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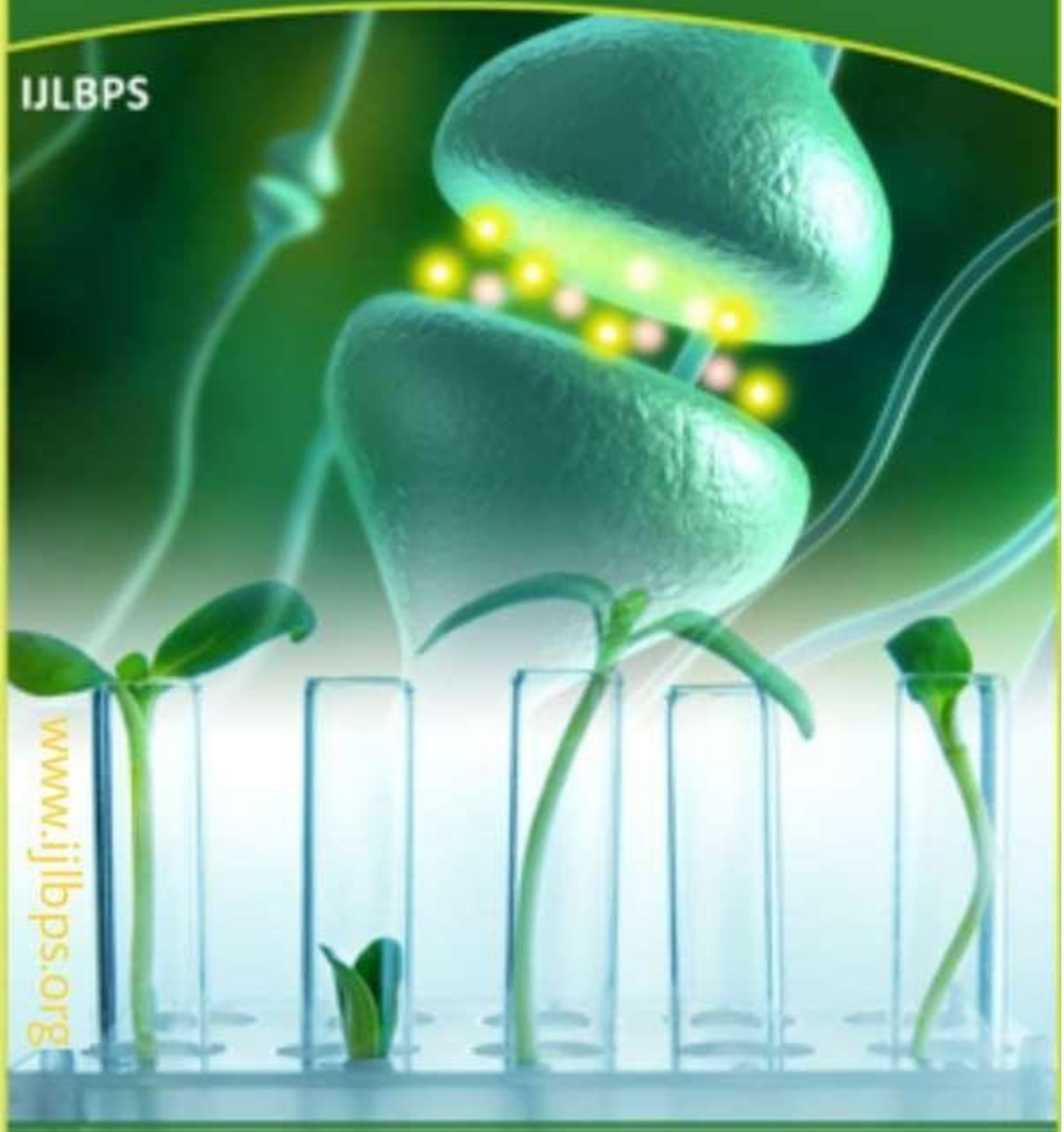

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REVIEW AND CASE STUDIES OF INTELLECTUAL PROPERTY RIGHTS

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ABSTRACT:

The present study adds to the ongoing discourse regarding the function of innovation and intellectual property rights (IPRs) in developing countries' (DCs') catch-up programs. We review the research on four main areas. We start by going over the evolutionary and neoclassical theoretical underpinnings of innovation and catch-up. Second, we look at the reasons underlying some of the lags, especially with regard to path dependency and the diversity of convergence dynamics. The issue of how to encourage innovation in DCs arises from this. In the third and fourth points, we look at the topics of industrial policies and IPR protection. International organizations frequently advise strengthening IPR protection. The relevant literature, however, demonstrates that their impact is highly non-linear because the ideal level for DCs is first low and subsequently rises as the nations advance. This outcome holds up well under a variety of models and techniques. Ultimately, research indicates that industrial policies have the potential to play a significant role in stimulating innovation in developing countries (DCs), despite significant obstacles to their implementation. These include the need to target industrial policies appropriately and the emergence of rent-seeking practices in an institutionally decaying environment.

1. INTRODUCTION

The dynamics of long-term growth and development gaps between countries have been a concern for both scholars and public authorities for several decades. However, although technology is often considered as a plausible explanatory factor, its inclusion in theoretical models and the subsequent empirical developments do not always reflect its crucial importance (Fagerberg, 1994). This debate about how to foster innovation and catch-up is particularly relevant today for two main reasons.

