






Bangalore's IT entrepreneurial ecosystem: a systemic and evolutionary understanding from Latin America

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ABSTRACT

Bangalore's IT entrepreneurial ecosystem boomed in the 2010s. However, its recent development is the result of an accumulative process of capacities building. The objective of this article is to analyze this process from systemic and evolutionary perspective, inspired by some Latin American contributions. This study adopted a single in-depth case study design based on more than 20 semi-structured interviews with key actors of Bangalore's IT entrepreneurial ecosystem. This approach allows us to identify and reflect on the different long-term, multi-level and context specific processes, events and actors that influenced the configuration of Bangalore's IT entrepreneurial ecosystem, pointing out some systemic and structural constraints that may hinder its further development. The idea of structural heterogeneity is introduced in the entrepreneurship literature to denote the coexistence of a vibrant nucleus of entrepreneurial activity surrounded by certain underdeveloped systemic conditions. Finally, by introducing several Indian contributions, this study helps to deepen the dialogue between Asian and Latin American scholars to develop a research agenda on innovation and entrepreneurial systems giving account of the Global South development challenges.

KEYWORDS: Bangalore; Entrepreneurial ecosystem; IT; Evolution; Latin America; India

1. Introduction

Bangalore entrepreneurial ecosystem (hereafter, EE) is booming. During the last ten years the Bangalore EE has witnessed a significant increase in the number of incubators, co-working spaces, accelerators, venture capitals, and other support institutions (KRISHNA, 2019; DALAL, 2019). Pushed by both external and domestic demand, together with specific entrepreneurship policies at the national and state level, Bangalore's IT EE has been experiencing vibrant growth with near 2.300 Bangalore new IT start-ups created in the last 5 years, that is, 25% of all IT start-ups founded in India (NASSCOM, 2019). However, as some Indian scholar suggests, this Bangalore's EE is not 'new' (BALA SUBRAHMANYA, 2015, 2016). Certain antecedents and framework conditions can be traced back in Bangalore's evolution since independence, and particularly, the emergence and development of the IT sector in the 1980s (PARTHASARATHY, 2000, 2005, 2013; RAJARAMAN, 2012).

This study seeks to analyze Bangalore's IT EE evolution from a systemic and evolutionary approach to entrepreneurship (KANTIS; ISHIDA; KOMORI, 2002; KANTIS; ANGELELLI; MOORI KOENIG, 2005; KANTIS; FEDERICO; 2020) that dialogues with the Latin American structuralism of ECLAC (Economic Commission for Latin America and the Caribbean) (PREBISCH, 1962; FURTADO, 1966; PINTO, 1970) and some important Latin American contributions around the concept of national system of innovation (e.g. CASSIOLATO; LASTRES, 1999, 2005, among others).

Such a wider framework allows us to analyze the recent entrepreneurial boom of Bangalore and enables us to point out and reflect on some systemic and structural constraints that may hinder its further development. There are two relevant issues in which the Latin American approach could shed some light into the Bangalore case, namely, the structural heterogeneity and the systemic view of EE evolution. Indeed, this extension of Latin American structuralist approach to the reality of other Global South contexts has been previously

adopted in other studies about SNI (GONZALO; CASSIOLATO, 2016; GONZALO, 2018). In addition, we give special account of several Indian authors (e.g. PARTHASARATHY, 2013; BALA SUBRAHMANYA, 2015; KRISHNA, 2019; JOSEPH; SARMA; ABRAHAM, 2008) looking to deepen the dialogue between Asian and Latin American scholars. Precisely, one of the main contributions of this paper is this effort to integrate different approaches and perspectives to develop a Global South research agenda on innovation and entrepreneurial systems.

2. A systemic and evolutionary approach to entrepreneurship and EE evolution

Recent reviews of the entrepreneurial ecosystem (EE) literature highlight the need for a deeper theory-based discussion of the concept and particularly, a dynamic approach on the EE evolution (e.g. BROWN; MASON, 2017; ALVEDALEN; BOSCHMA, 2017). Hence, in the last five years, different contributions have been made trying to theorize and comprehend EE evolution (e.g. AUDRETSCH et al., 2021). In common, these approaches tend to call for the need of adopting a systems perspective when it comes to understand how an EE evolves over time. However, there are still some unanswered questions like the role of each EE element in the evolution of the system, how each element relates to the rest and how to capture different growth trajectories departing from different initial conditions and EE configurations.

The approach we present here tries to address some of these questions and was introduced in the pioneering studies of entrepreneurship in Latin American and East Asian countries done in the early 2000s by the Inter-American Development Bank (KANTIS; ISHIDA; KOMORI, 2002; KANTIS; ANGELELLI; MOORI KOEING, 2005) long before the concept of EE was introduced in the literature¹. A systemic perspective was introduced considering the specificities and structural

¹ Notwithstanding, there were earlier contributions arguing for a systemic approach to understand the emergence of new firms (VAN DE VEN, 1993; BRUNO; TYBJEE, 1982).

factors of less developed countries that affect not only the creation and growth of young firms but also the existence of entrepreneurial human capital itself and the emergence of scalable opportunities. This systemic approach considered the creation of new firms as the result of a long-term development process influenced by a myriad of socio-economic, cultural, political, and regulatory conditions (KANTIS; ISHIDA; KOMORI, 2002).

The concept of 'structural heterogeneity' (PINTO, 1970) was highly influential and enriched the received entrepreneurship literature with a broader approach, emphasizing the structural constraints faced by less developed economies. The same kind of approach has been also present among some Latin American scholars studying innovation and NSI (e.g. KATZ, 1978; AROCENA; SUTZ, 1999; CASSIOLATO; LASTRES, 1999). Indeed, a recent review highlighted this common intellectual root between this Latin American approach to entrepreneurship and the contributions made by Latin American NSI scholars (KANTIS et al., 2020).

