Foreign Patent Rights, Technology & Disembodied Knowledge Transfer Cross Borders: An Empirical Application

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ABSTRACT

This paper attempts to evaluate empirically how foreign patent rights affect French technology services exports cross borders. We apply a reduced-form econometric equation relating French receipts in technology services cross-borders to an index of patent strength, real GDP per capita, openness, and technological characteristics of knowledge-recipient countries. Patent rights do have a role to enhance technology markets overseas when the profitability of commercializing knowledge is matched to technological capacity and market size. Thus, patent protection in low-income countries seems to be not significant (or not pertinent). Finally, we found that for low-technology sectors foreign patent rights (stronger patent protection) may deter knowledge flows cross borders.

Key Words: *Intellectual Property Rights, disembodied knowledge, patent licensing*
JEL Classification: O34, K42, F14, O31

Introduction

There is an ongoing intensive research attempting to better understand innovation activity by firms and countries, and the way new technologies are internationally diffused. The study of disembodied knowledge trade, and particularly, the analysis of international trade on technology services (international patent licensing, technical assistance, engineering and external R&D services, know-how contracts,), have been rather neglected by economists. Nevertheless, to the extent that they constitute a more direct transfer means of innovation and knowledge, they constitute therefore a matter of analysis. Spillovers related to disembodied knowledge embedded in patents, have been recently an issue of intensive research [Kortum and Lerner, 1998, Verspagen et al. 1999, see Guellec and Van Pottelsbergue 2001, on the internationalisation of technology analysed with patent data]. International trade of embodied knowledge on technology intensive products such as machinery and equipment imports have been traditionally a matter of research in the spill over and the absorption capacity literature [Cohen and Levinthal, 1989]. Finally, the importance of technology suppliers on the development of international technology markets has been stressed by Arora et al. [2001].

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Although the public-nature of knowledge, the role of imitation threat, the role of patent protection cross-borders have been very few explored by the empirical work. A number of papers have analysed the impact of intellectual property protection as a determinant of trade, FDI and licensing, the former being two indirect channels of technology transfer. Nonetheless, they arrived to very mixed conclusions about the role of patent rights and economic activity overseas [Maskus and Penubarti, 1998; Primo Braga & Fink; 1998, Yang and Maskus, 1999; Smith, 2001]. Besides, although these means, particularly FDI and trade; they do represent indeed a way of production transfer, the quality regarding the technologies transferred or the effective knowledge transferred (to locals) is doubtful.

To transfer technologies and particularly, to trade disembodied knowledge becomes a special question when innovating firms decide to commercialize intellectual assets in technology-followers or technology-importers countries [Maskus, 1998]. Furthermore, to the extent that the imitation threat varies across sectors it is expected consequently that the role played by patents to foster knowledge markets through the different transfer means should differ also among industries.

How international differences in foreign patent protection affect decisions to transfer knowledge using technology services receipts [technology balance of payments] is an important question that has attract virtually no econometric study. This paper evaluates empirically the role of intellectual property protection, technology endowments and market size, both macro and from an industrial perspective on technology-services receipts received by French firms from abroad. We explore data contents on the technology-services balance of payments, containing intellectual property and disembodied knowledge trade overseas: international patent and trademark licensing [both to affiliated and non-affiliated firms], technical assistance and engineering services, R&D overseas and R&D services, etc.

Our analysis attempts therefore to give some insights on the ongoing discussion related to international harmonization of IPRs protection and its potential effects on global innovation, knowledge transfer and knowledge access. This debate has emerged since the creation of the TRIPs [Trade Related Intellectual Property Rights] Agreement under the WTO negotiations [1986-1994], for which an important number of developing

countries were required to strength patent protection, or reform entirely their intellectual property system.

The paper is organized as follows: Section 1 discusses the conceptual framework. Section 2 describes the specification, method and data. Section 3 provides results. Section 4 concludes.

1. Previous Literature

The next section provides a summary of theoretical considerations involved generally to study technology trade and intellectual property protection. It provides also a brief review of empirical contributions.

2.1 Theoretical Literature

As stated by the existing literature on IPRs [Intellectual property rights], since knowledge is non-rival in nature, it can be freely available (apart from the cost of transmitting knowledge). If this were the case, however, the market or firms would under invest in the production of new knowledge, because innovators would not be able to recover their costs [Arrow, 1962]. By granting innovators the exclusive rights to commercialize their intellectual assests over a certain period of time [20 years for patents], IPRs offer an incentive for the production of knowledge. Hence, in principle IPRs should play an significant role in technology trade.