The first reason is that usual innovation metrics, like the number of patents filed by residents (World Development Indicators, World Bank), show that only today's middle-income economies like India, Vietnam, Iran, Egypt, Chile or South Africa succeeded in increasing their innovation capabilities. The innovation performance of lowincome countries remains weak. For instance, sub-Saharan African countries filed less than 10 000 patents since 1990, while countries like the United States are leading with more than 6 million. Mauritius (45th) and South Africa (61st) are the only sub-Saharan African countries among the top 80 innovative countries (out of 132), according to the Global Innovation Index 2022 (WIPO, 2022). In this context, the second reason is that one has to quite cautious about taking for granted that

policies aimed at fostering innovation in the South, such as increased intellectual property rights (IPRs) protection by the World Trade Organization Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement,1 would have significantly favourable effects in low-income countries.

This paper aims to contribute to the debate by providing a state-of-the-art of the most diverse and complementary literatures possible in their perspectives and methods. To this end, we review the theoretical and empirical literature, addressing four crucial issues: First, what are the theoretical foundations of innovation and catch-up? Second, why do some countries struggle to develop innovative capabilities and thus catch-up? Third, does the strengthening of IPRs foster innovation in developing countries (DCs), as often advocated? And finally, what is the relevance of industrial policies, and what are the potential obstacles to their implementation in DCs?

From a theoretical point of view, Schumpeter's contribution is considered to be seminal when it comes to integrating innovation and technology into the growth process. His ideas were gradually included in theoretical models of growth. In the 1950s and 1960s, the features of technology were little explored, which meant that it was little integrated into theoretical modelling. This is well illustrated by its exogenous position in traditional neoclassical models (Solow, 1956; Swan, 1956). It was not until the early 1980s that innovation and technology were more fully integrated. In this respect, endogenous theories propose models that base economic dynamics on innovation. However, the evolutionary theory and its developments regarding convergence stand out in the analysis of the specificities of innovation, its central position in economic dynamics and in the explanation of development differences.

The evolutionary approach applies the concepts of cumulativity and path dependence (David, 1985, 2001, 2007) to the analysis of catch-up, which is based on the development of technological capabilities and innovation system creation. Authors in this field (Dosi et al., 2019; Lall, 2003) argue that the cumulativity and path dependence characterizing knowledge and innovation legitimize state intervention in the process of catching up. Apart from the evolutionary approach, the implementation of specifically targeted industrial policies is nevertheless debated. International institutions (World Bank, IMF) generally argue that the success of economic development and the reduction of development inequalities between countries are best achieved through the free play of market forces (Castellacci, 2006), and thus advocate market policies for DCs, very often in the style of the Washington Consensus (Rodrik, 2006; Stiglitz, 2002; Williamson, 1990). However, the effectiveness of these policies in achieving catch-up is controversial (Easterly, 2019; World Bank, 2005). Dosi et al. (2021) show in this respect that industrial policies intentionally aimed at developing firms' capabilities and investments in R&D are more likely to lead to catch-up than market policies. This does not mean that the implementation of industrial policies in the South does not face some serious challenges, such as rent seeking, which is particularly harmful in low-income countries (Hillman & Van Long, 2019), and can reach the form of Nietzschean behaviour by the political elites who directly appropriate output from the weak (Hillman, 2004).

There are four main takeaways from this paper. First, in the light of evolutionary theory and its developments, we show that the origin of growth divergences between countries can be investigated in terms of gaps in technological capabilities. Second, the extension of the concept of innovation persistence to the analysis of development gaps helps to understand the divergence pattern at the global level, and how this pattern can sometimes evolve over time, at the margin or in a more structural way, as the position of some countries changes radically with shifts in industrial leadership. Third, we reveal, by reviewing the theoretical and empirical literature, the strong non-linear impact of IPRs on innovation and growth, as it depends on the level of technological and economic development. We argue that the robustness of this result calls for a reconsideration of the policy recommendations aimed at developing innovation in DCs. Finally, we show that, even though their implementation faces some serious challenges in the context of DCs, industrial policies can be a valuable tool to foster innovation. This calls for a specific investigation of the trade-off between the content and implementation of industrial policies, on the one hand, and the understanding and control of their rent externalities, on the other hand.

The rest of the paper is organized as follows. Section 1 presents a review of the theoretical grounding of innovation-based growth and catch-up processes. It particularly highlights the cumulative and path-dependent nature of technological change, which helps understand the global divergence pattern. Starting from path dependence, Section 2 thus examines why some countries lag behind in terms of innovative capabilities and how the pattern evolves over time. Section 3 investigates the case of IPRs strengthening policies for the development of innovation by reviewing the theoretical and empirical literature on the relationship between IPRs, innovation and growth in the context of DCs. Finally, Section 4 discusses the relevance and challenges of industrial policies.

2 | INNOVATION AND CATCH-UP: THEORETICAL FOUNDATIONS

Joseph Schumpeter's (1912, 1939, 1942) contributions are widely considered substantial in the development of theoretical and conceptual approaches that place innovation at the core of the dynamics of the capitalist system. Let us briefly examine the Schumpeterian legacy2 in neoclassical theories of growth, before laying particular emphasis on its articulation in evolutionary theories.