Based on these antecedents, the conceptualization of the EE evolution offered here departs from the recognition of two ontologically different kinds of variables: (i) structural framework conditions and (ii) dynamics or transformational drivers, where the former influence the latter, which in turn transform the previous configuration of framework conditions into a new configuration (KANTIS; FEDERICO, 2020).

a) Structural framework conditions

The framework conditions define at every moment and space a specific configuration of actors and factors upon which some dynamics and forces start to take place. For instance, by considering how social heterogeneities affect the development of entrepreneurial human capital and social capital. Low-income levels limit the access to education and skills' development opportunities, affecting entrepreneurial human capital. Also, unequal social structures tend to create barriers to developing contacts between people from different social segments, blocking access to social capital and the building of informal networks, which are vital to create new firms and help them grow (KANTIS;

ANGELELLI; MOORI KOENIG, 2005). Social conditions have been demonstrated to be key to understand where do entrepreneurs come from and their growth potential in the Latin American context (KANTIS; FEDERICO; TRAJTENBERG, 2013) but it could be also extended to the Indian case where social inequalities tend to be even greater.

Cultural conditions may also affect the awareness of the entrepreneurial career as well as the social valuation of innovation and entrepreneurship (AUDRETSCH; BOENTE; TAMVADA, 2010; KANTIS; ANGELELLI; MOORI KOENIG, 2005). Particularly, in the Indian case, cultural differences are complemented by religious-based asymmetries. The caste system has direct implications not only in terms of educational and training possibilities, but also regarding the access to key resources and networks (AUDRETSCH; BOENTE; TAMVADA, 2013; DESAI; DUBEY, 2012; IYER; KHANNA; VARSHNEY, 2013).

The existence of such structural asymmetries at the social level is complemented by heterogeneities at the productive level, affecting the emergence of entrepreneurs and opportunities. This situation, largely studied in Latin America under ECLAC's structural heterogeneity perspective, shows how the characteristics of the industrial structure affect the development of employees' skills, the emergence of corporate spinoffs, and the generation of opportunities for new firms. Indeed, high levels of market concentration, usually observed in both regions, coupled with a disarticulation between an elite of large world-class firms and a sizeable base of micro, small and medium enterprises (MSMEs) with low levels of productivity and innovative capacity (LEDERMAN et al., 2013) define a structure that limits the foundations on which innovative firms can be launched since new firms tend to be characterized by a strong structural inertia (KANTIS; ANGELELLI; MOORI KOENIG, 2005). A similar situation has been found by Indian scholars (JOSEPH; SARMA; ABRAHAM, 2008).

Another structural factor of paramount importance for the emergence of new firms and opportunities, particularly for scientific/ technological-based entrepreneurship, is to understand the extent to which the NSI actors and their innovative activities are conducive

to the emergence of such science- and/or technology-based startups (KANTIS; ANGELELLI; MOORI KOENIG, 2005; KANTIS; ANGELELLI, 2020). In this regard, Latin American NSI scholars have successfully contributed to contextualize the innovation process, the actors involved, and the lower performance of NSI in this region, moving away from a narrow focus on R&D activities to a broader, historically grounded explanation of the innovation process, highlighting aspects like institutional weaknesses, the lack of infrastructure, volatile growth paths, the relevance of the geopolitical structures, brain drain, and the financial exposure (CASSIOLATO; LASTRES, 1999; 2005, AROCENA; SUTZ, 1999; GONZALO; CASSIOLATO, 2016). Finally, demand side conditions are also relevant. As it was illustrated in some previous studies low-income levels lead to low levels of demand, lower sophistication in demand preferences, and their concentration in some segments of society, affecting the type of firm that can be set up (GONZALO, 2018; CASSIOLATO; GONZALO, 2015; GONZALO; CASSIOLATO, 2016; KANTIS; ANGELELLI; MOORI KOENIG, 2005).

b) Transformational driving forces

The second element of this conceptualization of EE evolution are five interrelated dynamics or transformational driving forces (KANTIS; FEDERICO, 2020):

Entrepreneurial dynamic: It encompasses not only the entrepreneurial process of newly born firms (start-ups) but also the growth of existing young firms (scale-ups). The multiplication of high-growth firms and blockbusters is one of the expected results of this dynamic (BROWN; MASON, 2017). But there are other manifestations that include the surge of spin-offs, serial entrepreneurs and the 'entrepreneurial recycling' (MASON; HARRISON, 2006) which constitute the self-reinforcing driver of the entrepreneurial dynamics (BROWN; MASON, 2017). All these outputs contribute directly to the densification of the productive structure and the emergence of new activities and sectors.

Institutional dynamic: It includes the initiatives of organizations such as incubators, accelerators, mentoring networks, coworking spaces

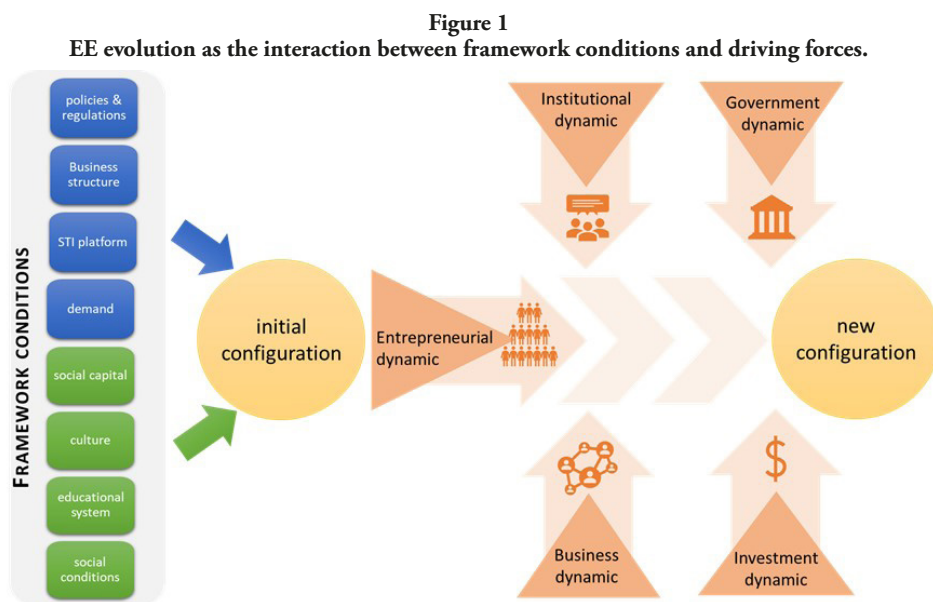
and others supporting entrepreneurship. As well, this category refers to the general institutional dynamic comprised by the initiatives led by universities and other educational and science and technology institutions, chambers of commerce, and entrepreneurial associations. As well, the characteristics of the NSI actors, stated before, would affect the relative importance of this dynamic.

