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Intellectual Property Rights and Endogenous Economic Growth – Uncovering the Main Gaps in the Research Agenda

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1. Introduction

Intellectual Property Rights (IPRs) are "the rights to use and sell knowledge and inventions" (Greenhalgh and Rogers, 2007: 541), with the aim of guaranteeing adequate returns for innovators and creators. There are different types of intellectual property protection (Granstrand, 2005): old types such as patents, trade secrets, copyrights, trademarks and design rights, and new forms such as breeding rights and database rights. Nonetheless, patents are commonly considered as the most important and representative IPR (*e.g.*, Besen and Raskind, 1991).

IPR have a long legal and economic history, since the idea of intellectual property was already present in ancient cultures such as Babylonia, Egypt, Greece and the Roman Empire. Mokyr (2009) discusses the relevance of the late 19th century, when political events created a system which supported an executive that was sufficiently well-organised to create a "rule of law" and respect private property rights. This argument emerges, in part, in the context of an Industrial Revolution marked by important technological improvements, whereby IPR began gradually to be accorded more respect.

Despite this long history, only recently has IPR come to play a central role in debates concerning economic policy, being a stimulus for innovation through monopoly power (Menell, 1999). This change, related to the pro-patent era, only emerged in the 20th century – first in the USA and then globally in the world. Beneath this profound transformation lay a "deeper, more broad-based and much slower flow of events towards a more information- (knowledge) intensive and innovation-based economy" (Granstrand, 2005: 266). Therefore, in this period, knowledge and information assumed an important role in economics, which implied important changes in policy-making both in developed and developing countries.

The relationship between IPR, technological change and economic growth is ambiguous (*e.g.*, Horii and Iwaisako, 2007; Harayuma, 2009; Panagopoulos, 2009). Although knowledge and innovation are crucial for economic growth (*e.g.*, Romer, 1990; Aghion and Howitt, 1992; Hall and Rosenberg, 2010), if they are (completely) free there will be no incentive to invest in new knowledge and inventions (*e.g.*, Arrow, 1962; Romer, 1990). Thus, the potential need to protect both knowledge and inventions emerges, and the discussion of the importance of

IPR for this protection function gains relevance. In forming the decision whether to protect or not, a typical trade-off emerges: if we protect, only the owner of the knowledge design will use it (for some years she/he will have the monopoly power) and so the impact on economic growth will be smaller; in cases where no protection exists (which would allow innovators to be rewarded), knowledge will be easily diffused and all adopters will benefit from associated profits without having supported the corresponding costs; in the latter case no incentive to create new knowledge will exist. Thus a greater diffusion could have a higher economic growth impact, but at the same time the inexistence of a clear incentive could also reduce growth enhancement. This issue is only one of (the) several extant trade-off debates concerning the IPR-economic growth relationship.

The main purpose of this essay is to construct a survey of the theoretical and empirical literature on the relationship between Intellectual Property Rights (IPR), technological change and economic growth, as well as to expose some of the gaps in the current research. The relevance of this task is directly related to the ambiguous role that the literature has identified relating to the relationship between these dimensions. After systematization of the relevant theoretical literature, we focus on the empirical studies concerning the effect of IPR protection on innovation and economic growth. In presenting this overview, we intend to analyse to what extent empirical results allow (for) a consensual conclusion, faced as we are with the ambiguity of the theoretical contributions.

The present chapter is structured as follows. After a brief introduction, Section 2 presents an overview of the relationship between the economics of IPR, innovation and technological change. Section 3 focuses in detail on the relationship between endogenous economic growth and IPR from a theoretical perspective, whereas Section 4 offers an analysis of this relationship, but in empirical terms. Section 5 concludes, highlighting the main gaps that currently exist in this research agenda.

2. The economics of Intellectual Property Rights (IPR) and innovation: An overview

The conceptualization of IPR as a mean of protecting ideas is relatively recent. Several international agreements, such as the General Agreement on Tariffs and Trade (GATT), Trade-Related aspects of Intellectual Property Rights (TRIPS) and (the) World Intellectual Property Organization (WIPO) are examples of conventions and/or organizations connected with IPR (Senhoras, 2007).

IPR, in their various forms, play a crucial role in innovation systems.[1] Firms invest in innovation activities, find new products or new processes and increase their profits. To prevent the imitation of their innovations, firms can benefit from IPR protection. In this sense, IPR serve as an incentive for innovation, since knowledge has the characteristics of a public good (non-excludable and non-rival), and hence is easily appropriable. So in the case of IPR, the good is non-rival but becomes excludable. The significance of spillovers

[1] Arrow (1962) was a pioneer in addressing the economics of IPR. However, early authors such as Adam Smith, John Stuart Mill and J. W. Goethe had already conceived the patent as a price society must pay for discovery, which was fundamental for the unfettered diffusion of useful knowledge. Furthermore, it had already been recognized that the complete specification of the patent made the technological details more accessible to others (Mokry, 2009).

associated with technological knowledge being widely recognized, the related literature clearly stresses the importance of property rights, patents and other policies designed to protect innovative firms from spillovers. Nevertheless, spillovers are crucial for technology transfer and development (*e.g.*, Hall and Rosenberg, 2010). Hence, within this framework, a topic that is frequently discussed concerns the optimal patent length and the consequent trade-off between dynamic efficiency and static efficiency.