2.1 | Neoclassical growth theories: from Solow and Swan to endogenous growth theory

The model developed by Solow (1956) and Swan (1956) is the signature neoclassical growth model. However, it incorporates relatively few elements of innovation and technology into the growth process. Indeed, the model considers technology as exogenous, allowing for long-term growth by overcoming the assumption of diminishing marginal returns to capital. Technology is also considered a public good, freely available to all (Denison, 1967). The neoclassical theory thus predicts a pattern of absolute convergence, at a time when some countries are experiencing problems of low growth and high unemployment (Fagerberg, 1994).

The importance of innovation in the modelling of growth is particularly clear from the beginning of the 1980s, through

the development of two major approaches: endogenous growth theories and evolutionary theories. The endogenous growth theories propose a theoretical model that bases the dynamics of growth on the behaviour of agents, rather than on exogenous elements. In endogenous growth models (Aghion & Howitt, 1992; Lucas, 1988; Romer, 1986, 1990), the diffusion of technology via technological spillovers is key to achieving increasing returns at the aggregate level. Endogenous growth theorists recognize the stochastic nature of R&D and technology, even if they consider uncertainty to be low since firms determine their optimal level of R&D spending based on a cost– benefit analysis. They do place technology flows between agents at the core of long-run growth dynamics, in line with Schumpeterian ideas. These elements are found in evolutionary models such as Nelson and Winter (1982) or Fagerberg (1988).

2.2 | Evolutionary theory

The evolutionary perspective on innovation combines diverse insights into the specificities and micro-complexities of the innovation process. From the 1980s onwards, following the seminal work of Nelson and Winter (1982), many authors adopted evolutionary ideas, positioning them as an alternative to the neoclassical theory, known as 'orthodox theory' (Nelson & Winter, 1982). Two major aspects distinguish the evolutionary approach from the two previously mentioned approaches.

The first pertains to the microeconomic foundations that determine the behaviour of economic agents. In the evolutionary approach, agents are represented as evolving subjects, with an adaptive rather than maximizing logic, and with a limited rather than perfect rationality. The evolutionary theory thus suggests, through the limited rationality of agents, that they cannot perfectly apprehend the context in which they evolve, contrary to what standard models suggest (Nelson, 2008). In terms of aggregate economic performance, the evolutionary theory suggests that the functioning of the capitalist system and aggregate economic performance rest on two aspects: the generation of novelty and selection. Innovation generates novelty, and markets serve as selection mechanisms. It is important to note that the evolutionary process thus described does not have as its initial objective the realization of a complex technological artifact (Verspagen, 2005). The process of accumulation of incremental innovations may give the impression of having a complex objective, but the functioning of the system, its evolution (which is contingent and path-dependent), is not initially anticipated by the actions of the various agents involved in its dynamics. For example, when applied to the information and communication technologies (ICTs) revolution, the evolutionary approach does not assume that all the resulting applications were necessarily anticipated from the beginning of the process.

The second aspect that distinguishes the evolutionary approach relates to the state of equilibrium, or rather non-equilibrium, of the economy. Evolutionary authors suggest that the economy is far from what could be characterized as a steady state, an equilibrium (Nelson, 2017). This reasoning is based on some concepts developed by these authors, allowing for a better analysis of economic history from the perspective of innovation and technological progress. On the one hand, Dosi (1982) highlights the notion of a technological paradigm, that is, a model of solutions to certain technological problems, based on a number

of principles of natural science and some material technologies. A technological paradigm thus gives the general direction of technological development, which follows a 'technological trajectory' (Dosi, 1982). On the other hand, the dynamics of innovation would be structured by temporal clusters of innovations. Schumpeter (1939) argued in this respect that innovations 'are not evenly distributed over time, but on the contrary tend to cluster together (…)'. This suggests that history displays periods with a high rate of fundamental innovations, contrasting with periods that could be described as 'flat' in terms of fundamental innovations (Verspagen, 2005). Thus, catching-up processes accelerate or slow down (or even reverse) depending on whether economies (advanced and/or developing) go through periods of high innovation.

More generally, the approaches reviewed in this first section highlight the cumulative and historically contingent nature of technological change. This implies that the technological evolution of a firm, a country or on a global scale is characterized by a process of accumulation in which past events exert a persistent influence. In a second section, we discuss how this path-dependent nature of innovation explains why some countries lag behind and how changes in industrial leadership occur.

3 | WHY DO COUNTRIES LAG BEHIND IN TERMS OF INNOVATION AND HOW TO CATCH-UP?

Section 1 laid the theoretical foundations of innovation and catch-up. However, it is clear that there are still huge cross-countries differences in innovation performances, even though catch-up miracles did happen, with latecomers sometimes taking the industrial lead. Insights about the nature of technological change can help us understand these cross-countries innovation performances and changes in industrial leadership.

3.1 | How does path dependence and the persistence of innovation shed light on the lack of convergence?