Business dynamic: This refers to the role played by the existing firms located in the EE, particularly the large companies and their initiatives towards entrepreneurship (KANTIS, 2018). It is also the source of spin-offs and potential mentors, fuelling other dynamics of the EE like the entrepreneurial dynamic, the institutional dynamic and the investment dynamic. Structural heterogeneity and demand-side conditions would decisively affect the strength and contribution of this dynamic to EE evolution.

Investment dynamic: This involves the role played by different funding sources ranging from banks, business angels, seed funds, early stages funds, venture capitalists to other actors that directly or indirectly influence the availability of deals and investments (BROWN; MASON, 2017). Structural framework conditions would affect the depth of financial markets, the existence of “smart capital”, and the relative returns of long-term productive investments (versus the short-term speculative ones) affecting the relative potential of this dynamic. Shortcomings in this dynamic may force entrepreneurs to rely on bootstrapping strategies, foreign VCs, the diaspora and/or to sell significant portions of their businesses earlier than desired, in a process of “venture foreignization” and “entrepreneurial drain” (GONZALO et al., 2013; GONZALO; KANTIS, 2018; PIRES-ALVES; GONZALO; LYRA, 2019).

Political dynamic: It encompasses all the deliberated interventions made by the State to support entrepreneurs and young firms. It includes all the changes in regulations that influence the development of start-ups and young firms as well as those that may affect the demand conditions (public procurements) and the investment dynamic (financial regulations, incentives, direct investments or co-investments). The role of the State

in fostering EE evolution also depends on the framework conditions. For instance, in less developed countries the different organizations of the State must play several roles to promote economic development, innovation, and new firms, given the incompleteness of markets and institutions (CASSIOLATO; GONZALO, 2015; GONZALO, 2018; KANTIS; ANGELELLI; MOORI KOENIG, 2005; KANTIS; FEDERICO, 2012). (See Figure 1).



The amount and strength of the interdependencies between the different driving forces will explain the different trajectories of evolution that an EE could follow, conditional to the nature of the framework conditions. Thus, evolution is neither natural nor accidental, it is a historically rooted process (ROUNDY, 2016).

In addition, EE are open systems and multi-scalar in nature (BROWN; MASON, 2017) so external actors and factors may also influence the evolution of a single driving force and the EE as a whole. So, EE evolution would be also the result of the ability of the local driving forces to successfully accommodate external influences and leverage from them.

Finally, evolution is defined in terms of 'quantum leaps' from one configuration to another one. This transformation could be achieved by a cumulative process where framework conditions and drivers interact over the same trajectory, generating several 'geological layers' of actors and factors over time. That is, small but incremental changes are gradually accumulated to bring about a qualitative change. Alternatively, this qualitative change would take place by the intervention of certain (internal or external) factors, and/or actors, which act as catalysers. Finally, there could be combinations of the previous two patterns, where a configuration of accumulated 'geological layers' of actors and factors is changed by the intervention of some catalysers, whose transformative effect would not be possible without the previous accumulation (KANTIS; FEDERICO, 2020).

In sum, departing from a systemic approach to entrepreneurship, inspired by Latin American NSI studies and the ECLAC tradition, a dynamic – systemic model of EE evolution is presented, where it is understood in terms of a long term, systemic, and context-specific process where actors, factors, and structural conditions interact in non-linear ways. This perspective is used next to describe and analyze Bangalore's IT ecosystem.

3. Methodological approach and research context

The research methodology adopted in this paper is a single in-depth case study design (YIN, 1989). This research strategy is particularly useful when the research tries to address "how" and "why" questions as in this case (EISENHARDT; GRAEBNER, 2007). In addition, qualitative research is well suited for the study of the complex nature of the EE concept and its evolution as Roundy, Bradshaw and Brockman (2018) clearly stated. Finally, this method is chosen because its sensitivity to capture complex heterogeneous circumstances, its capacity to facilitate exploratory discovery and its

suitability for analysing different phenomena or trajectories in their own context (EISENHARDT; GRAEBNER, 2007; YIN; 1989).

To elaborate this case study, a myriad of sources was employed. First, an in-deep literature review on Bangalore's productive and economic history was done, with a particular focus on the contributions of Indian authors on Bangalore's IS and EE evolution. Based on this literature, a research protocol and some guidelines were designed to undertake semi-structured interviews with key actors of the city and its EE. These key actors included representatives from each of the key driving forces described in the theoretical framework: entrepreneurs, investors, academicians, business incubators and accelerators' managers, MNCs' accelerators programs, and policy-makers. In total, 25 semi-structured interviews were done. The average duration of each interview was from 45 minutes to 1 hour. The fieldwork was done during a research stay of three weeks in October of 2019 at the International Institute of Information Technology (Bangalore, hereafter IIITB). The selection of the interviewees was done in consultation with professors and researchers at the IIITB, based on their local knowledge and expertise trying to assure the participation of as many actors from each of the proposed driving forces as possible.

In addition to these interviews, some additional sources of data were used such as specialized magazines reports, digital media and press material, and several official documents, from the local and national authorities, as well as from NASSCOM. Given the objective of this study, all the information gathered was analysed into a chronological narrative, that would help to understand the different phases of the EE evolution and the factors and actors involved.

The research context is the city of Bangalore and its IT-based EE². Since Indian independence in 1947, Bangalore has grown both spatially and in terms of population by more than 10 times (SUDHIRA; RAMACHANDRA; BALA SUBRAHMANYA, 2007). With an estimated population that surpasses 12 million inhabitants, Bangalore is the 3rd most populous city in India and the 5th most populous urban agglomeration.

² Since 2014, Bangalore has been renamed as Bengaluru. Nevertheless, in this paper we will still use Bangalore instead given the long-term tradition of the city name.