IPR play an important role not only in the innovation system but also on structural dynamics across sectors and countries, and over time. Authors such as Langford (1997) conclude that, despite there being some disadvantages, one of the most important economic effects of IPR is that they induce innovation, increasing the possibilities of technology transfer.

Resources, competences and dynamic capabilities are addressed within this wider broader discussion concerning appropriability. According to Hall and Rosenberg (2010: 689), "resources are firm-specific assets that are difficult, or impossible, to imitate. They are stocks, not flows." Resources are most likely to be intangibles; they are not easily transferred, some examples being intellectual property rights and know how processes,. As regards competences, they "are a particular kind of organizational resource", since "[t]hey result from activities that are performed repetitively or quasi-repetitively" (Hall and Rosenberg, 2010: 690). So routines are closely linked to competences. The firm's resources are considered sources of advantage, and in this context IPR correspond to firm-specific, intangible resources, which are not easy to transfer to other firms because it is difficult or even impossible to imitate them.

According to Mokyr (2009) and others, it is important to pay attention to the difference between institutions which stimulate technological progress and institutions that support the growth of markets by protecting property rights. In a completely unlegislated society, technological progress is less likely. Yet in order for rapid technological change to occur, it is necessary to eliminate some property rights. So this author is forced to ask "What kind of institutions encouraged technological progress?" (Mokyr, 2009: 349). He starts by emphasising the idea that incentives are a requirement for inventions and IPR offer incentives for successful inventors. Using the historical fact that the number of patents was stagnant until the mid- 18th century, and suddenly started growing in the 1750s, the author concludes that IPR show how institutions contributed to the origins of the Industrial Revolution. However, Mokyr also states that the main difficulty lies not in whether the patent system has a positive effect on technological progress in equilibrium but whether the effect could be sufficiently large to explain a considerable share of the acceleration in technological progress that it is intended to explain. Furthermore, it is interesting to know whether other institutions could have been similar to or even more important than the patent system. Mokyr (2009) concludes that, even as far as the historical importance of patents on the Industrial Revolution is concerned, the impact is not clear.

Cozzi (2009) discusses the possibility of innovation and growth without IPR. His main [line of] reasoning is that, since the main engine of economic growth is innovation, IPR may not necessarily be crucial for innovation and growth. In other words, although the IPR regime allows innovators to be rewarded for their innovations, constituting a mechanism whereby they are stimulated to innovate , innovation is still possible in the absence of IPR through other means, such as education (see also Greennhalgh and Rogers, 2007). Furukawa (2007)

and Horii and Iwaisako (2007) also show that increasing patent protection against imitation has ambiguous effects on R&D and growth.

Hence, we may question whether the rise in profits associated with a patent increases the incentive to innovate. Initially the answer would be that two incentives are better than just one (Cozzi, 2009). However, as Cozzi (2009) also mentions, Haruyama (2009) proves that this is not always the case, because in a very populated world, the introduction of IPR could have adverse effects on the skill premium, which could consequently lead to a reduction in the tacit knowledge incentive and intensify the expected capital loss resulting from obsolescence.

The issue of appropriability is of course related to "profiting from the innovation framework" (Hall and Rosenberg, 2010: 698) and to Schumpeter's concept of creative destruction. To guarantee profits from innovation efforts and to protect inventors/innovators from imitators, two possibilities are presented: strong natural protection and strong intellectual property protection, both of which are related to appropriability regimes (Hall and Rosenberg, 2010). Patents can also be a means of protecting inventors/innovators from their rivals and ensuring the generation of profits. However, the use of patents is considered imperfect because "they are especially ineffective at protecting process innovation". This ineffectiveness is associated with e.g. the existence of considerable legal and financial requirements to prove they have been violated or with the presence of weak law enforcement relating to intellectual property (Hall and Rosenberg, 2010: 700). Thus patents act as an incentive to innovate while at the same time possibly discouraging some innovators and therefore reducing knowledge spillovers (Panagopoulos, 2009). Therefore, a concave relationship between patent protection and innovation may emerge, differing from the relationship advocated by Arrow (1962), which argues that stronger patent protection brings about leads to more innovations.

In brief, some authors criticize the argument that strong patent protection offers greater incentives to innovators and therefore increases economic performance. Cohen *et al*. (2000) maintain that the increasing number of patents is not necessarily a sign of their greater effectiveness. Both empirical contributions such as those of Hall and Ziedonis (2001) and theoretical approaches such as those of O'Donaghue *et al*. (1988) lend support to this latter perspective. Moreover, as also stressed by Panagopoulos (2009), Horii and Iwaisako (2005) maintain that stronger intellectual property protection reduces the number of competitive sectors. Since it is easier to innovate in these sectors than in monopolistic sectors, this study advocates that the innovator tends to be concentrated in a smaller number of competitive sectors.

Chu (2009b) studies the effects of IPR on the specific framework of macroeconomics. He stresses that since it is not possible to meet or recreate ideal situations in the real world, market failures can engender the overprovision or underprovision of certain resources. In fact, whereas the competitive market or Walrasian equilibriums are efficient, leading to the Pareto efficient allocation of resources, competitive conditions are difficult to come by in real economies. For example, investment in R&D activity has two implications in terms of returns: the social return and the private return. Empirical studies in this area (*e.g*., Jones and Williams, 1988, 2000) show that the social return to R&D is much higher than the private return. This being the case, R&D, innovation, economic growth and social welfare would increase towards the socially optimal level were market failure to be overcome.