Innovation is at least in part a path-dependent phenomenon. The concept of path dependence is a conceptual approach that aims to give more importance to history in social science analysis, particularly in economics. It emerged in the 1980s with the work of Arthur (1989, 1994). Nevertheless, it is really under David's impetus that the concept develops, with his seminal article on the QWERTY keyboard (David, 1985). He defines path dependence in two ways (David, 2001, 2007). First, the 'negative' definition (starting from what path dependence is not to define what it is) stipulates that path dependence is a property of processes that are said to be non-ergodic. Unlike ergodic processes for which past movements of the system have no long-term influence, past random events can have a lasting effect on the movements of non-ergodic processes, in terms of the result achieved. Supplementing this definition, David also adds a 'positive' definition of path dependence: 'a path-dependent stochastic system is a system with an asymptotic distribution that evolves as a consequence (or a function) of the process' own history'. Thus, for David, path dependence is a property affecting phenomena whose outcome, or distribution of possible outcomes, is affected by the flow of past events, the sequence of transient states visited by the system. Other authors take a somewhat different approach to path dependence (see, for instance, Martin & Sunley, 2010, who propose a broader tripartite typology of path

dependence, depending on where the approach under consideration stands with respect to the neoclassical equilibrium paradigm and evolutionary thinking).

Past knowledge, however, is not a deterministic element but is subject to the crucial influence of managerial strategies. Organizational economics highlights the concept of dynamic capabilities, that is, 'the subset of skills or capabilities that enable the firm to create new products and processes, and to respond to changing market circumstances' (Teece et al., 1997). These capabilities shape the firm's ability to generate new knowledge at a given moment in history and support the persistence of innovation through choices of R&D investments and interactions with the external knowledge environment. Firms that leverage their dynamic capabilities are able to innovate persistently in the long term. Thus, firms are influenced, but not necessarily trapped by their past, to the extent that managerial contingencies can affect the non-ergodic dynamics of the innovation path (Antonelli et al., 2013; Clausen et al., 2013).

In terms of the analysis of catching-up processes, the persistence of innovation and its path-dependent character provide a fresh perspective to the understanding of the existence of global economic divergences. This perspective is linked to what evolutionist authors call 'capability failure' and 'system failure' (Lee, 2013). On the one hand, countries that have succeeded in building up firms' innovative capabilities and a working innovation system maintain high rates of innovation introduction, which sustains growth. This process is itself reinforced by the action of dynamic capabilities, that is, the lasting effects of innovation resulting from the cumulativity of knowledge and from learning processes. On the other hand, countries that have not succeeded in building firms' innovative capabilities and creating operative institutions and innovation systems have a lower capacity for innovation and therefore lower growth. The result is a pattern of divergence: the most innovative countries widen the gap with the least, or even the non-innovative. However, like firms, countries are not necessarily trapped by their past; it is possible to intentionally affect the technological (and thus macroeconomic) trajectory, as suggested by the dynamic capabilities approach and organizational economics.

Finally, the concept of path dependence, with its emphasis on the weight of history in dynamic processes, is of particular interest for the analysis of growth differences between countries in a framework emphasizing technology. It contrasts with an equilibrist approach to economic dynamics, according to which the economy would inevitably and deterministically converge towards a single equilibrium, invariant in time and space. It provides a better understanding of the patterns of economic divergence arising from the persistent and path-dependent nature of innovative activities. Countries on a path of technological accumulation maintain their technological and economic lead, widening the gap with non-innovating countries.

3.2 | Capabilities building, leapfrogging and windows of opportunity: how can catch-up occur and industrial leadership be reversed?

The pattern of divergence previously described can sometimes be altered as latecomers succeed in building innovative capabilities and sometimes overtake the incumbents; this is usually called

leapfrogging. Brezis et al. (1993) argue that this phenomenon may happen due to the very nature of technological change. They suggest that technological change happens in two main ways. On the one hand, most of the time, technology evolves incrementally, in a well-established framework. This is in line with the concept of the technological paradigm (Dosi, 1982) discussed earlier (Section 1). This 'normal' technological change mainly happens through learning by doing and is likely to occur in countries with established innovative sectors. In this framework, the aforementioned scenario takes place: accumulations of knowledge and experience allow innovative countries to maintain their technological and economic lead. However, some catch-up is possible, provided that latecomers build firms' capabilities and an innovation system. At this stage, DCs with reasonable innovative capabilities can target sectors in which technology is relatively constant or already mature, enabling a higher possibility of technology transfer available at low costs (Lin, 2012a, 2012b). The low level of wages at the beginning of the process favours the use of this strategy.

On the other side, technological change can also happen in the form of major breakthroughs radically changing the present paradigm. These breakthroughs provide 'technological windows of opportunity', that is, major changes in technologies that reset the industrial race so that latecomers can take the industrial lead. For Brezis et al. (1993), whenever such a new technology appears, it may not seem attractive to a nation that has established a lead in the former technology. On the contrary, the latecomer, in which the old technology is less well developed, sees it as an opportunity. The overtake in industrial leadership or leapfrogging is not automatic, however, and only happens if (i) there is a large wage difference between the leader and the challenger, (ii) the new technology seems to be initially unproductive to leading producers, (iii) experience in the old technology is not too relevant in the new technology and (iv) the new technology offers substantial productivity gains over the former.

In evolutionary thinking, however, leapfrogging is only accessible to DCs having built relatively high levels of capabilities (Lee & Malerba, 2018), for at least two reasons. The first reason is that leapfrogging is strongly related to 'short cycle' technologies, that is, in which the specific knowledge and competences tend to change periodically (the ICTs are a typical example). In these high-tech sectors, only DCs having built relatively high levels of capabilities can operate. When such radical changes occur, the industrial race is reset, but incumbents often stick to the old technology from which they derive their lead, while latecomers engage in the new paradigm.