An effective protection of intellectual assets overseas might in theory further stimulate international commercialization of knowledge by innovating firms. Under a weak or lax intellectual property rights regime, the provision and sharing of tacit knowledge and intellectual assets with domestic firms becomes too risky when the threat of imitation posed by the partner or by third firms is strong [Glass and Saggi, 1997, Markusen, 1998].

Mansfield and al. [1968] founds that imitation in relative-patent sensitive sectors such as chemicals and pharmaceuticals can take place in a relatively very few time at extremely low costs [in a survey study, pharmaceutical firms declared that 65% of their innovations would have not been developed without recurring to patents, a 68% would have not been commercialised]. Lanjouw [1998] founds for instance, that imitation by Indian firms of new launched pharmaceuticals in northern home countries takes less than 2 years.

Therefore, patent protection is *à priori*, a major condition when transferring knowledge; at least in a number of industries. However, to the extent that patents rights are linked to the exercise of market power, and therefore, to monopoly markets, patent rights might not be pertinent when commercializing knowledge in poor income countries. So, even when patent protection is available in the host country, and there is not a imitation threat, patents might not be relevant for technology trade.

Thus, for countries achieving certain market size [some income level], it has been argued that strengthening IPRs might enhance the development of technology markets particularly when conditions to absorb knowledge are present -whether a previous imitative has been developed or the country host has an innovative capacity-, and a guaranteed profitability related to commercialize technologies in that market also exist [Smith, 1999; Vaswishrao, 1999].

However, the issue is more complex since IPRs affect international technology trade -when incentives and conditions for technology markets exist- in several ways. Literature on IPRs and trade concludes thus that stronger patent protection [or IPRs] has indeterminate effects because firms might have different answers to foreign patent protection and so their interest to further commercialize knowledge assets [or knowledge services] can both increase or not [Maskus and Penubarti, 1998].

As noted by the literature, intellectual property protection may provoke a "*market expansion effect*" on international trade of goods, or a "*market-power effect*" which is translated, into higher prices of technologies, and thus, reduced flows of knowledge commercialized towards those countries. Accordingly, a strengthening of a country's patent regime would tend to increase the local demand as foreign firms would face an increasing market for their products or services once the pirates are displaced. On the other hand, a firm may choose to reduce its sales in a foreign market as a response to stronger IPRs protection because of its greater market power in an imitation safe environment. Overall, these opposing effects imply that the effect of foreign patent protection on bilateral flows is theoretically ambiguous [Yang and Maskus, 1999, Maskus, 2001].[2]

[2] Stronger foreign patent protection may affect the mode of serving a foreign market. Hence, it may affect internalisation decisions (stronger foreign direct investment vs. Exports, FDI vs. Licensing, etc. See Markusen, 1995), and the trade-off among the different entry modes. Since such an aspect of production decisions modes deserves its own study and a different framework, we limit here our analysis to the relationship of foreign patent rights, countries' technology endowments and

2.2 Empirical Literature

Little empirical work has been made evaluating the impact of patent protection on technology services or on international licensing overseas. A number of studies have explored foreign patent protection and economic transactions flows, in a more general way : the impact on overall trade, trade on technology-intensive products, FDI and in a very lesser extent on licensing. They suggest nonetheless, a potential negative relationship between a weak patent regime country and the volume of US or European Direct Investment, which seems to be particularly strong for technology-intensive sectors (Lee & Mansfield, 1996, B. Smarcinszyka, 2000). Maskus [1998b] and Lee & Mansfield [1996] show that patent strength may affect the decisions of multinationals regarding the stage of production in developing countries [the nature of FDI]. In particular, Maskus finds that weak IPR protection deters the multinational from locating R&D intensive activities in such countries so that FDI should be restricted to assembly and production plants. This tendency confirms that firms are more concerned with IPRs the higher the stage of production carried over to all sectors [these findings hold also for Japanese and German firms in a following study by Mansfield [2000] and confirmed also by Kumar [1996] regarding the impact of IPRs on R&D intensity of American firms abroad.