Within this context, Chu (2009b) stresses the relevance of quantitative dynamic general-equilibrium (DGE) analyses for studying the macroeconomic repercussions of rising IPR protection. He further emphasises that, although some empirical evidence points to a positive relationship between IPR protection and innovation, this evidence appears to be stronger in the case of developed rather than developing countries. Hence, this author maintains that the optimal level of patent protection[2] leads to a trade-off between the social benefits of improved innovation and the social costs of multiple distortions and income inequality. In an open economy, achieving the globally optimal level of protection demands international coordination rather than the harmonization of IPR protection.

Another interesting question in terms of policy implications is the magnitude of welfare gains from changing the patent length towards its socially optimal level. Kwan and Lai (2003) found that the extension of a patent's effective lifetime would lead to a significant increase in R&D and welfare. But Chu (2009a) maintains that while the extension of patent length beyond 20 years leads to a negligible increase in R&D and consumption, the limitation of the patent length leads to their significant reduction. So it seems that patent length is not an effective instrument for increasing R&D in most industries. In line with this argument, patent reform in the USA implemented in the 1980s focused on other aspects of patent rights such as patentability requirements (the invention would have to be new and non-obvious). Nevertheless, O'Donoghue and Zweimuller (2004) also show that if the patentability requirements are lowered, there will be contrasting effects on R&D and innovation. On the one hand, it becomes easier for an inventor to obtain a patent, which increases the R&D incentives. On the other hand, the amount of profits generated by an invention would decrease due to its smaller quality improvement, so the possibility that the next invention is patentable takes away market share from the current invention, decreasing R&D incentives. The policy implication mentioned by Chu (2009b) is the ambiguous effect of lowering the patentability requirement on R&D and growth.

Another instrument also discussed in Chu (2009b) is the patent breadth (the broadness or the scope of a patent) that determines the level of patent protection for an invention against imitation and subsequent innovations. There are two types of patent protection: the lagging breadth and the leading breadth. In relation to the former, Li (2001), using the Grossman and Helpman (1991) model, found a positive effect of the lagging breadth on R&D and growth; i.e. the increase in protection against imitation improves the incentives for R&D. This unambiguous positive effect emerges because larger lagging breadth allows (the) monopolists to charge a higher markup (Li, 2001).

Chin (2007), Furukawa (2007) and Horii and Iwaisako (2007) also show that the increase in patent protection against imitation exerts ambiguous effects on R&D and growth. Chu (2009b), basing his hypothesis on these three works, concludes that if IPR protection has asymmetric effects on different generations of households, it can also have a negative effect on innovation. Leading breadth is also discussed, underlining the point that increasing leading has opposite effects on the incentives for R&D. Once more, Chu (2009b) reports on

[2] Relative to patent policy, there are some instruments that can be used to influence the incentives to R&D and innovation, to the extent that they will affect economic growth. One example of these instruments is the patent length that establishes the statutory term of patent. Judd (1985) cited in Chu (2009b) argues that the optimal patent length is infinite, whereas Futagami and Iwaisako (2003, 2007) maintain, in a version of the Romer model, that the optimal patent length is finite.

O'Donoghue and Zweimuller (2004) and their analysis of Grossman and Helpman's (1991) model, to show the following: while the profits generated by an invention increase due to the consolidation of market power through generations of inventors, leading to a positive effect on R&D, the delayed rewards from profit sharing occasion a lower present value of profits received by an inventor, thus bringing about a negative effect (the profit growth rate is lower than the interest rate). This negative effect is also known as blocking patents (Chu, 2009b).

To sum up, we can conclude from the analysis of the different studies discussed above that the relationship between IPR and economic performance is ambiguous.

Although the codification of patents and copyright laws, as well as the regulation of privileges, emerged in the late 15th century, the concern with the relationship between IPR and economic growth only began in the 20th century, gathering pace as time went on. The first really relevant studies regarding IPR and growth emerged around the 1980s or even 1990s,[3] which corresponds with the emergence of the New Economic Growth Theory, also known as [the] Endogenous Economic Growth Theory, in the 1980s (Romer, 1994). The next section discusses and compares these two issues.

3. The bridge between IPR and Endogenous Economic Growth: Main theoretical contributions[4]

Innovation has assumed increasing importance in economic growth theory. In this context, it is consensually recognized as a crucial engine of growth (for example, Romer, 1990; Aghion and Howitt, 1992), and many studies have discussed the role of knowledge and technology in growth and development (*e.g.*, Hall and Rosenberg, 2010).

In particular, some authors focus their attention on the relation between IPR and growth. For instance, Dinopoulos and Segerstrom (2010) develop a model of North-South trade with multinational firms and economic growth in order to formally evaluate the effects of stronger IPR protection in developing countries. These effects have been the subject of intense debate, with one side advocating stronger IPR protection reform[5]and the other opposed to this (Taylor, 1994).