On the other hand, on the basis that achieving catch-up requires capacity building and innovation system creation, the reference literature from economic history such as Gerschenkron (1962), or Abramovitz (1986), as well as more recent works in the evolutionary field (Dosi et al., 2019, 2021; Nelson et al., 2018; Verspagen & Kaltenberg, 2015) recommend the implementation of selective industrial policies for achieving convergence. The next two sections will address these questions: the case for strengthening IPRs in DCs and the implications of industrial policies for catch-up.

4 | DOES THE STRENGTHENING OF IPRS FOSTER INNOVATION IN DEVELOPING COUNTRIES?

In their catch-up quest, DCs are generally advised to adopt specific economic policies. This is notably the case for the strengthening of IPRs, which is generally perceived as a factor that fosters innovation. Let us now examine more closely, from a theoretical point of view, the reasons underlying the existence of an IPRs system (particularly the patent system). We then turn to the empirical literature on the impact of IPRs on innovation and growth.

4.1 | Nature of knowledge, incentives and patent system

The rationale behind the existence of an IPRs protection system, particularly the patent system, is related to the quasi-public good nature of knowledge (Dosi & Stiglitz, 2014), that is, it is often difficult to exclude access to it, and its use by one agent does not prevent another agent from using it. Insofar as private resources are involved in the production of knowledge, this quasi-public good nature raises a problem of incentives and free riding: agents can benefit from the good without bearing the costs. In this context, the level of knowledge produced is lower than the social optimum, which is detrimental to the development of innovation and growth. The system of IPRs protection provides a solution to these problems, restoring the incentive to innovate by allowing the appropriation of the innovation rent3 by the innovator. Besides rewarding innovation, IPRs protection also stimulates knowledge acquisition and diffusion, as patenting involves the disclosure of information to other potential inventors (Maskus, 2000).

In addition, excessive protection can limit the diffusion of knowledge and lead to monopoly situations. Thus, as Dosi and Stiglitz (2014) note, the 'artificial' scarcity of knowledge resulting from excessively strong IPRs leads to inefficient use of knowledge. More generally, they also point to an overemphasis on IPRs and the private production of knowledge and suggest that IPRs should be thought of as part of a country's innovation system, which consists of a variety of institutions involved in the innovation process and a variety of research funding mechanisms.

This previous point about limiting the use and dissemination of knowledge echoes what is known as the 'anticommons' problem4 (Heller & Eisenberg, 1998), that is, the underutilization of a resource due to the multiplication of property rights over that resource. This aspect is particularly evident in industries where technologies are 'systems' (Dosi & Nelson, 2018), such as those involving electronic devices (telecommunications, computers, etc.). Here, technological advancement relies on different interconnected components. Thus, a multiplicity of property rights holders over these interconnected components can hinder innovation by making it difficult for new players to enter.

In general, economic theory therefore suggests a positive effect of IPRs protection on the development of innovation and growth. It also suggests that IPRs are not necessarily the most efficient mode of appropriation and that excessive protection is harmful to the diffusion of knowledge. Along these lines, Dosi and Nelson (2018) emphasize that these flaws in the patent system are not 'an argument for junking the patent system or significantly weakening patents across the board' but should certainly 'warn against proposals that increasing patent strength is a good way to increase the inventing we get'. On this basis, we review empirical studies of these relationships, analysing the effect of IPRs with respect to levels of development.

4.2 | Impact of IPRs on innovation and growth: empirical evidence with contemporary samples

In Sections 4.2 and 4.3, we review two perspectives in the empirical literature regarding the impact of IPRs on innovation and growth in the context of DCs. The first perspective is related to the literature on the impact of IPRs on innovation in DCs via the channel of international technology transfers; and the literature on the possibly non-linear impact of IPRs on innovation and technological catch-up, with contemporary samples of DCs (Section 4.2). A summary table of aims, methods and results of these papers is proposed in Table 1. The second perspective is that of the literature on that same impact, but from a historical perspective, using samples of today's advanced countries, at the time of the second industrial revolution (Section 4.3).

The building of a knowledge economy through the exploitation of international technology diffusion and the stimulation of domestic innovation is crucial for successful catch-up. Foreign direct investment (FDI) is generally identified as the main channel for the acquisition and assimilation of foreign knowledge and technology (Archibugi & Filippetti, 2010; Naghavi, 2007). Thus, an abundant literature studies the impact of IPRs on innovation in the context of DCs, via the channel of technology transfer by multinational firms (MNFs).

Following this body of literature, Bhagavatula et al. (2019) carry out an analysis of the Indian entrepreneurial ecosystem from the 1990s to nowadays. They highlight liberalization reforms and the implementation of TRIPS, as a notable 'spark' for the development of an innovative environment, first in ICT, and then in other economic sectors. They emphasize the complementarity between the two groups of firms operating in the innovation system, the MNFs from developed countries (metaphorically called the 'pillars') on the one hand; and the local firms (the 'ivy') on the other hand, whose success initially depends on their connections to the MNFs. In a similar vein, Brandl et al. (2019) explore the influence of MNFs and supranational organizations (notably the IMF) on the effective implementation of TRIPS in a sample of 60 DCs. They find that when MNFs are a major constituent of a country's innovation system (in terms of the share of patents owned in the country's patents), TRIPS implementation is faster and more stringent. This influence of MNFs on the pace of implementation and stringency of IPRs is reinforced if the country is dependent on the IMF (if the country has a stand-by arrangement with the IMF during the period), highlighting the complementarity of the two types of actors. The authors thus argue that the presence of MNFs in a developing country is beneficial for the development of the local innovation system and its convergence in terms of international institutional standards. However, the first conclusion seems to go beyond the results of the paper, which focus on the influence of external actors on the institutional transition in terms of IPRs. One interesting result is that DCs with relatively high innovation capacities are more likely to have a faster transition and more stringent enforcement of TRIPS, suggesting a threshold effect in the impact of IPRs.