Bangalore boasts a population that is young and cosmopolitan: around 77% is less than 49 years old (CENSUS 2011, 2022), and nearly half are migrants. English is widely spoken in Bangalore which constitutes a key advantage of city. Bangalore's GDP in 2018 was 70 US\$ billion, with an expected rate of 8,5% for 2019 (BUSINESS INSIDER, 2018). It is known as the IT hub of India, but it also encompasses a wide range of heavy and light industries and services, including electronics, aerospace, pharmaceuticals, biotechnology, automobiles, banking and finance, mining, steel, and cement. Bangalore also houses prominent Universities and R&D institutions, like the Indian Institute of Science (IISc), the International Institute of Information Technology Bangalore (IIITB), and the Tata Institute for Fundamental Research (TIFR), among others. As well, several R&D labs of multinational firms like ABB, Airbus, Bosch, Boeing, General Electric, Google and Microsoft are in the city, giving its leading role in the Indian NSI. Finally, some state-owned aerospace and defense organizations are located in the city like Hindustan Aeronautics Limited (HAL), National Aerospace Laboratories (NAL), and Bharat Electronics Limited (BEL).

Nevertheless, Bangalore echoes India's structural asymmetries and could not be detached from the rest of the country. Indeed, despite the important economic progress witnessed in the last years, social- and caste-based segregation in Bangalore still remain as a worrisome feature of the city (BHARATHI; MALGHAN; RAHMAN, 2018). Likewise, the unplanned spatial growth of Bangalore led to an increasing congestion and chaos whose main expression is the higher commuting time supported by its inhabitants. As well, the important influx of IT firms and investments during the last years, led to an increase in the land prices and living costs, which had a clear impact on urban poverty growth, the raise of slum settlements, severe water shortages and sewage problems, pollution, and public health crises (SUDHIRA; RAMACHANDRA; BALA SUBRAHMANYA, 2007).

In sum, Bangalore stands out as a young, cosmopolitan, and diverse city with important economic progresses but with equally

relevant social and environmental challenges. We will return to these issues in the last section.

4. Bangalore's IT EE pre-configuration, emergence and boom

a) The pre-configuration and Bangalore's place in the Indian NSI

During the Nehruvian period (1947-1964), the Indian NSI was configured, acquiring most of its strongest features, which are still present today: an emphasis on “big science” projects with nuclear energy and space as key sectors, a dense network of public labs, universities and institutes, a strong industrial policy support and an aspiration for self-sufficiency (JOSEPH; SARMA; ABRAHAM, 2008; KRISHNA, 2013; PARTHASARATHY, 2000; GONZALO; CASSIOLATO, 2017).

At that time, geopolitical and macroeconomic reasons convinced the Government on the importance of developing local electronics and communications sectors for defense and industrial growth³. This was the trigger that started the development of the Indian computer industry⁴. The availability of high-quality computer engineers was of course a key advantage at the local level that coupled with some changes within the computer industry at the global level, led Indian Government to start developing a national minicomputer.

That policy and the project of producing a national computer had an enormous influence on Bangalore, and Bangalore's IT industry (RAJARAMAN, 2012; SRINIVAS, 1997). On the one hand, the computer division of the Electronic Corporation of India Ltd. (ECIL),

³ At the geopolitical level, there were several border disputes with China and Pakistan during the sixties. Especially the war with Pakistan resulted in embargoes on Indian computer imports from the US. The Indo-US relationship deteriorated further due to the advance of the Indian nuclear tests in 1974, which resulted in new embargoes on the import of electronic equipment, including computers and software.

⁴ Also at that time, the Foreign Exchange Regulation Act was enacted imposing strong controls over foreign exchange and foreign firms. Due to that regulation, US MNEs like IBM left the country during the seventies. More details about this Act and the effect that it had over the Indian NSI could be examined in Joseph, Sarma, Abraham (2008) and Gonzalo (2018).

started to develop in Bangalore ruggedized computers for the Indian Air Force, that required the indigenous development of a complex interface electronic system. On the other hand, that aspiration for self-sufficiency and a national computer industry confirmed Bangalore's leading role as India's engine of engineers due the number and quality of Universities, R&D institutions and State-owned technological firms located in the city, most of them created during the Neruvian period (PARTHASARATHY, 2013)⁵.

In sum, ECIL's role during the 1970s and the tentative of producing a national computer served as catalyzers that put in motion the stock of R&D capabilities accumulated in Bangalore during the post-independence period and confirmed its leading role within the Indian NSI. Nevertheless, this policy had pros and cons (RAJARAMAN, 2012; PARTHASARATHY, 2000). On the one hand, it demonstrated that computers could be manufactured in India. As well, during this process, over a thousand engineers were trained in designing systems, enriching the already qualified Indian computer engineers base.

On the other hand, commercial achievements were not as satisfactory as technological ones. The domestic private sector demand was scarce and computer exports were hindered by the Indian geopolitical context. Hence, most machines were bought by government departments and universities. Besides, this tentative of a fully indigenous national minicomputer delayed the entry of the private sector into the local computer industry, with negative implications in terms of design capabilities and efforts.

b) The emergence of Bangalore's IT EE: Private sector entrance and the "super export orientation"

In the mid-eighties, Rajiv Gandhi became Prime Minister with a vision off modernizing the country. Then, a wave of both liberalization and support policies for the IT industry were tabled⁶. Software was

⁵ Even today, Bangalore graduates between 100.000 and 150.000 engineers per year (around 10% of the Indian total amount), most of them in computer sciences.

⁶ For instance, the Computer Policy of 1984 and the Computer Software Export, Development and Training Policy of 1986 (RAJARAMAN, 2012).

recognized as an industry, making it eligible for investment allowances and incentives. As well, new policies were implemented to stimulate private sector entrance to the computer and IT industries. Computer Science education was pushed through the Indian Institutes of Technology. Public procurement was also instrumental promoting the use of computers with Unix in banks, computerizing the ticket reservation system of Indian Railways, and developing Electronic Voting Machines, among other projects. Indian telecommunication policies were also revised, supporting the development of indigenous digital switching technology and, introducing, among other policies, a National Technology Mission to improve customer services and accessibility (PARTHASARATHY, 2000).

In Bangalore, three main milestones of the IT industry were reached during the 1980s. First, Electronic City, a specialized technology district spread across 322 acres, on the outskirts of Bangalore, was developed by R. K. Baliga, the first Chairman and Managing Director of the Karnataka State Electronic Development Corporation, who dreamt of making Bangalore the Silicon Valley of India. Second, given Bangalore's manpower and its cheaper land prices, Infosys, an Indian IT firm founded in 1981 in Pune, moved to Bangalore in 1983, and Wipro, an old Indian business group, also moved to Bangalore in the mid-1980s, launching its IT unit. Both Infosys and Wipro grew to be among India's largest IT firms. Finally, Texas Instruments chose to locate in Bangalore in 1985, a decision that had a significant reputation effect. As a result, many MNEs also decided to move to Bangalore.

