# Imitation, Patent Protection and Entry Mode*

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**Abstract**

The purpose of this paper is to evaluate how international variations of intellectual property rights (IPR) protection may affect the choice to serve a foreign market. Since the risk of imitation differs for each entry mode, the effects of stronger patent protection vary consequently across FDI, licensing and exports. Accounting for independency and simultaneity of decisions, empirical analysis is conducted for German bilateral flows over the $1992 - 2000$ for the aggregated manufacturing industry and $38$ country destinations. First results confirm that foreign IPR protection influences differently each entry mode. Seemingly Unrelated Regression (SUR) estimates show that IPR strength do have a positive larger impact on FDI and licensing, the latter being the most responsive. But no evidence has been found concerning a higher impact of IPR protection on more imitative countries. However, pooled estimates show that stronger IPR can improve the attractiveness of host countries, particularly for internalization and location decision.

Keywords : Intellectual Property Rights, Entry Mode, Technology Transfer.

JEL Classification : O34, F23, O14

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# 1 Introduction

Globalization implies on the one hand a strong interdependence between the national economies, and other, an increased market of good and services (Neary 2003). These two aspects of the globalization are reflected by the behavior of the multinational firms (MNF) and their increasing role in the world economy. The number of the multinational firms passed from 37 000 at the beginning of the years 1990 to 70 000 in 2004, with a rise of the number of the foreign subsidiary companies from 170 000 to 690 000 (CNUCED 2005). Similarly, the share of the developing countries in the geographical distribution of the foreign affiliates is also more important[1].

It's widely acknowledged that developing countries, which often fails to have enough or appropriate resources and capacity to create new technology, have a huge interest to provide a favorable environment to attract foreign knowledge. On the other hand, with regard to the multinational firms, which hold the great part of the stock of research and development (R&D), the risk of knowledge dissipation constitutes the principal determinant of the internationalization decision. Within this framework, the reinforcement of the intellectual property rights (IPR) is consistent with the process of economic globalization, national and regional markets' integration, tariffs reduction, but especially with the technological spillovers.

A significant number of the emerging countries reinforced considerably their systems of IPR since the mid-80s[2]. South Korea in 1987, Indonesia, Bulgaria, Turkey and Chile in 1991, Thailand, Taiwan, Romania, Russia and the Ukraine in 1992 and Brazil in 1996 promulgated new patent laws[3]. Still, there is a strong ongoing debate about the effects of intellectual property rights (IPR) and the impact of patent protection on global innovation and welfare. A raising question about technology transfer and patent laws is whether and how IPR protection affect technology flows, such as licensing and direct investment (FDI), which in turn should affect growth of the recipient countries (McCalman 2001; Saggi 2002).

Imperfect protection of IPR allows firms to copy directly an existing good or technology, or to develop "knock-off" products (Primo Braga and Fink 1999; Fosfuri 2000; Nicholson 2002). Through

[1]UNCTAD reports that half of the affiliates of MNF is in the developing countries (CNUCED 2005; **?**).)

[2]For an exhaustive review on the impacts of the IPR reinforcement in the developing countries, see Siebeck et al. (1990).

[3]However, the reform of the IPR system being a continuous process, these dates only indicate a significant turning point in this process.

reverse engineering, technology-lagging countries may acquire knowledge and technology skills from foreign innovations[4], that could allow them to compete in the local market with the multinational firm (Maskus 2000). To the extent that there is a risk of knowledge spillovers emanating from weak IPR protection, multinational firms will redefine their production strategies and the way they enter into a foreign market (Markusen 2001; Fosfuri 2000). Stronger IPR should then stimulate further production transfer overseas, leading to an overall increase in technology transfer, both within and outside the firm.

Since the likelihood of imitation differs for each entry mode (licensing being riskier than exports and FDI), the impact of stronger IPR should consequently vary across the different modes of serving markets (Glass and Saggi 2002b; Glass and Saggi 2002c; Maskus 2000), and across sectors (Mansfield 1994)[5]. Therefore, stronger protection of intellectual assets does not only determine the attractiveness and the way to enter into foreign markets but also the intensity or quality of transferred technology, which in turn will affect the host economy in different ways[6].

This paper attempts to evaluate whether differences in intellectual property rights protection affect the strategy of production overseas. More exactly, we pretend to shed some light on how stronger foreign patent protection affects FDI, licensing and exports. Theoretical literature predicts that imitation risk by licensing is higher than those by FDI and trade, and the knowledge leakage through FDI should be lower than the one by trade. Consequently, given the economic returns effect on rent share and on R&D, the impact of tighter IPR regimes would be higher for licensing than for FDI and trade, respectively in this order (Galini and Wright 1990; Yang and Maskus 2001b).

We use data on Germany's cross country bilateral flows corresponding to three economic transactions: receipts of patent licensing fees to non-affiliated firms (for which German participation is less than $20\%$ of capital), direct investment and bilateral exports as explained variables, over the period $1992 - 2000$. Accounting for the simultaneity of decisions, we estimate the relative effects of patent protection in the host countries. Seemingly unrelated regression (SUR) estimates show that countries with stronger patents and an important market size attract larger volumes of bilat-

[4]Local firms may appropriate new technology by the means of process innovations through direct interaction with multinationals and product innovation from exports.

[5]See Markusen (1995a) for a survey on entry modes of multinational firms.