TABLE 1 Summary table of a selection of empirical studies on the relationship between IPRs protection, innovation and growth.

	Brandl et al., 2019	Naghavi & Prarolo, 2018	Chen & Puttitanun, 2005	Neves et al., 2021	Panda & Sharma, 2020
Title	Foreign actors and intellectual property protection regulations in developing countries	Harmonisation and globalisation of intellectual property culture	Intellectual property rights and innovation in developing countries	The link between intellectual property rights, innovation, and growth: A meta-analysis	Impact of patent rights on innovation: A meta-analysis
Journal	J. of International Business Studies	The World Economy	J. of Development Economics	Economic Modelling	Journal of Public Affairs
Type of model	Empirical	Empirical	Theoretical and empirical	Meta-analysis	Meta-analysis
Sample	60 developing countries	14 NICs and 30 OECD countries	64 developing countries	22 articles	14 articles
Period	1993–2005	1995–2008	1975–2000		
Estimation method	Two-step mixed IV Ordered Probit	Gravity model	2SLS	Multivariate meta-regression	Multivariate meta-regression
Dependent variable	TRIPS adoption index	Internationalization of NICs innovative activities (patents filed in patent offices of OECD countries)	Level of IPR protection; domestic innovation	Effect sizes reported in the papers	Effect sizes reported in the papers
Independent variables	Proportion of local firm patents Proportion of AMNEs (advanced country MNEs) patents IMF Dependency	IPR protection in NICs IPRs protection in OECD countries Population size GDP per capita Human Capital Distance between country-pair Commonality of borders Commonality of language	Level of technological ability or development Economic Freedom Education Population Trade openness (international trade volume)	Number of observations Year of publication Number of citations Number of countries in the sample Dummy variables: Journal, Developing vs. developed, Panel data, IVs, Trade openness, GPI, Country vs. Industry level, Precision	Dummy variables: Panel data, Developing countries, Developed countries, GDP, Openness, Education Precision
Control variables	Macro: GDP per capita, FDI, Exports Disease outbreak Institutions (4 variables) Backward citations Local vs. foreign public sector patents EMNE (Developing vs. Emerging country MNE) patents Proportion of individuals	Impact of harmonisation of the IPR regime within each country-pair Bilateral import flows between country-pair	WTO membership Square of GDP per capita		
Main results	1. Higher proportion of AMNES in a developing country's innovation system leading to faster and more stringent TRIPS adoption. 2. Reinforced by IMF dependence.	1. Stronger IPR protection in the South encouraging NICs firms to the internationalization of domestic innovation. 2. Rigid protection in the North detrimental to the export of NICs innovation.	1. Non-linear U-shaped relationship between IPRs and development. 2. In early stages of development or technological ability, optimality of low levels of IPRs.	1. Publication bias in favour of significant results. Average positive effect of IPR on growth and innovation after correction. 2. Stronger effect in advanced countries 3. Heterogeneity in the reported effects partly explained by methods (data, measurement of IPR, sample size) or publication quality.	1. Publication bias in favour of significant results. 2. Positive effect of PRs on innovation in advanced economies. 3 For developing countries, negative and highly significant effect implying that developing countries PRs policies do not contribute to national innovation.

needs FDI, it is in its welfare interest to enforce a stringent IPRs regime, either for attracting foreign investment in less R&D-intensive industries or for stimulating domestic innovation in high-tech sectors. A subsequent empirical work (Naghavi & Prarolo, 2018) looks for the presence of location effects of the prevailing IPRs regime (in the North and the South), and how this difference in prevailing IPRs regime impacts the internationalization of innovation from newly industrialized countries (NICs). Using data on the patenting activity of NICs in OECD countries, he finds a double positive effect of stronger IPRs in NICs, on the one hand in terms of the internationalization of domestic innovation and, on the other hand, in terms of attracting MNFs for technology transfer. In contrast, a rigid IPRs regime in the North is detrimental to the export of NICs innovation. The author thus suggests a convergence of IPRs levels in the two zones, allowing the participation of each country in international innovation activities and the diffusion and use of state-of-the-art technologies.

This body of literature, while showing a positive impact of IPRs on innovation and technological catch-up in DCs, nevertheless suggests a non-linear relationship. This idea of a non-linear relationship between IPRs' strengthening and innovation is supported by several works. In a theoretical and empirical approach, Chen and Puttitanun (2005) propose a model that suggests a U-shaped relationship between IPRs protection and the level of development of countries: increasing the level of development initially reduces IPRs protection and then increases it after a given threshold. Empirical results on a sample of 64 DCs (including many low-income countries) between 1975 and 2000 confirm the theoretical considerations: the increase in a country's level of economic and technological development eventually leads to an increase in its level of IPRs protection. Similarly, Chu et al. (2014) develop a Schumpeterian growth model of distance to the frontier and show that the optimal level of IPRs protection depends on the country's level of development. Specifically, they show that at an early stage

of development, it is optimal for countries to have a low level of IPRs protection in order to promote imitation, while at later stages of development, countries tend to strengthen IPRs protection to encourage domestic innovation.