The former view argues that the reform would promote innovation and benefit developing countries because it would contribute to more rapid economic growth and would accelerate the transfer of technology from developed to developing countries. The latter argues that stronger IPR protection would neither accelerate economic growth nor transfer international

[3] Towse and Holzhauer (2002) have compiled a selection of the most important articles relating to the economics of intellectual property, and show that, in essence, they are of 20th century provenance, belonging in particular to the 1980s and 1990s. Additionally, on 29th September 2011, in a piece of internet research conducted in "SCOPUS", using "Intellectual Property Rights" and "endogenous growth model" as search words (in all text) and collecting only journal articles (including reviews), we obtained 56 records, the first dating from 1991.

[4] The selection of these studies was based on Towse and Holzhauer (2002), Pejovich (2001), Cantwell (2006) and on a thorough search of related literature on several international bibliographic databases, including Econlit and Scopus.

[5] This reform emerged from the Uruguay Round in 1994, more specifically from the TRIPS agreement, whose aim was to establish minimum standards of IPR protection by all WTO members up to 2006.

technology more quickly, since it only "results in the transfer of rents to multinational corporate patent holders headquartered in the world's most advanced countries especially in the US" (Dinopoulos and Segerstrom, 2010: 13).

Dinopoulos and Segerstrom (2010) also offer an overview of several contributions focusing on multinationals and relating to this issue. Glass and Saggi (2002), Sener (2006) and Glass and Wu (2007) show an unambiguous relation(ship) between strong IPR protection in the South and a lower rate of technology transfer, while Helpman (1993), Lai (1998), Branstetter *et al*. (2006) and Branstetter *et al*. (2007) reach the opposite conclusion. However, it is worth mentioning that, in all those previous models, the absence of R&D spending by affiliates, which is not empirically sustained (Dinopoulos and Segerstrom, 2010) is assumed. Dinopoulos and Segerstrom (2010: 14), in an effort to be coherent in considering this empirical evidence, consider that "R&D conducted by the affiliates in developing countries is focused on the absorption of patent-firm technology and on its modification for local markets." This study finds a positive relationship between stronger IPR in the South and a permanent increase in the rate of technology transfer from the North to the South. Additionally, this strong protection in the South results in a temporary increase in the Northern innovation rate and in a permanent decrease in the North-South wage gap. Hence, Dinopoulos and Segerstrom (2010) conclude that, under these conditions, Southern strong IPR protection promotes innovation in the global economy and this explains the faster growth of several developing countries compared with the growth performance of typical developed countries.

Moreover, Dinopoulos and Segerstrom (2010) analyze the long-term welfare effects, and at this level some contradictions emerge. In some North-South trade models, such as those proposed by Lai (1998), Branstetter *et al*. (2007) and Glass and Wu (2007), patent reform increases the economic growth rate permanently (and therefore the consumers must be better than they would be without patent reform). In other models, such as in Glass and Saggi (2002) and Sener (2006), patent reform permanently decreases the economic growth rate (and consequently consumers must be worse). In Dinopoulos and Segerstrom's (2010) model, growth is semi-endogenous and so the long-term welfare effects are ambiguous, because patent reform does not permanently alter the economic growth rate. Nevertheless, by combining all the effects gleaned from the related literature, the authors find optimistic long-term welfare effects in those developing countries with strong IPR protection. Moreover, as regards the two possible ways of transferring technology between two countries, FDI (Foreign Direct Investment) and imitation, Dinopoulos and Segerstrom (2010: 15) argue that "the effects of stronger IPR protection would depend on how important each mode of technology transfer is."

Regarding IPR protection in an open economy, Chu (2009b) emphasises three main results derived from Lai and Qui (2003) and Grossman and Lai (2004). The first indicates that, due to the asymmetries in terms of innovation capability, developed/northern countries would [tend to] choose a higher level of IPR protection than developing/southern countries. The second underlines the fact that if the North's level of IPR protection, such as TRIPS, were imposed on (the) southern countries, it would lead to a welfare gain (loss) in the North (South). And finally, although TRIPS require the harmonization of IPR protection, this harmonization is neither necessary nor sufficient for the maximization of global welfare.

Chu and Peng (2009), quoted by Chu (2009b), also consider the effects of IPR protection on income inequality across countries and find that stronger patent rights in one country tend to lead to an increase in economic growth and income inequality both in domestic and foreign countries. Another result of this research is that TRIPS tend to improve or reduce global welfare according to the domestic importance of foreign goods. Thus, only if these goods were sufficiently important for domestic consumption would the harmonization of IPR protection that the TRIPS require improve global welfare.

Cozzi (2009) also highlights the role of IPR in economic growth in both developed and developing countries. Typically, while the developed countries are the northern countries, which create new varieties of goods and services, the developing countries are the southern countries, which have a production cost advantage. In this sense, the source of growth is the horizontal innovation of new intermediate products. In the case of northern firms, they may export (the) intermediate goods, they may directly invest in the South (through knowledge transfer), or they may grant a licence for their product (complete transfer). These firms desire to transfer the maximum possible knowledge, but this implies the transfer of more knowledge about their patented goods. The southern firms can try to undertake costly imitation activities, so that in the South IPR protection is not complete: the more intensive is the knowledge transfer, the higher is the probability of southern firms imitating their northern counterparts. The greater is the IPR protection, the higher is the equilibrium FDI,[6] which makes it possible to improve the international division of labour. Thus, while very high IPR protection implies licensing - this method being the most efficient - very low IPR protection induces the firms of the North not to transfer at all, but to produce domestically and to export their intermediate goods to the South. The advantage of this last situation is the absence of unproductive Southern imitation costs. Cozzi (2009) also maintains that different IPR effects can exist: the combination of the general equilibrium effects of adverse incentives and wasteful imitation costs implies that the increase in international IPR protection is beneficial to the welfare of the South if the initial level of IPR is already above a certain threshold. However, in the case of weak protection of initial IPR, the increase in protection might be dangerous for (the) southern consumers.