[6]See Cincera and Van Pottelsberghe (2001) and Mohnen (1991, 1996) for literature a review on spillover effects on host countries.

eral economic transactions, for all entry modes. Contrary to theory, we didn't identify any impact on licensing flows in general, whereas FDI and trade flows show positive answers for higher and upper middle income countries but negative for the lowest ones. Finally, in the last section we provide a more refined analysis by controlling countries' imitation skills and by differentiating location, internalization and the joint effects, all flows pooled.

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

# 2 Related Literature

The theoretical linkages between IPR and entry modes are numerous and depend mainly on the technology or the industry in question, as much as the circumstances defining bilateral transactions between the two countries. The joint decision or the joint impact of foreign intellectual property protection and whether and how strengthening IPR systems across countries affects the entry mode by firms has been a subject rather unexplored up to date. With the exception of Smith (2001), Maskus (1998) and Ferrantino (1993), the empirical analysis of the IPR's impact on multinationals' localization choice has been conducted individually for each entry mode, without taking into account the interrelation or simultaneity of decisions.

## 2.1 Theoretical framework

Intellectual property rights play an important role in technology transactions since they are the most important mean of safeguarding property knowledge from imitation (Scherer 1991). The reinforcement of IPR protection has two controversial effects on innovating firms (Maskus and Penubarti 1995). The first one is a positive market expansion effect, which corresponds to an increase of economic transactions given the displacement of imitators when strengthening the IPR system. The second one is the market power effect, which translates an increase in prices given the higher monopoly power, and reduces the welfare. In this framework, if the market expansion effect dominates over the market power effect, overall technology transfer flows would increase in the economies reforming their IPR or patent systems, regardless of the entry mode.

Nonetheless, in the presence of spillover risks in the host country, the arbitration between the various entry modes depends strongly on the degree of control over the intellectual capital (Horstmann and Markusen 1987). it is widely recognized in the theoretical literature that the likelihood of imitation is stronger for knowledge assets located in the recipient country (FDI/Licences versus exports), but still stronger when they are shared and located outside the firm (arm's length licensing versus FDI/exports). Consequently, a stronger increase of FDI and licensing is expected relative to exports, and moreover, a stronger responsiveness of licensing over the other two entry modes (Galini and Wright 1990; Helpman 1993; Glass and Saggi 2002a; Smith 1999).

The rational of such tradeoffs is as follows. One may assume that a firm will prefer exports rather than FDI or licensing when the destination country has weak IPR system, despite lower production and transport costs (Ethier and Markusen 1996; Maskus and Penubarti 1995). Under asymmetric information and incertitude about contracts' enforcement, the risk of knowledge dissipation is stronger under FDI or licensing given the non-rival nature of knowledge (Horstmann and Markusen 1987; Markusen 1995a). Exporting constitutes therefore a strategy, although not the best, to circumvent imitation by domestic firms in the host country.

The direct investment constitutes the second option in commercializing new technology. Innovating firms cannot always find a suitable licensing contract given its inability to signal successfully the quality of the new technology (Galini and Wright 1990; Vishwasrao 1994). By producing in local markets, multinational firms control the diffusion of technologies in different ways. They preempt competition of potential imitators by being first-movers in the market, acquiring domestic competitors, controlling commercialization of products or limiting training and skills of employees, etc. (Ethier and Markusen 1996; Glass and Saggi 2002c). Finally, one may consider that subsidiary production is aimed at deterring would-be imitators since local affiliates may also serve to detect and prosecute infringers.

However theoretical studies on FDI and IPR arrive to mixed conclusions. Partial-equilibrium product-cycle models in a North-South framework suggest that the effect depends on the intensity of the production transfer channel before the IPR reforms and on the imitation threat of the local firms. Helpman (1993) finds that when only trade happens between the two regions, stronger IPR

can induce a reallocation of production to the North, increasing trade and displacing production by imitators in the southern region. Lai (1998) find that stronger IPR can stimulate further FDI when multinational production is already present in the country. Glass and Saggi (2002b) found that strengthening IPR in southern countries might deter FDI flows since the higher costs of imitation might provoke a resource wasting effect, limiting in turn the resources available for FDI.

To sum up, for firms commercializing new intellectual assets, externalization of production by licensing in countries with weak patent or IPR protection constitutes the last option given the highest risk of knowledge appropriation by the licensees or third local firms. Innovating firms are forced to pay a higher premium on licensees, and thus to sacrifice rents, in order to deter locals to defect contract conditions (Galini and Wright 1990; Helpman 1993; Glass 2000). Firms might follow different strategies to make licensees to accomplish and respect contracts' conditions. Firms can strategically use for instance the vintage or age of technologies to deter imitation by the licensees (Rockett 1990; Fosfuri 2000). Consequently, transfers to affiliates might be less efficient than technologies sold to outsiders (Markusen 1995a)[7]. To the extent that exports and foreign direct investment do not incur these costs in the same way, the degree of IPR protection could influence the decision to earn returns on a new technology by licensing rather than exporting or delocalizing an affiliate (Yang and Maskus 2001b). Consequently, we expect a higher impact, i.e. a higher return, on license flows over direct investment and trade, when patent protection is strengthened.