4.3 | Impact of IPRs on innovation and growth: empirical evidence with historical samples

Finally, one strand of literature addresses the question of the effect of IPRs protection on innovation and growth from a historical perspective. We call this the 'historical argument'. This literature mainly stresses that history shows that national IPRs systems often reflect the production needs of countries. 'All emerging economies, at some point in their history, have relied on the adoption of foreign technologies. Even Northern countries have at some point exempted certain industries from IP protection based on their needs' (Archibugi & Filippetti, 2010). At different times and in different regions of the world, countries have realised high rates of growth under varying degrees of IPRs protection (World Bank, 2001).

Moser (2005, 2012, 2016) fits into this historical approach. Analysing extensively the exhibitions of technological products in the 19th century (a period of industrial growth in Europe), she notes a low patentability of inventions. She also notes that several countries without a patent system at the time (notably Switzerland) regularly presented quality inventions (rewarded by a prize system, as a proxy for the quality of inventions). Similarly, Chang (2002, 2010) questions the importance of the patent system for the development of innovation. He note that the majority of developed countries introduced their patent systems in the first half of the 19th century (1815 in Prussia, 1817 in Belgium and the Netherlands, and 1834 in Sweden). These systems were largely imperfect and lax, for example, concerning foreign inventions. This last point is today considered as a major failure for a patent system. Moreover, as mentioned above, some countries had simply not implemented a patent system. Chang notes that it was not until 1954 that the Swiss patent system became comparable to that of other developed countries. It is important to note that despite these imperfect patent systems, there was indeed industrial technological development even in countries without patent systems.

Thus, the literature shows rather mixed empirical evidence of the impact of IPRs on innovation and growth in the context of DCs. While technology transfer through FDI seems to be a reason to strengthen IPRs in the South, the effect of such a measure is only really beneficial for relatively advanced DCs, suggesting that a strong IPRs regime is not in itself a sufficient condition for technology transfer. The optimal level of protection would depend on a variety of country-specific factors (Archibugi & Filippetti, 2010). It is as countries 'climb' the technological and economic ladder that they are led to strengthen their IPRs regime, as the historical argument suggests. This literature casts doubt on an overly rigid implementation of IPRs and invites instead to foster capability building by firms and innovation system creation in countries with low patent protection. The evolutionary literature suggests that industrial policies may help in this matter.

5 | WHAT ARE THE POTENTIAL AND CHALLENGES OF INDUSTRIAL POLICIES?

Several works emphasize the implementation of selective industrial policies for achieving convergence, from economic historians like Gerschenkron (1962) to recent works in the evolutionary field (Dosi et al., 2019, 2021; Nelson et al., 2018; Verspagen & Kaltenberg, 2015). These scholars consider industrial policies as both necessary and possible. If the necessity of industrial policies may be accepted, the possibility is often much more challenged outside the evolutionary literature. We first discuss industrial policies in the evolutionary field, before examining potential obstacles to their possibility, with insights from the public choice literature on rent and rent seeking following Tullock (1967) and Tullock (1989) on the cost of rents and rent seeking; Hillman (2004) on specific Nietzscheantype configurations where the strong who appropriate rents themselves hold power and therefore have no interest in changing the rules to reduce the prevalence of rents; and Hillman and Van Long (2019) on the corruption/rent nexus, based on the positive relationship between corruption and rent, causing greater investment in resources intended for rent appropriation, particularly in autocracies where public decisions are not taken collectively and are therefore easier to influence. The joint analysis of these literatures allows us to formulate a trade-off between the content and implementation of industrial policies, on the one hand; and the control of the externalities associated with the resulting rents, on the other hand. In what follows, we refer to this trade-off as the 'industrial policies/ rents' trade-off.

5.1 | Industrial policies: a recipe for catch-up?

The question of the necessity of industrial policies relates to the nature of knowledge and technology and its implications in terms of market failure. The question of possibility relates to the social utility of these selective policies and depends on the ability of the public authority to control the resulting costs (budgetary costs, opportunity costs, etc.). In the evolutionary literature, industrial policies are seen as both necessary and possible (Lall, 1987, 1996, 2003; Lall & Teubal, 1998). The idiosyncratic nature of knowledge, the path-dependent nature of learning processes, and the market failures inherent in technology production and transfer imply the necessity of industrial policies. The possibility of industrial policies is based on historical validation, notably provided by what is commonly referred to as the 'Asian miracle'. Indeed, the case of the Asian tigers is pretty much considered as a story of successful implementation of industrial policies, as these countries moved from low-value-added industries to short-cycle technologies like ICTs, thus achieving technological diversification (Lee & Malerba, 2018). The example of South Korea is interestingly analysed by Hannigan et al. (2013) who contrast it with Brazil. They identify well-planned and consistent government policy, technological specialization and nurturing of corporate champions as the three key factors behind the Korean success story. In contrast, Brazil seems to have lacked consistency and continuity in the catch-up effort.