Globalization, inequality and innovation are phenomena crucially associated with IPR. Spinesi (2009) extended Dinopoulos and Segerstrom's (1999) work on Schumpeterian economic growth, by studying the relations between all those dimensions. Among others issues, Spinesi emphasises that IPR achieve a similar result even in the presence of constant returns to scale. This result is advantageous because it would also apply in the case of firms competing *a la* Bertrand. Moreover, he finds that, while horizontal innovation has a positive level effect, it is vertical innovation that sustains the growth effect.

Panagopoulos (2009) explores the relationship between patent breadth and growth, by studying how patent breadth affects innovation and output. This study finds an inverse U relationship between patent protection and growth.

From the different studies mentioned above, we conclude that there is no consensus regarding the relationship between IPR and economic growth, including within the specific theoretical framework of endogenous growth literature. In Table 1 we offer a systematization of this theoretical literature.

[6] The relationship between IPR protection and FDI is also analyzed by Chu (2009b): technological transfer between northern and southern firms occurs to a significant extent *via* FDI.

IPR conceptualization	Author (date)	Net final effect
Patents	Scherer (1997); Koléda (2008)	On innovation: 0
	Tandon (1982); David and Olsen (1992)	On welfare: +
	Merges and Nelson (1994)	On technological progress: -
	Taylor (1994)	On economic growth: + (symmetric protection) and – (asymmetric protection).
	Michel and Nyssen (1998); Goh and Oliver (2002); Iwaisako and Futagami (2003)	On economic growth: +
	Futagami and Iwaisako (2007)	On economic growth: + (finite patent length) and – (infinite patent length); a patent strategy with a finite patent length is optimal.
	Naghavi (2007)	On South welfare: + (if attract foreign investment in less R&D intensive industries or if they stimulate innovation in high technology sectors).
	Dinopoulos and Kottaridi (2008)	On economic growth and on income distribution: + (if each country selects the level of patent enforcement optimally, with the North having an incentive to choose stronger IPR protection than the South).
	Eicher and Garcia-Peñalosa (2008); Chu (2009a)	On economic growth: 0
	Panagopoulos (2009)	On economic growth: a concave relationship.
Index of Patent Rights from Park (2008)	Chu (2010)	On economic growth: +; on income inequality: 0
Patent length and breadth; protection trademarks; copyrights and trade secrets; and the degree of enforcement.	Kwan and Lai (2003)	On economic growth: optimal degree of IPR protection.
Copyright	Novos and Waldman (1984)	On social welfare: +

IPR conceptualization	Author (date)	Net final effect
	Landes and Posner (1989)	On welfare associated with a given work: -
Patent length and breadth; copyright policy	Furukawa (2007)	On economic growth: - (when the impact of accumulated experience on productivity is large enough, an inverted U relationship is suggested).
Increase in imitation costs	Stryszowski (2006)	On economic growth in technologically lagging countries: 0
	Glass and Saggi (2002); Mondal and Gupta (2008)	On innovation and on FDI: -
	Mondal and Gupta (2009); Connolly and Valderrama (2005)	On welfare: + (both in North and in South, although the marginal welfare gain is higher in the former than in the latter)
	Wu (2010)	On innovation: +
Tariffs; Increase in the costs of imitation	Datta and Mohtadi (2006)	On South's economic growth: tariffs (-); IPR (-)
Imitation intensity	Mondal and Gupta (2006); Glass and Wu (2007); Zhou (2009)	On innovation: 0
	Dinopoulos and Segerstrom (2010)	On innovation: +
Imitation probability and the return of innovation.	Horii and Iwaisako (2007)	On economic growth: 0
Royalties	Saint –Paul (2008)	On welfare: +
N/a	Furukawa (2010)	On innovation: inverted U

N/a: not applicable; 0: ambiguous or inconclusive net effect; +(-): positive (negative) net effect.
Own elaboration.

Table 1. The impact of IPR on innovation and growth: a synthesis of the theoretical literature

As mentioned above, the relevant theoretical literature points to both positive and negative effects of patent protection on innovation (Chu, 2009b). For example, Furukawa (2007) and Eicher and Garcia-Peñalosa (2008) refute the idea that stronger IPR protection is always better. Using an endogenous growth model with costless imitation, Furukawa (2007) proves that IPR protection cannot increase economic growth, whereas Eicher and Garcia-Peñalosa (2008) support the idea that the relationship between IPR and economic growth is ambiguous. Iwaisako and Futagami (2003), Mondal and Gupta (2006) and Futagami and Iwaisako (2007) identify two opposite effects on this relationship. Wu (2010) presents inconclusive results that depend on such features as the countries' level of development or the channel of technology transfer. Scherer (1977) also maintains that patents involve an

impact that depends on such factors as the market position of the innovator, the features of the technology (whether it is easy or difficult for it to be imitated), the cost, the risks and the potential payoffs from innovation. Furukawa (2010) and Panagopoulos (2009) find an inverted U relationship between IPR protection and innovation (and economic growth). Kwan and Lai (2003) and Connolly and Valderrama (2005) argue that IPR are important to R&D investment and (to) welfare.