Finally, as suggested by Viswasrhao [1994] and Yang & Maskus [2000], stronger IPRs can induce licensing activity since patent protection reduces the monitoring and litigation cots, and others enforcement measures [the idea of patents as catalysers of technology markets has been pointed by Arora & Gambardella, 1994, 2000]. Indeed, using the Ginarte-Park index in a panel of 26 countries in 1985, 1990, and 1995 for unaffiliated royalties and licensing fees paid to U.S. firms a recent study found [Yang and Maskus, 1999] that the patent index has a significant and positive impact on international licensing. Applying the elasticity found [5.3] to anticipated changes in patent rights, and using existing fees for 1995, Maskus [2000] found that important changes in licensing activity can emerge in some countries. For instance, large responses were identified for Korea, Mexico, Brazil, and Indonesia. [3]

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market size on overall knowledge flows by technology services exports, without entering into the discussion on firms' decision of market serving.

[3] Nevertheless, we must take these results with caution since these works do no take into account the potential increase in (monopoly) licensing fees that could emerge with increased patent protection –and other anti-competitive practices- as noted by several studies (Saphiro, 2000). It is also not reported if increases in flows are related to a higher number of contrats or a higher royalty rates paid.

2. Specification, method and data

We apply a reduced econometric equation of technology transfer flows suggested by Glass and Saggi [1998] and Yang & Maskus [1999] relating countries'factor endowments notably in technology; labour, market size and openess of knowledge-recipient countries; and foreign intellectual property protection to the extent of knowledge commercialization overseas by French firms.

Following earlier specifications, the equation form express knowledge flows by commodity (or sector) as:

$$Y_{jk} = \alpha_0 (CGDP_j)^{\alpha_1} (POP_j)^{\alpha_2} (CGDP_k)^{\alpha_3} (POP_k)^{\alpha_4} (IPR_k)^{\alpha_5} (SK)^{\alpha_6} E_{jk} \quad (1)$$

Where Y_{jk} is bilateral exchange from source country j to foreign country k; GDP_j and $CGDP_k$ are the per capita incomes of countries j and k; $POPj$ and $POPk$ are the populations of countires j and k; $IPRk$ is the level of intellectual property protection of the host country, SK are the skills that can be represented by different variables of foreign country k (school enrolment ratio, tertiary education ratio, total researchers, technicians, etc.), E_{jk} is a log normally distributed error term.

The statistical specification is derived by taking natural logs of Eq. (1). We include a variable of market openness and define dummy variables to account for IPRs interaction with variables of income levels and technology capacity [or imitation threat]:

$$\begin{aligned} Ln(Y_{ijk}) = {} & \alpha_0^* + \alpha_1 \ln (CGDP_k) + \alpha_2 \ln (POP_k) + \alpha_3 (IPR_k) + \alpha_4 \ln (SKk) + \\ & \alpha_5 (OPjk) + \alpha_6 IPR\,(D1) + \alpha_7 IPR(D2) + Ejk \end{aligned} \quad (2)$$

where $\alpha_0^* = \alpha_{01} + \alpha_{02} \ln(CGDP_j) + \alpha_2 \ln(POP_j)$. This intercept captures constant terms for France -the only source country j. D1 and D2 are dummy variables for low/middle and high income countries to estimate in a first regression, and dummies also for strong and weak technological capacity. We interpret the parameters based on prediction from the theory literature described above in section 2. We expect coefficients on GDP (CGDP) and population to be positive related to the extent of knowledge flows. Second, the coefficient on SK may be positive indicating that complementarities between local technical effort and technology-services importing exist [Braga and Willmore, 1991].

That is, the partner country technological capacity expressed by R&D labour and expenditure, human skills (mean years of schooling, gross tertiary science enrolment ratio), are included to capture the absorption capacity and expected to affect positively the technology transfer between countries. A negative sign would indicate substitution, of knowledge acquisition to local effort, thus weak flows of knowledge exports by French firms [Katrack, H., 1997, Lee, 1996].

Following Smith (2001) and Yang and Maskus (2000), we expect that imitating countries and countries with intermediate and high technological capabilities, and accounting with strong intellectual property rights will attract larger volumes of technology services, rather than countries with low levels of technical skills and strong patent regimes. The idea being that patent protection is valuable when a technical capacity for knowledge transfer and when a market for technology consumption co-exist. In this way, we expect that real GDP per capita indicating the level of economic development and controlling for the demand characteristics of the recipient country, affects positively the volumes of technology flows.