Similarly, low-income countries, mainly African, still struggle to initiate industrial catch-up in a substantial way. A key reason for this is that in those countries, state steering capacity, that is, the ability of policymaking authorities to pursue domestic adjustment strategies that help transform the economy, remains particularly scarce (Yülek et al., 2020). In

fact, political leaders tend to be self-serving and lack incentives to implement welfare-enhancing policies. This is detrimental to the implementation of any type of public policy, whether industrial or not, and underlines the need for institutional reforms in parallel with, or even prior to, industrial policies. The scope of these reforms does not have to be broad in order to achieve take-off. In a series of widely echoed contributions, Rodrik shows that it should be sufficient to identify the more binding constraints. Broad reforms are, of course, necessary in a second phase to guarantee the sustainability of the growth dynamics (see, for example, Rodrik, 2007).

Considering the theoretical backbone provided by the evolutionary literature and empirical validations, the fact that the poorest countries aim to de-specialize from commodity exports cannot be disputed for a whole range of reasons, from the need to reduce vulnerability to international commodity price shocks to the legitimate aspiration to break out of an international division of labour that is generally considered to remain extractive. In our view, this is not inconsistent with the spirit of Tullock's work, mainly because the de-specializing objective in DCs via industrial policies aims to create a new kind of activity in the economy. In advanced economies, these policies generally direct resources from one (efficient) industrial or tertiary activity to another (inefficient) activity that is also industrial or tertiary (Tullock, 1967). In DCs, the aim is to direct resources from the exploitation of natural resources to the industrial or tertiary sectors, considering that the exploitation of natural resources can actually generate rents and rent-seeking behaviour (domestic or international). Having in mind the dynamic effects on (material and human) capital stock and growth of the transition from an essentially primary to a more diversified activity leads us to consider with particular attention the trade-off between industrial policies and limiting their rent-seeking externalities.

5.2 | Industrial policies and catch-up: is it possible?

The previous discussion highlights that the possibility of industrial policies seems to depend crucially on the fact that political elites are willing and able to design and implement welfare-enhancing policies. However, this is not always the case in the developing world. According to the public choice and political economy literature, two main challenges particularly stand in the road of industrial policies in the context of DCs: how to determine in which sector to intervene, that is, how to design the policies; and what are the implications of corruption, rent seeking and the selfserving behaviour of political elites.

Moreover, industrial policies assume somehow a political willingness to adopt good policies. This may, however, not always be the case. Hillman (2004) highlights the case of a society where elites behave as Nietzschean strong, appropriating output from the weak, and thus lack incentives to implement efficiency-enhancing policies. This is a situation from which it is particularly difficult to escape, as the concern is not about the adequacy of certain types of policies, but about the ‘the persons who govern’. Hillman (2004) argues that ways out of such situations include emigration, at a personal level, or ‘spontaneous moral revival that leads the strong to adopt ethical behavior’. It is interesting to note that the two solutions are not incompatible since this revival could also be kindled by the external pressure of the global community,

or the diaspora. The Nietzschean systems mentioned by Hillman that have come to an end are, however, very specific, caused by colonial occupation or international conflict, which suggests that this configuration is a borderline, and not the general case of the institutional quality/corruption nexus.

In sum, industrial policies have the potential to foster capabilities building, as clearly revealed by the East Asian experience. However, an institutional context characterized by contestable rents, corruption and unwillingness to adopt good policies constitutes a serious challenge to their implementation and even to policymaking more generally. Although worthy of interest, disclosing comprehensively the implications of a deteriorated institutional environment on policymaking is beyond the scope of this paper.

6 | CONCLUSION

Finally, the analysis of growth and convergence dynamics with a focus on innovation and technology proves fruitful. The articulation of Schumpeterian ideas in theories of growth and convergence suggests that catching up depends crucially on the development of technological capabilities to absorb the international diffusion of technology and stimulate domestic innovation. The cumulative and path-dependent nature of technological change sheds new light on the pattern of global divergence in innovative activities, as well as how this pattern is sometimes altered.

As catching up depends on the development of technological capabilities, these particular characteristics of innovation raise the question of what policies should be implemented to foster innovation, which is hotly debated in the literature. Evolutionary authors stress the importance of state intervention through targeted industrial policies, while international institutions (World Bank, IMF) advocate market policies, including the strengthening of IPRs protection. On this point, we have shown, by analysing the literature from a historical and contemporary point of view, that the impact of IPRs protection on innovation and growth depends on the level of technological and economic development. This result seems to us to be important to consider in the formulation of policies aimed at developing innovation in DCs. Thus, we underline, following Archibugi and Filippetti (2010) and on the basis of the widest and most diverse state of the art in terms of methods, that beyond the different positions on the question of IPRs, it is essential for DCs to implement active learning policies targeting the significant development of their innovation capacities. Their implementation faces serious challenges related to the broader issue of the implications of a deteriorated institutional environment on policymaking. These issues are beyond the scope of this paper but will be the subject of future work, focused on the trade-off between the implementation and content of industrial policies, defined by the evolutionary literature, on the one hand, and the need to limit their inevitable externalities, linked in particular to the rents they generate, defined by the public choice literature, on the other hand. An initial point of interest is that the founding works of rent seeking can themselves be read from the perspective of the aspirations of the poorest countries to emerge from the current international division of labour.

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