The development of the software industry during the 1980s was mainly based on bodyshopping services to the US. The large pool of relatively cheaper, English-speakers engineers, the time difference with the US (that helped the Indian software industry to offer offshore maintenance after regular users in the US left their offices), and the experience gained by the Indian engineers in working in many platforms, particularly Unix, were the main advantages of the software industry in India and in Bangalore (PARTHASARATHY, 2013, 2005, 2000).

The 1990s were a inflection point for Bangalore with the establishment of the first Indian Software Technology Park (STP) in Electronic City, which provided space, satellite communications, and assured an uninterrupted power supply to software companies (PARTHASARATHY, 2000; RAJARAMAN, 2012). The STPs model was replicated all over India, pre-signaling a main feature of the 1990s development of the Indian software industry: the “super export orientation” (HEEKS, 1996). In fact, Indian software exports grew between 1987 and 1992 in a linear trend, but since 1992 exports grew exponentially. The share of exports in the Indian software industry sales went from 50% in 1990 to almost 70%, at the end of the decade (PARTHASARATHY, 2000).

To understand this super-export performance, it is useful to bear in mind certain contextual elements. In 1990 India launched the New Economic Policy (NEP) deepening the already liberal economic agenda (GONZALO, 2018). The NEP was accompanied by a devaluation of the rupee, an increasing openness to foreign investment, and the relaxation of controls over foreign components and equity regulation. Specific policies towards IT were also launched during this decade (JOSEPH, 2011; KRISHNA, 2013). Tax exemption on profits from service exports, elimination of import duties on software, and other policies oriented to the software industry were passed. A National Task Force on IT and Software Development was established in 1998, and a New Telecom Policy passed in 1999 with an emphasis on the provision of ‘world-class’ telecommunications infrastructure. NASSCOM, which was founded in 1988 as the association of the Indian IT industry, increased its influence over the public sphere during the 1990s by partnering key ministries. As well NASSCOM was key to obtain international quality certifications for the Indian IT industry (PARTHASARATHY, 2010).

In Bangalore, the regional government (Karnataka) was the first state to announce its own IT policy as a strategy to counter the increasing international competition from China and Russia and the emergence of some other Indian cities such as Chennai and Delhi as prominent locations of the Indian IT industry. The International

Institute of Information Technology, Bangalore (IIITB) was established to serve the local IT industry, gradually gaining a key role in Bangalore's IT entrepreneurial ecosystem and as an institution of national repute.

Bangalore continued to be the preferred location for IT in India. The presence of MNEs increased during the 1990s, mainly focusing on offshore development centers (e.g. Texas Instruments, IBM, Motorola) (PARTHASARATHY, 2005). Gradually, Bangalore was developing what Saxenian (1994) calls, a "technical community". Accompanied by the US growing demand, the institutional thickness was getting dense (AOYAMA; PARTHASARATHY, 2012). IISc Bangalore and IIITB consolidated as key training and research institutions. Foreign VC funds were entering (JOSHI, 2015; GONZALO; KANTIS, 2018).

Overall, the Indian software industry was advancing from bodyshopping to software factories and development centres and from competing on hour-based schemes to intellectual property rights-based businesses⁷. However, Indian exports remained extremely concentrated: twenty firms totalized 70% of exports in 1997-1998 (PARTHASARATHY, 2000). This concentration was even stronger in Bangalore, with a group of MNEs and domestic firms like Tata Consultancy Services (TCS), Wipro and Infosys, dominating exports of offshore services.

Thus, since 1990, in a context of broad public policies oriented to the IT sector, the Indian national groups and MNEs mainly led the "super-export" IT growth. In contrast, most startups and SMEs still relied on bodyshopping as their main way of subsistence. Finally, at that time, most of the Indian young engineers still preferred to work for a big company than starting their own firm (DALAL, 2019). Furthermore, a new US migration policy attracted the most talented young professionals to move, mostly to Silicon Valley (SAXENIAN, 2000, 2005), sowing the seeds of a very active diaspora that would help to ignite the boom of the IT startups in the next decade.

c) Bangalore's EE boom

⁷ This does not mean that cost advantages were not important. In fact, during the 90s the hourly cost in India was about 1/3 of the cost in the US.

According to Bala Subrahmanya (2015), by the end of the last century, the first explicit entrepreneurship policies took place. The focus of the first entrepreneurial programs was on knowledge-based entrepreneurship, inspired by the role of universities such as Stanford (US) and Cambridge (UK) in building their “high tech” entrepreneurial ecosystems. Incubators policy was pushed with the formation of Technology Based Incubators (TBIs) and a specific grant to technology-based entrepreneurs was settled: the *Technopreneur Promotion Programme* (BALA SUBRAHMANYA, 2015; MANI, 2014).

Broader public support to IT and telecommunications also continued during the 2000s (JOSEPH, 2011, 2014). The Information Technology Act and the Semiconductor Design Act were passed in 2000. In 2004, the Patent Act was modified to provide patents when software has technical applications in industry in combination with hardware (embedded systems) and a Broadband Policy was approved to accelerate the proliferation of broadband services. Also, in 2006, a National e-Governance Plan passed comprising 27 Mission Mode Projects including areas such as banking, insurance, and government digitalization⁸.

The first Indian policy documents that made explicit reference to supporting and easing the regulation of start-ups appeared in the 2010s (BALA SUBRAHMANYA, 2018). Also, there were other initiatives to strengthen financial support for startups through angel investors and through the stimulation of public funding in the early stages of startups development. The India Opportunities Venture Fund was created by the Small Industries Development Bank of India (SIDBI). In addition, Open Hub Systems were promoted, increasing the number of public and private incubators supported by private funding and tax exemption were also given.

In 2016, the Start-up India Action Plan was launched focusing on regulatory issues, funding support, promotion of industry-academia partnerships and incubation (BALA SUBRAHMANYA, 2018). A Fund of Funds (FFS) of US\$1.5 billion, and a credit guarantee fund were

⁸ <https://meity.gov.in/divisions/national-e-governance-plan>

created. As well different Innovation Centers, seven Research Parks (one of them at IISc Bangalore), and many innovation programs for science and technology students were created. In addition, Bangalore's regional government (Karnataka) was again among the firsts States to launch an exclusive policy for start-ups in 2015. The goal was to create an ecosystem through strategic investments and policy interventions to generate new age incubation schemes, foster partnerships between R&D institutions and industry, provide early-stage funding, and establish co-working spaces (Karnataka Start-up Policy 2015-2020).