## 2.2 How does stronger IPR affect entry mode?

Stronger IPR affects the way to serve foreign markets in different ways. First, by increasing imitation costs (litigation or product differentiation costs, etc.), stronger IPR, patent or trademark protection reduce the costs of transferring production in all entry modes, and particularly, the cost of externalize this production (Glass 2000). Markusen (2001) and Glass and Saggi (2002a) show that strengthening of protection reduces the premium that firms have to pay to their employees to dissuade them from disclosing their knowledge to rival firms. Hence, as IPR protection increases, the cost of FDI and licensing over exports decreases and allows a better exploitation of production cost differentials.

[7]Technologies introduced by joint-ventures are 3 to 4 times older than those introduced by the subsidiary companies (Mansfield and Romeo 1980; Lee and Mansfield 1996).

Second, by improving the legal framework, the costs of monitoring licensees and the risk of contract defection are also reduced with stronger IPR protection. Stronger patents allow the licensor to get a higher rent and a higher return on research and development investments, relative to the other entry modes. By diminishing transaction costs and modifying the sharing of rents between the licensor and licensees, stronger IPR can generate a higher rate of return on licensing. Yang and Maskus (2001b) show also that stronger returns on licensing can be translated into a higher rate of innovation in northern countries. Since more production is transferred to the South, more labor is freed up for innovation in the North.

## 2.3 Empirical survey

Very few empirical studies have explored the joint impact of IPR protection on the entry choice[8]. However, some insights can be found on the studies done by separate on the different entry modes; FDI, trade and licensing.

By analyzing the impact of intellectual property rights on trade flows, Maskus and Penubarti (1995) note that the level of the economic development explains a great part of the sign of the IPR impact[9]. The countries tend to soften their IPR regimes at the intermediate stages of the development, while they constitute their imitative capacities. The IPR protection is reinforced only when the countries reach a higher economic and technical capacity level. Smith (1999) shows that a weak protection of the intellectual properties could restrict trade flows when the host country represents an important "threat" of imitation. Otherwise, the absence of the patent protection does not necessarily harm the trade.

Studies concerning the impact of the IPR on investment flows are less conclusive. While Maskus and Eby-Konan (1994), or Primo Braga and Fink (1999) do not find no impact of the patent system' reinforcement on the FDI, Lee and Mansfield (1996) suggest at least the existence of a possible negative relationship between a country with weak patent system and the volume of the American or European investments. By analyzing the impact of the IPR on the composition of the direct invest-

[8] A considerable exception is Smith (2001), who takes into account the interdependence of the decisions when entering on a foreign market. We can also quote Ferrantino (1993) and Maskus (1998), but the latter do not distinguish the licensing agreements from the FDI, and analyze only the arbitrage between exports and investments.

[9] Numerous empirical studies found also a non-linear relation between the degree of IPR protection and the economic development (Gould and Gruben 1994; Park and Ginarte 1997).

ments in the post-communist countries of Eastern Europe, Smarzynska (2004) shows that a weak IPR protection discourages the production in the host country.

The positive impact of the reinforcement of patent system on the licensing agreements is more established. In a study by Yang and Maskus (2001a), U.S. receipts related to licensing by American firms to non-affiliated firms found to rise with stronger IPR as well as the ratio of receipts of licensing to U.S. exports. In contrast, and consistent with internalization theories, IPR have less significant effect on US receipts of affiliated firms' royalties and licensing fees. Similarly, Nicholson (2002) shows that the IPR reinforcement and the reduction of the imitation risks which follows stimulate licensing agreements over FDI.

Concerning the joint effect of IPR or patent protection on the entry mode, two empirical studies have been done to our knowledge. Maskus (1998) tried to capture joint impact of patent strength on the decisions of multinationals regarding sales of affiliates, exports to affiliates and the assets of foreign affiliates. Using the Ginarte-Park index in a panel of 26 countries the author found that the patent index had a significant and positive impact on FDI, and the average patent strength has positive impact on affiliates' sales in developing countries.

Smith (2001) analyzes the impact of the IPR on the American multinationals entry mode. Her results show that the reinforcement of the patent system promotes FDI and licensing agreements, with a higher impact on the licences and none on exports. By using more disaggregated data, Maskus, Saggi and Puttitanun (2004) show a negative impact on exports, and stronger impact on the FDI comparing to licences.

The few existing studies on the impact of IPR protection on the choice to serve a foreign market does not arrive at conclusive results. The goal of this paper is to bring another empirical example to this debate, by analyzing not the American data like the majority of the studies mentioned, but the decisions of the German firms. One of the reason for which we lean on the German firms, is the different tendencies between the American and European MNF in terms from transfers of technologies. Recent research has analyzed the internationalization of the R&D in 209 American, Japanese and Northern Europe (including German) technology-intensive firms and concluded that the European firms have more centers of excellence and R&D units abroad (Edler and Reger 2002;

Reger 2002).

# 3 Model Specification, Econometric Method and Data

## 3.1 Empirical Model

The purpose of this paper is to analyze the strategies of multinational firms vis-a-vis to technological spillover risks, by empirically evaluating the impact of the patent protection on the entry choice of the German firms. The preceding section (2.1) demonstrated us that the impact of the IPR reinforcement remains ambiguous, since two opposing arguments counteract; a "market expansion effect" arising when an effective displacement of imitators is translated into a greater commercialization incentives and a market expansion, against a "market power effect" by which innovators can charge higher prices at monopoly levels, and therefore, reducing bilateral transactions to the foreign country in question.

