader approach, a multilevel analysis, which means a multifaceted description and measurement of the various factors that contribute to shape the domestic TC (or the innovative capability or absorptive capacity). They include variables of the economic and social spheres (Castelacci and Natera, 2013, 2016; Cimoli and Porcile, 2011; Fagerberg and Srholec, 2008). These papers focus on the analysis of national TC; however, they neither explore the TCA at the firm level nor the relationship between economic and social indicators with TCA at firm level.

This paper argues that it is necessary to frame the TCA processes at firm and national levels in a broader context, which we called the techno-economic sphere (TES) and the socio-political sphere (SPS). TES includes STI and economic dimensions, while SPS comprises social and political dimensions. It is argued that the evolutionary trajectory of countries combines these spheres differently and results in different development profiles. This is expected to have an impact on TCA processes at the firm, sector and country level. An implicit argument is that research, innovation, productivity and economic growth lead to improvements in education, health and democracy, as well as lower inequality.

This paper draws on evidence on TCA coming from four Latin American countries and focus on countries' development profiles. It has two interconnected objectives: (i) to identify and analyse the development profiles of Latin American countries that relate to the techno-economic (TES) and socio-political (SPS) spheres, and (ii) to discuss the relationship between these profiles with the characteristics of TCA at the firm level. Based on these ideas, this paper explores some STI policy recommendations to strengthen TCA processes that take into account the co-evolution, on the one hand, of TES and SPS, on the other, of the TCA process.

We recognise that there are methodological difficulties to address such complex analyses at firm and country level. There is a lack of long-term indicators associated with STI, which would allow us to better characterize one of the components of the TES (STI performance), as well as some more appropriate indicators to measure the performance of economies (TES), and the socio-political sphere of the countries (SPS). This lack of information makes it difficult to analyse how TES and SPS interact with TCA, and impact on their evolution. In addition, as asserted by Radosevic and Yoruk (2016), we still know little about the appropriate metrics for understanding the determinants of the TCA of the business sector. The lack of reliable indicators on firm-level TCA in the long term is even more serious.

Hence, measuring TES, SPS and TC of the business sector involves making several analytical and methodological decisions. On the one hand, it is necessary to reflect on what kind of long-term indicators are necessary to achieve a better contextualization of the TCA, and to re-think how to measure that process, and, on the other, advance in new analytical frameworks to explain the TCA at firm-level and at the country-level with existing information.

This research focuses on the first challenge. It combines different steps and tools to analyse the countries' development profiles that affect TCA of firms and countries, considering such profiles according to the evolution of their TES and SPS over time. The period considered for this long-term analysis is 1980–2010. We verify the existence of cointegration between indicators of the TES and SPS spheres and identify and estimate long run paths to determine country profiles (Hendry and Juselius, 2000; Johansen, 1991, 1995).

The content of this paper is as follows; Section 2 briefly describes the general context of the Latin Americans' National System of Innovation (NSI). Section 3 describes some features of TCA in the region. Section 4 reviews literature related to socio-economic and socio-political dimensions and the TCA, and proposes a conceptual model to characterize, through macro-aggregate indicators, the co-evolution of TES and SPS with the TCA. Section 5 describes the research designs. Section 6 identify countries' profiles based on the long-term evolution of TES and SPS. Section 7 discusses countries' profiles and their relationship with the TCA, and their implications for STI policy. Finally Section 8 concludes.

2. The evolution of the STI policies

Latin American NSI have been the result of a process of aggregation of different institutions, as well as public and private organizations that still operate in an uncoordinated way. This is due to several factors. On the one hand, historically, the assessment of STI-related activities has been poor and technical change based on local and systematic STI efforts has rarely been identified as an important factor in improving the performance of the Latin American economy. On the other hand, it seems that the activities of greater productivity in the Latin American market (at the industrial or service level) are not related to the efforts in innovation, that is to say, signs of short-term relative gains appear to be dissociated from innovation (Cassiolato et al., 2003; Cimoli, 2000; Dutrénit et al., 2010; Dutrénit and Sutz, 2014; López, 2007; Viotti, 2002).

The STI agencies (CONACYT/CONICYT, etc.) were created mostly in the 1970s, with a supply approach. They still play a central role in the

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[3] Vera-Cruz and Torres-Vargas (2013) describe Katz's argument in detail.