Table 1 is also helpful in showing that different authors use different concepts of IPR. Some of them (Scherer, 1997; Tandon, 1982; David and Olsen, 1992; Merges and Nelson, 1994; Taylor, 1994; Michel and Nyssen, 1998; Goh and Oliver, 2002; Iwaisako and Futagami, 2003; Futagami and Iwaisako, 2007; Naghavi, 2007; Dinopoulos and Kottaridi, 2008; Naghavi, 2007; Dinopoulos and Kottaridi, 2008; Eicher and Garcia-Peñalosa, 2008; Koléda, 2008; Chu, 2009a; Panagopoulos, 2009) limit the definition of IPR to one of their forms – patents (considered as the most important form of IPR, as discussed above). Others use distinct definitions, e.g. Glass and Saggi (2002) and Mondal and Gupta (2008, 2009), who define IPR as the rise in the imitation cost. Connolly and Valderrama (2005) give a similar definition, assuming that imitators pay a licence fee which is similar to an increase in the fixed cost of the imitative research; Kwan and Lai (2003) consider IPR part of the imitation rate which can be influenced by some factors such as patents, trademarks, copyrights and trade secrets; Furukawa (2007) also defines IPR as a mixed measure of patent and copyright; Glass and Wu (2007) associate the measure of IPR with (the) imitation intensity, whereas Dinopoulos and Segerstrom (2010) define IPR as a reduction in the exogenous rate of imitation.

Despite these different ways of defining IPR, we do not find evidence of significant differences in terms of the results obtained. In fact, we have two studies in the table that achieve the same results using different measures of IPR: Furukawa (2007) and Panagopoulos (2009). Both suggest an inverted U relationship between IPR and economic growth, although the former defines IPR as a mix of patent and copyright measures, while the latter defines IPR only as patents. Furukawa (2010) also finds the same relationship, although he does not define IPR.

Two of the articles in Table 1, Stryszowski (2006) and Mondal and Gupta (2008), compare their assumptions and/or conclusions with other studies – some of them also analyzed in the present work. Stryszowski (2006) identifies and discusses studies which maintain that strong IPR protection is beneficial for (the) innovating economies (*e.g.*, Connolly and Valderrama, 2005). However, this study also highlights works that have found negative effects of IPR protection on lagging economies, based on the existence of a mechanism in which strong IPR protection tends to raise consumer prices and to diminish trade benefits that could be essential for developing economies (for example, Hekpman, 1993). Mondal and Gupta (2008) discuss several studies based on their distinct assumptions concerning the innovation framework (quality ladder framework *versus* product variety framework), and the alternative ways of treating imitation and of strengthening IPR protection, etc. Following this they present the assumptions of their own model, characterized by the use of a product variety model, a North-South model with endogenous innovation, imitation and multinationalisation, where innovation activities are set as costly and there is an endogenous rate of imitation. Lai (1998) gives a close approximation to this latter one, except for two features: the endogenous imitation rate in the South, given that imitation is considered costly; and the introduction of two kinds of labour in the South – skilled and

unskilled. In line with these two distinct assumptions, the results achieved are also different from Mondal and Gupta's (2008).

To sum up, we can state that the studies presented in Table 1 do not show a pattern regarding the relationship between IPR and economic growth (*via* welfare, for instance). From this table we can also state that patents are the most widely used measure of IPR in theoretical works. Hence, at this stage, we state the existence of two main gaps in this literature: the scarcity of studies, so that a potential research line would be to dig more deeply in this field; and the excessive focus on patents as an IPR measure, which neglects the potential impact of other instruments, such as copyrights, which are crucial for the development of specific ICT industries such as information technology and software.

In the next section we develop an analysis of the empirical studies concerning this same relation(ship) between IPR and endogenous economic growth.

4. IPR and Endogenous Economic Growth: Where do we stand? Insights from the empirical literature

After the systematization of the relevant theoretical literature in the previous section, we focus on empirical studies into the effect of IPR protection on innovation and on economic growth. In this review (*cf.* Table 2), we intend to show whether the empirical results permit us to reach a sustainable conclusion, faced as we are with the confirmed ambiguity of the theoretical contributions.

As we have seen above, according to the theoretical literature, patent protection generally has positive and negative effects on innovation (*e.g.*, Chu, 2009b). However, empirical studies usually find a positive effect, which according to Chu (2009b) is explained by the domination of the positive effects over the negative ones. As we can see in Table 2, the empirical evidence suggests a positive relationship between IPR protection and innovation, although with some 'restrictions' in the sample. For instance, the positive result is true only for developing countries (Falvey *et al*., 2009; Chen and Puttitanun, 2005). At a first glance, we could expect the opposite result. However, while some works, for example Park (2005) and Kanwar and Evenson (2003), generally find a positive effect, Chen and Puttitanun (2005) explain that, on the one hand, lower IPR can facilitate imitation, while on the other hand, innovation in developing countries increases in proportion to greater IPR protection. Moreover, these authors state that the optimal degree of IPR protection may depend on the country's development level. Furthermore, Falvey *et al*. (2006) find evidence of a positive effect between IPR and economic growth for both low and high-income countries, but not for middle-income countries. According to the latter, the positive relation between IPR and economic growth in low-income countries cannot be explained by the potential fostering of R&D and innovation, but by the idea that stronger IPR protection promotes imports and inner FDI from high-income countries without negatively affecting the national industry based on imitation.