Assuming that the former effect will dominate over the latter one, we expect that stronger protection of intellectual assets will stimulate further entry by foreign firms, for all choices. Furthermore, as discussed previously, the responsiveness by licensing should be larger than the one by FDI, and more larger relative to exports.

To sum up, over this paper, we will mainly test the validity of these 2 following hypothesis:

**Hypothesis 1 :**

Given the profit function relative to each entry mode, by increasing imitation costs and by reducing knowledge dissipation, stronger IPR in commercial partner countries will enhance internalization. Thus, entry by multinationals firms and exports will increase whenever "market expansion" effects prevail over a perverted "market power" effect carried by tighter IPR protection.

**Hypothesis 2 :**

The impact of the strength of IPR protection will be larger for licensing than for FDI and exports. The extent of this effect will depend closely on the host countries' market size. That is, a differentiated impact can arise for larger and lower income economies. The stronger are the

technical skills of the partner country, the larger effects are expected for licensing, a positive but weaker impact for FDI, and a likely non-significant effects on trade.

In a crude way, our first estimation applies theoretical predictions from the literature previously presented. We apply a reduced econometric equation inspired from traditional gravity models considering bilateral exchange in function of country characteristics including market size, income per capita or relative endowments, labor, distance, taxes on trade (average tariffs, black market premium, etc.) among others[10].

This estimation thus tests the validity of the theoretical predictions of the previously presented literature, using a gravitational model. This empirical approach, derived from international trade models in monopolistic competition (Bergstrand 1985), assess that bilateral exchanges of a country $i$ towards the country $j$ depend on the country $i$'s supply, country $j$'s demand, and on the forces likely to amplify or decrease these flows such as tariff barriers, geographical distance among others[11]. The basic version of the gravitational model, where bilateral commercial flows are positively related to the size of each partner and negatively affected by the level of the costs of transfer, is expressed as follows:

$$Y_{ij} = G\frac{X^{\alpha}{}_{i}X^{\alpha}{}_{i}}{{d_{ij}}^{\delta}} \tag{1}$$

where $Y_{ij}$ corresponds to bilateral exchanges, $X_i$ and $X_j$ are respectively supply and demand in the countries $i$ and $j$, and $d$ relates to the distortion factors as the tariffs or distance. Because of the multiplicative structure of (1), we log-linearize it:

$$Y_{ij} = \ln G + \alpha \ln X_i + \beta \ln X_j - \delta \ln d_{ij} + \epsilon_{ij} \tag{2}$$

where $Y_{ij}$ is bilateral exchange between Germany ($i$) and partner country ($j$) : $Y_{ijt}$ being FDI flows from Germany to country $j$; German patent licensing receipts flows by non-affiliated firms in country $j$, and exports flows by Germany to country $j$. $X_i$ and $X_j$ refer to income and labor respectively

[10]See Markusen, (1984, 1997); Markusen and Venables (1998) for the use of gravity equations, and Markusen (1995b) for a discussion of the explanatory variables.

[11]See Markusen (1984, 1997) and Markusen and Venables (1998) for a discussion on the use of the gravitational equation, and Markusen (1995b), for a discussion on the explanatory variables used in this type of estimate.

for countries $i$ and $j$. We introduce into this equation $A_{ij}$, which represents other host country' characteristics, likely to influence bilateral exchange flows such as the human capital, trade openness, FDI stock, or technological balance of payment. Finally, we integrate into it $IPR_j$, the level of intellectual property protection, our principal independent variable.

The empirical specification hence has the following form:

$$Y_{ijt} = \gamma + \alpha \ln X_{it} + \beta_1 \ln X_{jt} + \beta_2 \ln A_{jt} + \beta_3 IPR_{jt} + \beta_3 D * IPR_{jt} - \delta \ln d_{ijt} + \epsilon_{ijt} \quad (3)$$

$D$ corresponds to the dummy variables introduced in interaction with IPR protection. In order to differentiate the impact of patent protection according to countries' economic development level and imitation threat, we build two sets of dummies to be interacted with the indicator of IPR protection :

**Host country's economic development:** We group countries by income class as reported by the World Bank Categorization of per capita income (Higher Income, Upper Middle Income, Middle Income, and Lower Income). The dummies take the value of one if the country belongs to that class and zero otherwise. The groupes are as follows (in 1995 US dollars): high income (H) countries, superior to 8356 US $; upper-middle income (UM) countries, between 2696 and 8355 US $; lower-middle income (LM) countries, between 675 and 2695 US $; and lower income (L) countries with an income inferior to 674 US $.

**Host country's technical skills:** It is difficult to define a correct or adequate indicator of imitation threat. Although the technical capability is often approximated in the literature by variables relating to the research and development such as the R&D expenditures, the data availability do not allow us the use them[12]. In order to test the sensitivity of our results, we employ two sets of dummy variables to approximate the technical capability of the host country[13]. The first one is ratio of the number of researchers and engineers in R&D (RES) per million population[14]. The second one is the percentage of exports in high-technology products related

[12]R&D expenditures are most of the time available only for the OECD countries. Moreover, important differences exist in the collection and/or report of these statistics across the countries, in particular in the developing ones (Pissarides 1997).

[13]Other dummy variables were built such as expenditures on information and communication technologies related to GDP, or high school enrollment as a percentage of total population. But we expect that these criteria may not reflect host countries' technical and reverse-engineering skills at their best.