Furthermore, it is expected that the impact of strength of IPRS (or the extent of imitation threat), will vary not only across countries, but especially across sectors. Since the ease of imitation differs across industries, the reliance on IPRs protection varies, and consequently, the extent to trade disembodied knowledge overseas differs. It is acknowledged that pharmaceuticals and chemicals rely essentially on patents to appropriate returns and deter imitation, whereas machinery, such as the automobile industry; metal working industries, etc. relies more in other means of appropriation.

DATA. As a measure of disembodied knowledge flows our dependent variables (Y*jk*) are bilateral trade French receipts (flows) in technology services for a total of 19 countries destinations. We use total aggregates receipts for international patent licensing (inventions and processes), trademarks, the provision of technical assistance and engineering services and R&D services cross-borders exported by France, as the technology-exporter country, for 29 sectors over 1999. Data is based on the International Technology transfer Report published by the *National Institute of Intellectual Property* (INPI).

As explanatory variables we use cross-country data for destinations countries, referring to factors endowments, technological capacity and indicators of technological dynamism

besides real GDP per capita and market openness as control variables. Data on human skills are from UNESCO, labour, market openness [exports plus imports as a percentage of GDP], high technology exports and FDI stocks are from the World Bank Development Indicators [2001], patents are from WIPO [World Intellectual Property Organization]. Finally, our indicator measuring the strength of intellectual property rights in the country is the index Park and Ginarte [1997], previously employed in a number of studies.

3. Estimation Results

We proceed to a Tobit estimation given that we have countries for which a zero flow is reported, and in order thus, to account for the largest number of observations. In our first regression we control for sectors as the groups, so we can test income differences interacted with our IPR index. In our baseline regression (first column), our index of intellectual property rights (IPRS) protection is not significant. That suggests, that patents by themselves cannot explain enough knowledge transfer decisions. So we proceed to interact the index with different market and technology countries' characteristics. In a second regression, we use dummies identifying high and low income countries. We found that for high income countries we have a positive significant impact of foreign patent rights on knowledge flows though; the magnitude of the coefficient is rather small. For low income countries interacted with IPRs protection, the coefficient is positive and smaller than the one on the high income group, although is not significant. Since our data concerns 19 countries partners of France, and so most of them are rich countries (OECD), we may not have enough variability on income levels (GDP per capita).

In the second TOBIT regressions group (column 3 and 4), we are controlling for countries' effects, in order to identify sector's differences to react to IPRs protection. In the first regression we found that IPRs do have a positive effect on knowledge flows, although such an impact is not important. In a second regression (column 4), we create dummies for two groups of sectors: high technology sectors (such as chemicals, pharmaceuticals, manufacturing of machines and instruments, electronics, etc.) and low technology sectors (textile, food and tobacco, wood, furniture, printing and edition, etc.). Results show that high technology sectors are indeed more sensitive to IPRS protection overseas. And therefore, a "*market expansion effect*" can be identified. On the other hand, IPRs in low-technology sectors have a negative effect, but is not significant.

Looking at the GDP per capita as market size and labour which can be interpreted also as an indicator of local demand (higher demand on products), and as indicator of production costs (incentives for production), both remain highly significant and positive in all estimations. Therefore, knowledge transfer is largely explained by the market size. Finally market openness measured as exports plus imports as a percentage of GDP, is only significant in one regression, but it shows the expected positive sign.

Estimation Results for Macro-aggregates at the country level

	TOBIT (group sectors)		TOBIT (group country)	
Ln(gdcap)	6.46**	8.26**	6.72**	6.67**
	(1.41)	(1.42)	(1.72)	(1.63)
Ln(lab)	4.01**	4.96**	3.93**	4.11**
	(0.79)	(0.77)	(0.89)	(1.39)
Ln(op)	0.95	2.43*	1.02	1.11
	(1.22)	(1.17)	(1.41)	(1.39)
Ln(hs)	-3.97**	-3.92*	-3.25*	-3.13*
	(5.11)	(4.49)	(2.58)	(5.89)
IPRs	.650		0.36*	
	(1.42)		(1.64)	
HI*IPRs		0.700*		
		(1.31)		
LI*IPRs		0.441		
		(1.25)		
HTS*IPRs				1.21*
				(1.64)
LTS*IPRs				-0.18
				(1.64)
No. obs.	551	551	551	551
No. of groups	29	29	19	19
Obs. Per group	19	19	29	29
Wald chi2	94.55	125.56	73.63	87.72
Prob>chi(2)	0.0000	0.0000	0.000	0.0000