All these policies and accumulated processes led to the consolidation of a new generation of startups and entrepreneurs in the 2000s with multiple origins like ICT industries, higher education institutions, public sector enterprises and R+D labs, business incubators and accelerators, and the return of highly qualified and resourceful Indians from the US (BALA SUBRAHMANYA, 2018, 2015, 2016). Mostly, these entrepreneurs belong to upper castes, have technical and management qualifications and previous work experience (KRISHNA, 2019).

“From the 2000s to 2010s was the phase of the gemination of the startup culture in India... particularly in high tech areas ... From 2010s to 2020s you can see the real “blossoming” of that effect.” Researcher, Indian Institute of Science, Bangalore

Special relevance had the return of around 35.000 skilled professionals to India, with Bangalore as the preferred location, after the US dotcom crisis of 2000. These “argonauts” (SAXENIAN; SABEL, 2008) used their transnational and local networks (particularly in upper castes), wealth, and skills to contribute to the emergence of home-grown startups and the development of entrepreneurial financing⁹.

The number of VC funds located in India jumped in the 2000s, going from 41 in 2002 to 309 in 2013, with IT taking two-thirds of the deals (GONZALO; KANTIS, 2018; JOSHI, 2015; MANI, 2014). Many of the Indian Americans who came back acted as angels or as

⁹ Getting close connections between Indian startups and the Silicon Valley had been deliberately promoted since the location of a Science and Technology Park in 2000 in the Silicon Valley. This organization supported startups in their exporting activities to US and provided them access to financial institutions in the US such as VC funds (JOSEPH; HARILAL, 2001).

managers of both Indian and American VC funds and the Indian Angel Network (IAN) was founded in 2006. In 2017, the Indian VC industry reached a record total, both in terms of investments, and the number of VC funds, mostly targeted at the IT industry. Several American, Chinese, Japanese and other global VC funds as well as home-grown VC funds such as Helion, Nexus and IDG ventures were the main players in Bangalore's financing scene (GONZALO; KANTIS, 2018). Public policy was also crucial for VC development, by nurturing it through different fiscal incentives and through the launching of the above-mentioned FFS. Until March 2020, 338 startups were invested by the Funds financed by FFS including Thirdwatch Data, Zipgo Technologies, Vogo Automotive, Vecto Technologies, among others (SIDBI, 2022).

“If you see the series A or series B... the investors are mainly from China, the US or Japan... All the global funds are now in India. But for a deal of up to 1 million dollar we are able to have Indian funding...”
 Manager of Oracle Accelerator

Quite importantly, a “new” demand driver gained volume since the 2000s: the Indian domestic market (KSHITIJA; KRISHNA, 2014; RAKSHIT, 2009). In 2016, 373 million Indians had access to internet, and the figure is expected to reach 829 million by 2021 (BALA SUBRAHMANYA, 2018). India's smartphone user base grew to over 300 million in 2016 and networked devices would go up to 2 billion (YOURSTORY, 2017). In fact, during the 2000s, telecommunications and IT were two of the fastest growing sectors of the Indian economy with IT reaching around 6% of India's GDP in 2010s. On the demand side, a credit boom, government digitalization needs, and a growing consumption have fueled new business opportunities and indigenous IT business models in the 2000s.

Large Indian IT firms, such as Tata Consultancy Services, Wipro, Infosys, HCL and Tech Mahindra-Satyam, have also begun to diversify their activities and methods to look beyond their traditional markets in Europe and North America (KRISHNA, 2013). For instance, Infosys launched in Bangalore the SETLabs (Software Engineering Technology

Laboratories) in 2000 to develop new technologies. SETLabs identifies emerging technologies working through a “co-creation” methodology, involving universities, research institutes and other technology partners both from India and from abroad (PARTHASARATHY, 2013).

Awareness of the domestic market also grew among MNEs, and many have deepened their involvement by launching R&D centers, open innovation programs, and accelerators (AOYAMA; PARTHASARATHY, 2016).¹⁰ For instance, Siemens opened the Corporate Research Technologies India (CRTI), in 2004, in Bangalore, to develop software engineering and embedded systems oriented to Asian consumers in areas such as energy systems, health care, embedded hardware, etc. (PARTHASARATHY, 2013).

Technology startups have capitalized on this domestic traction with two different business models: B2B or B2C (KRISHNA, 2019). For B2B startups the market emerges primarily out of the technologies from the R&D labs of MNEs. Involvement in MNE supply chains has increasingly led to upgrading, with opportunities to provide R&D services, IP-block development, and embedded-systems design (PARTHASARATHY; AOYAMA, 2006). For B2C start-ups, the market is mostly oriented to the urban Indian consumers. In fact, several Indian B2C unicorns (i.e., young firms with a valuation of more than US\$1 billion) such as Ola cabs, Swiggy, and Flipkart, have emerged in the last years.

The growth in accelerators spaces is a characteristic of Bangalore’s EE in recent years and is closely related to the growing presence of MNEs and VC funds (BATHIA, 2020). Microsoft, Amazon, Cisco, Google, Intel, Oracle, Rolls Royce, Axilor Ventures, Sequoia Ventures are some of the MNEs and VC funds that launched their corporate accelerator programs, mostly in Bangalore. At the same time, there are different accelerators models and programs run by former Indian ex-entrepreneurs, angels and VC funds managers, such as GSF Accelerator, Upekkha, and VentureNursery.

¹⁰ By 2015, 928 MNCs had established 1165 R&D centers in the country. <https://www.slideshare.net/zinnov/executive-summary-talent-report-final>

NASSCOM has also become more supportive of the Indian entrepreneurial ecosystem (AOYAMA; PARTHASARATHY, 2016). For instance, an incubation and acceleration program in partnership with Wipro, Google, Microsoft, and Intel. Also, under the NASSCOM Technology Start-up Registry, various skills development courses were established (NASSCOM, 2019).