[14]This variable is built as follows: Strong technological capacity $RES > 3000$ and low technological capacity $RES < 3000$.

to total manufacture exports[15]. Finally we also group this last variable into 4 groups, in order to proceed a more detailed analysis[16].

## 3.2 Nature of Data

The purpose of this paper is to identify internationalization strategies of MNF facing the risk of technological spillovers, by analyzing the market entry choice of German firms. Our study covers 38 destination countries and the 1992-2000 period. Among them we have both developed and developing countries[17]. This heterogeneity of host countries allows us to highlight differences concerning the development level, technical capacity, and especially the degree of IPR protection and its impact on the choice of entry.

As endogenous variables, we use data corresponding to German bilateral affiliate sales, exports and receipts referred to German international patent licensing. Data on cross-border receipts for patents, inventions and processes are from the DeutschBank's Technology Services Balance of Payments Reports. Data on german direct investment comes also from DeutschBank, from the report on International Capital Links. Exports are issued from Comtrade Database of United Nations.

The transborder investments by the German firms drew a considerable attention because of their recent growth (Buch and Toubal 2003; Wezel 2003). On a world level, the German firms hold the fourth larger stock of capital abroad, while in Europe, they are the second investor after the United States (Barrel and Pain 1999). Even if the majority of the studies relating to the German multinationals are concentrated in the developed countries and/or transition countries, German FDI stocks has more than doubled in the six greater Latin-American economies, and those of the German subsidiary companies on the eight larger Asian markets almost quadrupled for the period analyzed in this paper (Wezel 2003).

The relative labor cost, host country's R&D stocks and market demand were identified as determinants of the German transborder investments (Hurbert and Pain 1999). Recently, Wezel (2003) showed the role of the institutional framework on German FDI flows towards the Latin American

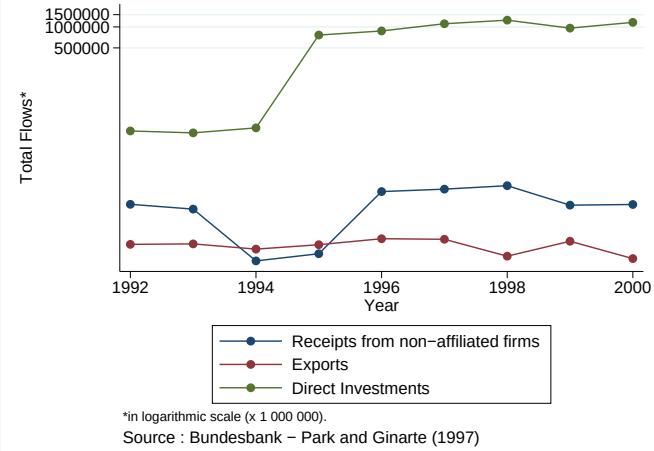
[15]See preceding section for more details on this variable, built as follows: Strong technological capabilities $HT > 14\%$; Weak technological capabilities $HT < 14\%$

[16]The use of 14% and 3000 as benchmarks is subjectively fixed, each constitutes a figure smaller than the overall mean.

[17]See Appendix 6.1 for the complete list of countries and descriptive statistics.

and Asian emerging countries. In addition to the traditional determinants of the FDI, economic risks and political uncertainties seem to explain a major part of the localization decisions of German firms. These results are confirmed by Buch et al. (2003), which concludes that the size of the market and the risk level that it involves are the principal determinants of German firms' choices; and by Chen and Reger (2002), which indicate the importance of the legal framework and the intellectual property rights in the case of China. The instability of the institutions increases the costs of transaction and thus influence the entry decision in the developing countries, such as the transition countries of Eastern Europe (Meyer 2001).

Figure 1: Evolution des Flux Bilatéraux Allemands




The figure 1 presents the three German flows. We observe a parallel tendency between the direct investments and the licensing agreements, and to a lesser extent, the exportations[18]. It seems that domestic firms increase their participation in other countries mainly for strategic reasons. German firms, particularly in the manufacturing sector, undertake frequently a process of internationalization by stages (CNUCED 1997). The geographical distribution of the investments is mainly identical to that of German exports.

As explanatory variables, we use cross-country data on market size and labor costs from World Bank Development Indicators. Larger markets imply higher consumer demands, and hence, higher firm demand on goods, technologies and knowledge contracts. Market size variable corresponds to

[18]However, note that Bundesbank reports a close link between the investments and exports in Germany, over a 20 years period (Bundesbank 1997).

GDP per capita and expected to have a positive sign. Labor costs are approximated by the wages and salaries, and its expected sign depends on the chosen entry mode. Relatively weak production costs make the country more attractive for the investors, and thus encourage direct investments over licences[19]. However, the impact of this variable on FDI depends on the nature of the investments. A positive sign would indicate that it's about delocalization investments, while a negative sign would translate a market seeking behavior of German firms. On the other hand, a weak labor cost often corresponds to low living standards, and consequently, a moderate local demand. The expected effect for this variable is thus positive for exports, since a high labor cost corresponds to high wages and salaries, and consequently, a high demand.