**Significant at 5 percent level. * Significant at 10% level. Standard errors are in parentheses.

4. Some preliminary conclusions

These very preliminary results suggest that IPRs protection do have a significant impact on the extent of French knowledge flows for countries with high market sizes. They suggest also the impact of foreign patent rights may differ according the technology endowments of the host countries, and moreover, it should differ mainly according the technology intensity and the sensitivity of sectors to IPRs. We attempt here to build a first empirical application on disembodied knowledge trade by French firms, highlighting thus the importance of studying direct technology transfers such as those reported in the technology balance of payments.

Whereas very few empirical studies have been done on international technology services and on the role of imitation or innovation protection regimes (for studies on patent licensing see Yang & Maskus, 2001, Smith, 2001, Arora and Gambardella, 1999, Arora and Fosfuri, 2002), we proposed to refine previous studies by differentiating countries' technological intensities, patent protection, as well as foreign patent behavior to the analysis of traditional variables such GDP per capita, openness to trade and population.

References

Arora, A., and A. Fosfuri and A. Gambardella (2001a) Specialized technology suppliers, international spillovers and investment: evidence from the chemical industry. Journal of Development Economics, Vol. 65 31-54.

Arora, A., and A. Fosfuri and A. Gambardella (2001b), Markets for Technology, MIT Press.

Braga, H. & Willmore, K. (1991), Technological Imports and technological efforts: an Analysis of the determinants in Brazilian Firms, The Journal of Industrial Economics, vol. XXXIX, pp. 421-432.

Cohen , W. M. and Levinthal, D. A. (1989) Innovation and learning: the two faces of R&D, Economic Journal, 99.

Contractor, F. (1980) The Profitability of Technology licensing by U.S. Multinationals: A framework for analysis and an Empirical Study" Journal o international Business Studies, 11, 40-63.

Ginarte J.C. and Park, W. G. (1997) Determinants of patent rights: a cross-national study. Research policy, 26, 283-301.

Glass, A. & Saggi, K. (1995) Intellectual Property Rights, Foreign Direct Investment and Innovation, Ohio State University Working paper.

Helpman, Elhanan (1993), Innovation, Imitation and Intellectual Property Rights, Econometrica, 61, 1247-1280.

Kumar N. (1996), Intellectual property protection, market orientation and location of overseas R&D activity by multinational enterprises, World Development, vol. 24, pp. 673-688.

Lee. J. (1996), Technology Imports and R&D efforts of Korean manufacturing firms, Journal of Development Economics, 197-210.

Mansfield E., Schwartw, M. and S. Wagner (1968) Imitation Costs and Patents: an Empirical Study. Economic Journal 91, 907-918.

Markusen, J. R. (1998) Contracts, intellectual property rights, and multinational investment in developing countries, NBER working paper 7164.

Pattel, P. and Pavitt, K. (1991) Large firms in the production of the world's technology: an important case of non-globalisation. Journal of International business Studies 1-20

Pavitt, K. (1982), R&D, patenting and Innovative Activities: a statistical exploration, Research Policy, 11, 33-51.

Soete, L. & Patel, S. (1985), Recherche-développement, importations de technologie et Croissance Economique, Revue Economique, no. 5, septembre ; pp. 975-986.

Vishwasrao, S. (1994) Intellectual Property Rights and the mode of technological Transfer. Journal of Development Economics 44, 381-402.

Guellec, D., Van Pottelsbergue de la Potterie, B. and (2001) The internationalization of technology analysed with patent data. Research Policy 30, 153-1266.

Yang G. & Maskus, K. (1998), Intellectual property rights and licensing : an Econometric Investigation, working paper University of Colorado, Boulder.

Yang. G. & Maskus, K. (1999) Intellectual property rigths, licensing in an endogenous product-cycel model, working paper University of Colorado, Boulder.

Smith, P. (1999), Are weak patent rights a barrier to U. S. Exports? Journal of International Economics 48, 151-177.

Smith, P. (2001), How do foreign patent rights affect U.S. exports, affiliate sales, and licenses?, Journal of International Economics 55, 411-439.