Hence, when the division between developed and developing countries is considered, the effects of patent rights on R&D are rendered ambiguous: for instance, according to Chen and Puttitanun (2005), in developing countries there is a positive and significant relationship between IPR protection and innovation, while according to Park (2005), there is an insignificant effect of IPR protection on R&D.

Measure of IPR	Methodology	Sample	Author (date)	Net estimated effect
Park and Ginarte (1997) Index of Patent Rights[7]	Econometric analysis – Seemingly Unrelated Regressions (SUR)	Cross-section of countries for the period 1960-1990.	Park and Ginarte (1997)	+
	Econometric analysis – cross section	48 countries for the period 1980 and 2000 (Sources: World Intellectual Property Organization (WIPO) and Penn World Table 6.1)	Xu and Chiang (2005)	
	Econometric analysis – panel data	64 developing countries over the 1975–2000 period (Sources: World Development Indicators and Statistical Yearbook by UNESCO (UNESCO, 1995, 1997, 2000); patent data come from the United States Patent and Trademark Office Website)	Chen and Puttitanun (2005)	
		79 countries and four sub-periods: 1975-79, 1980-84, 1985-89 and 1990-94.	Falvey *et al*. (2006)	+ (for low-income and high-income countries)
		80 countries for the period 1970–1995. (Sources: PennWorld TableMark 6.1, updated version of Summers and Heston, 1991; UNCTAD, 2005; World Bank, 2005; Ginarte and Park, 1995; Easterly and Sewadeh, 2005; Hall and Jones, 1999; and Barro and Lee, 2000).	Groizard (2009)	**Ambiguous:** **+** (FDI is higher for countries with stronger intellectual property protection). **-** (Negative relationship between IPR and human capital indicators).

[7] This index is a simple sum of the scores attributed to each of the five categories of patent rights (score from 0 to 1) on a scale of 0 to 5, with a larger number indicating stronger patent rights. The five IPR categories are the patent duration, the coverage, the enforcement mechanisms, the restrictions on patent scope and the membership in international treaties.

Measure of IPR	Methodology	Sample	Author (date)	Net estimated effect
		69 developed and developing countries over the period 1970–1999 (Sources: World Bank's World Development Indicators, 2001, Jon Haveman website, OECD's International Trade by Commodity Statistic (Historical Series, 1961–1990), International Trade by Commodity Statistic (1990–1999), and Barro and Lee (2001) database.	Falvey *et al.* (2009)	**Non-linear:** (Depends on level of development, the imitative ability and the market size of the importing country).
Park and Ginarte (1997) Index extended by Park (2008a)	Econometric analysis	50 countries (Sources: Ginarte and Park, 1997; Sachs and Warner, 1995; Hofstede, 1984 and UNESCO, 1998).	Varsakelis (2001)	+
		32 countries for the period between 1981 and 1990 (Sources: Ginart and Park, 1997; Esty *et al.*, 1998; United Nations, 1999; Word Bank, 2000; Barro and Lee, 2000; Heston *et al.*, 2001 and Pick's Currency Yearbook and World Currency Yearbook, several years).	Kanwar and Evenson (2003)	
Eight indexes:[8] index of patent rights constructed from Ginart and Park (1997) and Park and Wagh (2002); index of copyrights; index of trade-marks; index of parallel import protection; index of software rights; index of piracy rates; index of enforcement provisions and index of enforcement in practice.		41 countries (Sources: Penn World Tables (Version 5.6a), World Bank Development Indicators and UNESCO's Statistical Yearbook).	Park (2005)	

[8] For the first three indexes (relative to patents, copyrights and trade-marks) the index consists of four sub-categories: coverage, duration, restrictions and membership in international treaties. Enforcement can also be included as a sub-category (such as in Ginarte and Park, 1997) but it was considered useful to separate this sub-category and treat it as another index.

Measure of IPR	Methodology	Sample	Author (date)	Net estimated effect
Patent rights index data (Park, 2001)	Semiparametric model	21 countries for the period 1981 and 1997 (Sources: World Bank World Development Indicators, 1999; and UNESCO).	Alvi *et al.* (2007)	
Patents	Econometric analysis	Firms in the chemical, drug, electronics and machinery industries	Mansfield *et al* (1981)	
		Japanese and U. S. patent data on 307 Japanese firms (Sources: Japan Development Bank Corporate Finance Database, Kaisha Shiki Ho R&D, JAPIO, CASSIS CD-ROM, RAI patent database and Hoshi and Kashyap, 1990).	Sakakibara and Branstetter (2001)	**0**
		4 countries (manufacturing sector divided into 12 subgroups) between 1990 and 2001 (Sources: OECD STAN, EPO and PERINORM).	Blind and Jungmittag (2008)	
Impact of patent reform[9]		16 countries over the 1982-1999 period (Sources: U.S. Bureau of Economic Analysis (BEA) Survey; World Intellectual Property Rights Organization (WIPO)).	Branstetter *et al*. (2005)	**+**
N/a (property rights)		68 developed and developing countries between 1976 and 1985 (Sources: World Development Report 1988, Summers and Heston, 1988; World Bank, 1990; and Scully and Slottje, 1991).	Torstensson (1994)	

N/a: not applicable; 0: ambiguous or inconclusive net effect; +(-): positive (negative) net effect.
Own elaboration.