Human skills being an important factor in the attractiveness of the host country, we thus introduce the average number of higher education from the Barro and Lee Database (2000) into our regressions. We do not expect on the other hand a significant impact of this human capital variable for the other entry modes (exports and licences). We also use a variable to take into account the technical capacity level of host countries. The intensity and the type of the entry mode depend closely on the latter (Smith 2001). We use the balance of technological payments, which measures technological exchanges according to financial flows of two types of operations (OCDE 1990): operations relative to intellectual property (patents, licences, techniques, know-how, etc...), and operations relative to technical services (studies of engineering, technical aid, services of R&D, etc...). While increasing host countries' imitation threat, technical capability also increases demand for the services in technology, in order to complete local efforts (Braga and Willmore 1991; Lee 1996)[20]. The expected sign for this variable is thus ambiguous both for the licensing agreements and FDI[21].

The trade openness variable is measured by the sum of the imports and exports over the GDP. This variable is supposed to have a positive effect on all the forms of bilateral exchange, with nevertheless a question mark on the direct investments. Indeed, the latter constitute the principal means to circumvent tariffs and non-tariff barriers, and in this case, the trade openness could deteriorate

[19] Even a negative impact can be expected concerning licensing agreements. A modification of the cost structure, by its impact on the rent share between licensor and local firms, could reduce licences flows.

[20] A negative sign would indicate a substitution between the knowledge acquisition and the local effort (Lee 1996).

[21] In case of direct investments, besides the spillover risks, a strong technical capability can also increase labor costs. But then again, the investors can also be attracted by the quality of labor force. The net impact will result from these two controversial effects.

investment flows (Wheeler and Mody 1992)[22]. We also introduce an export intensity variable, given that empirical studies often conclude a complementary relation between delocalization of production and trade[23]. For this purpose, we use the percentage of high-tech exports on total manufactured exports. This variable has thus the advantage of reflecting not only the technological abilities and absorption capacity, but also the host country' integration in the international markets. Given the level of aggregation of our analysis, we expect a positive impact of the intensity of exports on the FDI and the licensing agreements.

As a distortion variable, we also introduce taxes on international trade, from World Development Indicators. An increase of commercial barriers should reduce the expected gains in all forms of bilateral exchange.

Our main explanatory variable indicating the strength of IPR protection by country is the Ginarte and Park Index, a common measurement of intellectual property rights protection developed by Juan Ginarte and Walter Park (1997). The index of strength of IPR ranges from $0$ to $5$, higher numbers reflecting stronger levels of protection. It exists for the years $1985$, $1990$ and $1995$. In order to make exogenous the IPR protection we use the Ginarte and Park index one period lagged[24].

The difference between the Ginarte and Park and the Rapp and Rozek (1990) indexes is that Ginarte and Park use a more comprehensive set of criteria to build a score that weights a subset of conditions such as the availability of different IPR (patents, trademarks, utility models, etc.), the coverage by technology area (pharmaceutists, chemicals, etc.), the duration of protection, membership in international patent agreements, provisions for loss of protection and very important, it considers if the country has or not enforcement measures. Their index captures additional variation in the conditions that describe IPR standards. Rapp and Rozek in contrast, measures countries' conformity of national patent laws with minimum standards proposed by the United States Chamber of Commerce (Smith 1999)), relying on dummy variables, and thus, presenting less variability in the index reported. Although both indexes has each their advantages and disadvantages, we consider that the Ginarte and Park is more objective and more complete, following Mayer and Pfister (2001)

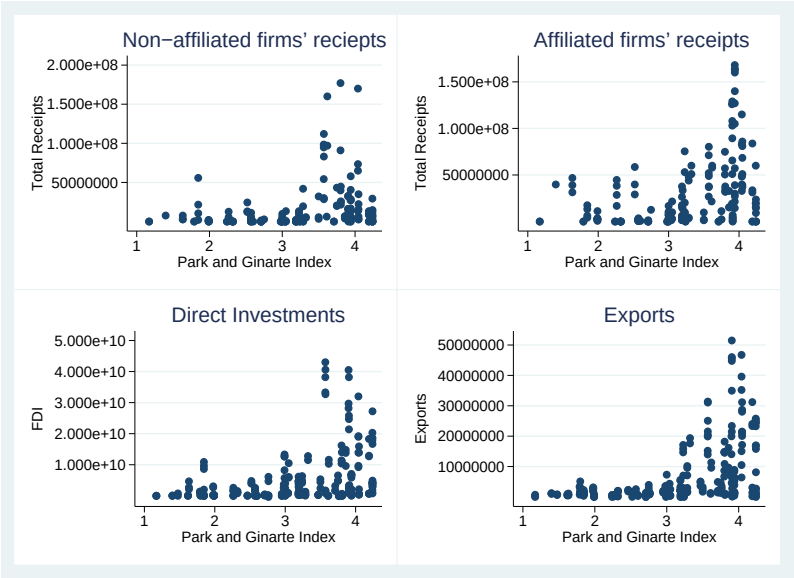
[22]For a positive impact of the trade openness on FDI, see Javorcik and Saggi (2004), Maskus (1998) and Markusen (1995a).

[23]Only exceptions are Blonigen (1999) which uses a very detailed level of analysis and Mucchielli et al. (2000) which find a relation of complementarity for intra-firm trade and not inter-firms.

[24]For $1992-1994$ flows we use the $1985$ G&P index, for $1995-1997$, the $1990$ G&P index, and for $1998-2000$, the $1995$ index, respectively.

and Javorcik (2004). However, these 2 indexes appear strongly correlated, consequently the use of one or other does not affect significantly the results[25].