In this vein, entrepreneurial education programs significantly advanced since 2010 (BALA SUBRAHMANYA, 2018). Major academic institutions such as the IISc, IIMB, and IIITB have developed their own incubator programs. Besides, there is a growing number of entrepreneurial websites and newsletters in India, such as india.startuplogic.com, desistartups.in, Start-upNews.in, YourStory, etc. (BALA SUBRAHMANYA, 2018). IT start-ups have also attracted a growing media attention. Financial dailies as general dailies such, carry daily news relating about start-ups.

In sum, during the last two decades Bangalore has witnessed a startup boom in its IT ecosystem built from a mix of accumulated location-specific assets, returned 'argonauts' from the Silicon Valley, a growing role of the domestic demand, increasing influxes of VC funds to startups, specific policies at the national and regional level, and the surge of new supporting organizations. As a result, today Bangalore tops the list of Indian cities attracting highest startup funding (LIVE MINT, 2020), and ranks among the world's leading startup ecosystems according (CHAUDHURY, 2019; STARTUP GENOME, 2019).

5. Discussion: the evolution of Bangalore's IT EE

a) An evolutionary and systemic understanding

Once we described the evolution and the current momentum of Bangalore's IT EE, this section recaps our conceptual framework to shed some light about the role of the structural conditions as well as the driving forces throughout this process.

On the first place, different framework conditions could be identified. For instance, the “Bangalorian” atmosphere, related to its cosmopolitan and migrant-friendly city profile, the relative higher religious diversity, the high number of English speakers, and the complementation with the US market.

“Among the Indian cities, Bangalore is the more liberal in terms of culture, communication, accepting new ideas, new models. The fact that 70% of its population are immigrants has a lot to do” Manager, Oracle Accelerator

In addition, Bangalore’s historical military profile, led to the location of relevant military and aerospace organizations and public-owned enterprises with a significant R&D intensity. Furthermore, since the Nehruvian period several of the main Indian R&D institutions have been created in the city, contributing to build a dense network of R&D organizations and capabilities at the local level. Equally important was the location of certain IT MNEs, mainly from the US, and the emergence and consolidation of some national IT champions during the ‘80s that contributed to shape a dynamic though concentrated IT business structure.

On the demand side, three different phases could be traced back. First, an inward-looking, State-based demand during the post-independence period due to geopolitical and macroeconomic reasons which helped to consolidate some strategic sectors at the local level such as electronics and the computing industry. Then, a super export orientation led by the US demand that helped to ignite and set up the IT sector emergence during the ‘80s and ‘90s. And finally, a renewed relevance of the domestic demand, especially since 2010, built upon the successful super export orientation phase and chiefly encouraged by the digitalization of the economy which created a whole new opportunity space for new firms.

Over this configuration of framework conditions, different geological layers of actors and drivers are identifiable, following our conceptual approach. First, the political dynamic, embodied in the key role of the State, both at the regional and central level. The role

of the State could be traced back to the post-independence period, when a network of public-owned companies and R&D organizations in the aerospace, defense and related sectors was created (GONZALO; CASSIOLATO, 2016). In the specific context of the IT industry, this supply-side role materialized itself in the decision of developing an indigenous mini-computer, something that consolidated the indigenous technological capability.

Since the 1980s, however, the role of the State gradually changed, giving more space to the local private sector, the business dynamic. A liberalizing policy agenda, and several explicit IT regulations and policies led the IT industry to the so-called super-export phase. During this phase, the role of the State experienced a transition: from direct producer to infrastructure developer. The development of the telecommunication infrastructure and the Electronic City in the '80s, the Software Technology Parks in the '90s, and the incubators facilities in the 2000s, are good examples of that changed role. Nevertheless, the centrality and strength of the political dynamic has diminished over the last years and except from some initiatives aiming at the investment dynamic, the role of the State during the booming phase of the EE has been more supportive than promoter.

The institutional dynamic took much of the promoting role of the EE during the last phase of the EE evolution. Built on the accumulated process of institutional thickness where universities and R&D institutions have played a key role, during the '80s the IT ecosystem became more institutionalized by means of the creation of NASSCOM, the national association of IT entrepreneurs and enterprises. The role of NASSCOM has been central at the beginning of the IT super-export phase by encouraging the acquisition of globally accepted certifications but also by giving voice to the demands of the IT sector. NASSCOM has actively put forward an entrepreneurial policy agenda, especially during the later phases of the EE evolution. Precisely during these phases, pre-existing actors deepening their involvement in the institutional dynamic, and new actors come to existence – mainly accelerators – nurturing and specializing the institutional support network. As well,

different actors, neither strictly related to the State nor to the private sector, such as NGOs, social and transnational entrepreneurs, are becoming increasingly important to constitute a 'hybrid domain' within this dynamic (AOYAMA; PARTHASARATHY, 2010).

Business dynamic, whose role has been critical in the early development of the IT cluster during the '80s and '90s, has been increasingly active in the development by nurturing the institutional dynamic. On the one hand, MNEs are increasingly developing open innovation initiatives and business accelerators. On the other hand, the Indian IT national champions such as Infosys and Wipro are getting closer to Bangalore's startups, by means of corporate venturing initiatives and different forms of partnerships.

The investment dynamic has been the last one to enter the scene, although it is one of the main current drivers of the EE evolution coupled by the institutional dynamic. Venture capital started to play a role in the EE just in the '2000s, mainly through the intervention of the Indian diaspora in the US and the Indian-Americans who returned to the city to build local VC funds or acted as angel investors. Public financing re-entered in the scene in the 2010s, through different instruments such as the Fund of Funds launched in 2016. Then, as long the EE develops global VC Funds, from Silicon Valley and also from China, started to invest on Bangalore's new firms, being nowadays the main investors in the EE.

Alongside these dynamics a key actor in the evolution of the EE has been the Indian diaspora in the US (SAXENIAN, 2000, 2005) who has played a significant role since the 1990s and have contributed decisively to the densification of the institutional platform, the development of the local VC industry, the export orientation of the IT industry, and the cultivation of an entrepreneurial culture within the population, affecting also the entrepreneurial dynamic. In fact, it could be reasonably affirmed that the diaspora and the returnee Indian-Americans played some of the driving functions of the entrepreneurial dynamic, feeding the rest of the dynamics and helping to develop the EE.