Table 2. The impact of IPR on innovation and growth: a synthesis of the empirical literature

Chu (2009b), in giving a plausible explanation for this contrast emanating from empirical analyses, points to the fact that developed countries are typically close to the technology frontier, and that consequently economic growth in these countries requires original innovations, while developing countries are normally further away from the technology frontier, thus enabling economic growth to be driven by the reverse engineering of foreign technologies. Therefore, stronger patent rights, which discourage the reverse engineering of foreign technologies, can asphyxiate the innovation process in developing countries. Chu

[9] "Each reform can be classified according to whether or not it expanded or strengthened patent rights along five dimensions: 1) an expansion in the range of goods eligible for patent protection, 2) an expansion in the effective scope of patent protection, 3) an increase in the length of patent protection, 4) an improvement in the enforcement of patent rights, and 5) an improvement in the administration of the patent system." (Branstetter *et al*., 2006: 14).

(2009b) emphasises that the increase in the level of patent protection by policymakers is similar to giving more market power to monopolists, which intensifies the deadweight loss. He recalls Nordhaus' (1969) contribution in stating that the optimal level of patent protection should trade-off the harmful effects of IPR protection on society, even when stronger patent rights are growth-enhancing, against the welfare gain from innovation. Hence, distortionary effects of IPR protection could emerge. The latter author also emphasizes that, when skilled and unskilled workers are assumed, (the) strong patent protection increases the return to R&D and the wage of R&D workers.

Through analysing the net effect of the IPR on economic growth we can state that it is not easy unequivocally to draw conclusions regarding the sign of that effect, despite the prevalence of the positive sign (*cf.* Table 2). We find evidence of both a positive sign and a negative sign. Possible explanations, beyond the focus on a patent index for measuring IPR (as also highlighted by Chu, 2009b, which mentions that it is not clear how each type of patent rights influences innovation on empirical grounds), are: the fact that some studies do not analyze the direct effect between IPR and economic growth; the adoption of different methodologies and of distinct samples. Hence, the gaps already mentioned when discussing the theoretical contributions clearly emerge here in association with the empirical studies. Once again, insufficient analysis, even more striking at the empirical level, and the excessive focus on patents as means of IPR measurement are evident.

5. Conclusion

This study supports the conclusion that there is no clear relationship between IPR and economic growth. Theoretical literature indicates that IPR protection has positive, negative or even ambiguous (or inconclusive) effects on innovation.

After a thorough review of this theoretical literature it has been possible to identify some gaps in the research agenda. Firstly, in general, this research does not study the direct and net effect of IPR on economic growth. In fact it only analyzes the relationship between IPR-induced factors and economic growth, or the impact of IPR on other economic indicators such as welfare, technological change, FDI, R&D, innovation, etc.. This happens because a standard argumentation is adopted, maintaining a strict relation between these elements and economic growth. For instance, Mondal and Gupta (2006: 27) point out that "[t]echnological change plays the most important role in determining a country's rate of economic growth. Strengthening the Intellectual Property Rights (IPR) is an important factor that motivates technological change". Furthermore, Koléda (2002: 1) argues that "[i]nnovation is an important source of economic growth". Mansfield (1986: 173) holds that "[t]he patent system is at the heart of our nation's policies toward technological innovation." Secondly, there is a disproportionate focus on patent measurement as a proxy for IPR, and thirdly, it is clear that there is a scarcity of studies in this field , particularly in empirical terms.

Despite the divergence of results regarding theoretical studies, most empirical studies find a net positive effect, which means that positive effects of IPR protection outweigh the negative effects. A possible explanation for this is that the empirical measure of patent protection, which is typically used, is just a summary of the statistics relating to the different categories of patent rights and so it is not clear how each type of patent rights influences innovation on empirical grounds (Chu, 2009b).

From the above, we consider that more research on this specific topic is crucial in order to further advance our understanding of the relation(ship) between IPR and economic growth on a worldwide scale, and to be able clearly to go beyond the strict modelling frame.

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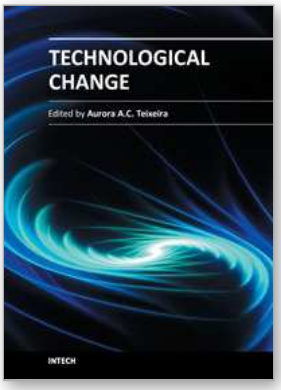

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Technological change is today central to the theory of economic growth. It is recognised as an important driver of productivity growth and the emergence of new products from which consumers derive welfare. It depends not only on the work of scientists and engineers, but also on a wider range of economic and societal factors, including institutions such as intellectual property rights and corporate governance, the operation of markets, a range of governmental policies (science and technology policy, innovation policy, macroeconomic policy,competition policy, etc.), historical specificities, etc. Given that technology is explicitly taken up in the strategies and policies of governments and firms, and new actors both in the national and international arenas become involved, understanding the nature and dynamics of technology is on demand. I anticipate that this book will decisively contribute in this regard.

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