Figure 2: Protection des Droits de Propriété et Flux Bilatéraux




The figure 2 proposes a graphic interpretation of the relation between the IPR index and German bilateral flows. Contrary to the theoretical and empirical studies presented, the different entry modes do not seem to answer differently to the protection of property rights. A recent survey carried out on American, Japanese and German firms finds that IPR impact is very sensitive to industries (Mansfield 2000). The major part of German firms affirms that the degree of the protection has an important effect on certain types of foreign investment decisions. For example, in the chemical and pharmaceutical industries, more than 80% of the questioned firms underlined the role of the IPR on the localization choice of the R&D investments, but only 20%, for exports (Mansfield 2000).

## 3.3 Econometric Method

We carry out an analysis into two steps[26]. In order to asses whether and how entry modes are sensitive to foreign IPR protection, we estimate the joint decision of serving a foreign market, through a system of equations taking into account the simultaneity of decisions and the possibility that resid-

[25]Correlation between the two indices vary between 0.75 and 0.85, according to samples.

[26]We first estimated regressions separately for each economic flow, by supposing the independence of the decisions. These results are presented in the Appendix, in Table 10.

uals of each entry mode can be correlated with those of others serving modes (Seemingly Unrelated Estimation). Then, we analyze whether the reinforcement of the IPR regime influences the decisions of internalization and localization when transferring production, by specifying parameters deviations through the equations for exports, FDI and licensing flows. For this purpose, we adapt the initial model by pooling data across the three forms of bilateral exchange (Smith 2001). Interaction-dummy variables are also introduced to identify answers in the effects of the explanatory variables on select forms of bilateral exchange.

# 4 Estimation Results

The individual estimates of the impact of patent system for each bilateral exchange form suggests that the IPR protection is only determinant for direct investment flows (see Table 10 in Appendix). Nevertheless, this analysis does not hold account of the simultaneous character of the entry choice, consequently we are not able to determine the real impact of the IPR protection when one considers the interdependence of bilateral exchanges. In addition, the residues of the individual estimates being correlated through the equations, the Ordinary Least Squares estimate would be skewed and non consistent. Tables 1 and 2 report the results of the Seemingly Unrelated Regression estimates. The effects on localization and internalization decisions are presented in Table 4[27].

## 4.1 SUR Estimates

Tables 1 and 2 present the results of Seemingly Unrelated Regression estimates. Country and year dummies are included to account for the panel nature of the data, and to control for non-unobserved heterogeneity across countries.

The first column presents the basic specification, which evaluates the traditional determinants of the entry decision into a foreign market. Confirming the theoretical (Horstmann and Markusen 1987) and empirical (Yang and Maskus 2001a; McCalman 2001; Javorcik and Saggi 2004) literature, the market size has a positive and significant impact, with the highest coefficient. The labor cost variable has the expected negative sign for direct investments, but also for the two other entry modes.

[27] Descriptive statistics of variables are listed in Table 6.

However, a rise in the labor cost, reflecting as well a rise of the living standards, should have increased the demand for foreign goods and technologies. This result indicates that direct investment is perceived as a cost-seeking strategy by German firms. The labor cost arises as an important factor for licence flows, by its impact on rent sharing (Puttitanun 2003). Export intensity has a positive impact on FDI flows, indicating a complementarity relation between these two modes of serving a foreign market (Lipsey and Weiss 1984; Head and Ries 2001). However, we do not find any positive and significant relation between the FDI stock and exports[28]. It is thus difficult to arrive at a conclusion on the exact nature of this relation. Finally, let us note that technological capacity, approximated by the technology payment balance, does not seem to affect export decisions at this stage of analysis.

Taking account of the simultaneity of the decisions, estimates by SUR (second column) show that the degree of IPR has a positive and significant impact on licence flows (with an elasticity of 3.25%) and a higher impact on FDI (3.35%), whereas it does not seem to have any impact on the trade. The market size and labor costs are the only variables whose coefficients have decreased between the first two columns, indicating that they were absorbing large country effects on institutional aspects such as IPR protection.

Nonetheless, market size remains the most significant determinant of the three bilateral flows followed by labor, which shows a negative sign in all equations, and seems to be more important for licensing and FDI than for exports. Indeed, relative production costs such as wages are more relevant for localization decision than for trade. Finally, conforming previous findings (Markusen 1995a; Yang and Maskus 2001a), a country with an important market size will attract more licensing and FDI flows relative to exports[29].

The results concerning the impact of the IPR on trade flows confirms our assumption on the spillover risks. Our findings show also the risk of knowledge dissipation is higher for the productions located in the country. Stronger patent laws might not alter significantly the intensity of trade, but they do enhance the location advantage of FDI and licensing (Puttitanun 2003). Reverse engi-

[28] Nevertheless, Blonigen (1999) stresses that the relation of complementarity found in the majority of the empirical studies could come from the level of aggregation used. In his study, using data at the product level, the author finds a strong relation of substitution between Japanese exports and direct investments in the United States. In the same way, Mucchielli et al. (2000) obtains a substitution relation with regard to the inter-firm trade in the French case.

[29] A striking point when one holds account of the simultaneity of the decisions, the size of the market proves significant in all the regressions whereas in the individual estimates 10, it seemed not to affect FDI flows, showing the skew induced by not taking into account of the interdependence of the decisions.

neering of products is feasible with and without IPR, whether the nature of the economic transaction, whereas imitation of innovation process through exports of goods is limited.