The combination of favorable framework conditions like the increasing demand, both at the local and international level, and the recent dynamism of the institutional support, policies and VC investments, results in an increasingly strong entrepreneurial dynamic in Bangalore. Evidence of that strength are not only the recent emergence of high-growth new firms, *aka* unicorns, but also the growing number of firms created in the city during these last years. Stated-owned enterprises and R&D institutions have been key actors nurturing the entrepreneurial dynamic.

“I think that the State has contributed a lot. If you see those people who where entrepreneurs in the 90s, those people come from the central government research institutes...” Funder, Upekkha Accelerator

In sum, throughout this section the evolution of Bangalore's EE has been described as a result of a cumulative process rooted at the post-independence period and the consolidation of a world-class IT industry, intervened by certain external and internal shocks and driving forces that acted as catalyzers to move the EE to successive new configurations and maturity levels.

b) Some reflections from a Global South perspective

Bangalore EE and its evolution certainly have several circumstances that make it quite unique. Nevertheless, it is possible to draw some reflections from our systemic and evolutionary approach, based on some commonalities between the Indian case and the Latin American reality, to start a dialogue with other Global South innovation and entrepreneurial systems.

In the first place, as previously pointed out in Gonzalo and Cassiolato (2016) and Gonzalo (2018) for the case of the Indian NSI, structural heterogeneities at the social and productive level are relevant. This also happens in Bangalore. As we mentioned before, despite the current evolution of the IT sector, it remains highly concentrated around a couple of large, national firms whose leadership started during the super-export phase, and the youngest high-growth firms based in the city. The rest of the industry is still under the bodyshopping or

software factory model, based on their cost advantages in terms of highly specialized human resources.

In addition, the integration between the different actors that formed the successive geological layers that have significantly contributed to Bangalore's IT EE boom still remains a challenge. For instance, Bangalore's public companies are quite isolated, without strong relations with the IT EE and its startups. The same could be said regarding R&D institutions, whose connections and interactions with Bangalore's EE and the Indian NSI still could be deepened. This does not to decry the importance of the current IT EE but rather to emphasize the need for further policy efforts to connect Bangalore's IT EE with the broader context of the city and the country productive, institutional, social and environmental challenges.

As well, despite the progresses of the IT industry and the EE, Bangalore still suffers from a deep cast-based social segregation (BARATHI et al., 2018) and serious vulnerabilities and inequalities at the social level (ROY et al., 2018). So, without ignoring the key relevance of the IT sector in the growth of the city and despite its increasing involvement with the domestic needs and demands, it still seems like an enclave. Structural heterogeneity here is not only related to the productive structure, but also to the social one.

Concretely, in terms of Bangalore's EE, we could extend the notion of duality to define it as a *'dual ecosystem'*, that is, a vibrant nucleus of entrepreneurial activity surrounded by several underdeveloped systemic conditions. Indeed, in a recent study Rault and Mathew (2019) defined Bangalore as an *'imbalanced ecosystem'*. This is also observed in many urban vibrant IT based EE in Latin America, like Sao Paulo, Medellin or Buenos Aires, where a significant portion of the entrepreneurial activity is spatially bounded into certain areas of the city and upper segments of the population. Hence, it could be affirmed that this *'ecosystem duality'* constitutes a specific feature of developing countries that should be further investigated as part of a Global South research agenda.

A second common issue between Bangalore and Latin American cities refers to the incidence of such social asymmetries on the sustainability of the entrepreneurial human capital flow, the entrepreneurial dynamic. Indeed, the Index of Dynamic Entrepreneurship ranks entrepreneurial human capital as the main weakness of India, echoed what happens in many Latin American countries (KANTIS et al., 2019). Even more, in the Indian case, this situation is worsened by the caste-based segregation. In fact, the access to higher education and to a rich social network locally and overseas, critical factors for the emergence of new IT-based startups, are strongly related with individuals' caste and class position (AUDRETSCH; DOHSE; NIEBUHR, 2010; IYER; KHANNA; VARSHNEY, 2013). Hence, the social base from where IT-based would-be entrepreneurs would be limited by the extent of social (and caste-based) segregation, imposing an endogenous constraint to the EE expansion. In Latin America, some governments started to attract potential entrepreneurs from abroad to enlarge the base of would-be entrepreneurs., however, the relative impact of such measures is still a matter of discussion and should be investigated further.

A third element in this shared agenda, refers to entrepreneurial financing. Despite angel investors and home-grown VC funds are gaining relevance in Bangalore's IT EE, foreign VC Funds are leading the industry (GONZALO; KANTIS, 2018). This situation may result in certain positive outcomes given the global scale of such funds, but it may also generate unfavorable consequences like a process of early foreignization of growing startups and entrepreneurial drain. These consequences were already identified and analyzed in the Latin American case, with both innovation and competition policy implications (GONZALO et al., 2013; PIRES-ALVES; GONZALO; LYRA, 2019). These issues are gaining presence even in official documents (GOVERNMENT OF INDIA, 2012) and should be included in the future policy agenda of the IT EE, considering the Latin American experience.

Finally, there is a common challenge related with urban infrastructure. As we said, Bangalore growth has led to several

infrastructural constraints, related to pollution, access to water, population displacement, commuting time, etc. Although these issues have not affected the current expansion of the IT EE, we could ask whether they may constitute a barrier in the future. Looking at Latin American big cities, we can also say that if rapid urban growth is not supplemented with relevant urban planning policies, this will increase urban stress, constraining the future of the EE and adding social tensions to the cities. Urban and telecommunication infrastructure constitute a key area of policy intervention to accompany the evolution of entrepreneurial ecosystems.

Summing up, by adopting a structural, evolutionary, and systemic approach we were able to trace back the different geological layers that defined the evolution of Bangalore's IT EE up to the current entrepreneurial boom and reveal its limitations. In particular, we conclude with the image of a 'dual ecosystem' to characterize Bangalore's EE, a shared feature with other Latin American vibrant EE. This commonality, rooted in the socio-productive structural heterogeneity, endures as a challenge for the Global South thinking. This future research agenda should include in the first place a deeper discussion of the commonalities and differences between the evolution and the driving forces in different EE from the region, including the main lessons learned and policy implications. This study constitutes a first attempt in such direction but should be complemented by more studies from other Latin American, Asian and African and entrepreneurial ecosystems.

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