The human capital variable is negative, although its impact is negligible, or even nonsignificant (for the FDI). Given the impact of the labor costs, a possible explanation is the cost-seeking incentives of German multinationals. The quality of the labor forcee does not seem to justify the MNF in their decisions of entry mode. Let us notice however that the human capital variable used could fail to reflect host countries' technical capacity, which will be studied in a more detailed way in the section 4.1.2. Finally, taxes on the international trade is only significant and negative on exports, confirming the trade theories.

### 4.1.1 IPR Protection and Economic Development

We calculate a set of economic development dummies (HI, high income; UMI, upper-middle income; LMI, lower-middle income and LI, low income), in order to assess the importance of patent protection rights while controlling for the host countries' economic level.

When differentiating countries by income level (third column, Table **??**), results differ considerably between middle-high and low income countries. Stronger IPR protection enhances economic flows in middle-high income countries, whilst no significant effects across the different income countries are found on licensing flows. For the two other entry modes, the size of coefficients and their significance level vary across income levels. The strongest positive effect are concentrated in middle-low income economies with an elasticity of $1.31$ for exports and $1.24$ for FDI.

These results show once again the importance of host country's demand. A higher level of development implies a higher demand for the goods and services. We also observe a more important effect for exports relative to FDI, which can be explained by the rise in the labor cost in the higher income countries.

However, in low-income countries, reinforcement of property rights seem to bring an increase in the licence agreements and a decline of direct investments. These results contradict the preceding literature (Maskus and Penubarti 1995; Maskus 2000) where a inverted relation between the level of the income and the licensing agreements has been found.

Table 1: **Relative Impact of IPR Strength and Income Effect**

| | Baseline | | | IPR Protection | | | Income Effects | | |
|---|---|---|---|---|---|---|---|---|---|
| | Licences | Exports | FDI | Licences | Exports | FDI | Licences | Exports | FDI |
| Market Size | 1.986*** | 1.305*** | 1.146*** | 2.022*** | 0.731*** | 0.794*** | 2.864*** | 0.912*** | 0.761** |
| | [0.208] | [0.192] | [0.167] | [0.266] | [0.240] | [0.241] | [0.352] | [0.324] | [0.325] |
| Labor | -0.763*** | -0.617*** | -0.973*** | -0.873*** | -0.213 | -0.582*** | -1.543*** | -0.320 | -0.576** |
| | [0.180] | [0.162] | [0.127] | [0.237] | [0.212] | [0.208] | [0.323] | [0.290] | [0.286] |
| High-Tech Export Intensity | 0.007 | | 0.079*** | -0.034 | | 0.095*** | -0.040 | | 0.084*** |
| | [0.030] | | [0.029] | [0.032] | | [0.029] | [0.032] | | [0.027] |
| Taxes on Int. Trade | -0.083 | -0.353*** | | -0.200 | -0.444*** | | -0.187 | -0.479*** | |
| | [0.156] | [0.135] | | [0.169] | [0.142] | | [0.167] | [0.140] | |
| FDI Flows (% GDP) | 0.000 | -0.000*** | | -0.000 | -0.000*** | | 0.000 | -0.000*** | |
| | [0.000] | [0.000] | | [0.000] | [0.000] | | [0.000] | [0.000] | |
| High-School Enrollment | -0.028*** | -0.029*** | 0.055* | -0.022* | -0.038*** | -0.010 | -0.023* | -0.030*** | 0.031 |
| | [0.011] | [0.009] | [0.245] | [0.012] | [0.010] | [0.224] | [0.012] | [0.011] | [0.278] |
| Sold of Technology Balance | | 0.064* | 0.030 | | 0.048 | 0.083** | | 0.035 | 0.043 |
| | | [0.037] | [0.042] | | [0.038] | [0.042] | | [0.037] | [0.038] |
| IPR index | | | | 3.025** | 1.271 | 3.356*** | | | |
| | | | | [1.485] | [1.351] | [1.484] | | | |
| IPR*HI | | | | | | | -0.360 | 1.152*** | 0.802*** |
| | | | | | | | [0.288] | [0.254] | [0.254] |
| IPR*UMI | | | | | | | -0.170 | 0.899*** | 0.897*** |
| | | | | | | | [0.310] | [0.273] | [0.267] |
| IPR*LMI | | | | | | | 0.228 | 1.318*** | 1.240*** |
| | | | | | | | [0.327] | [0.290] | [0.294] |
| IPR*LI | | | | | | | 2.558*** | 1.196 | -3.811*** |
| | | | | | | | [0.983] | [0.879] | [0.909] |
| Observations | 293 | 293 | 293 | 254 | 254 | 254 | 254 | 254 | 254 |
| Country Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Year Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| R-squared | 0,39 | 0,41 | 0,38 | 0,58 | 0,74 | 0,59 | 0,42 | 0,46 | 0,48 |
| Breusch Pagan Test of Independence Chi2(x) | | | 0,218 | | | 0,1946 | | | 0,29 |

*Significant at 1 % level, ** Significant at 5 % level. ***Significant at 10% level. All variables are in log except IPR index and IPR-Dummy interacted variables
Seemingly unrelated estimates, standard errors corrected for heteroscedasticity and autocorrelation.
Dummies to account for country and year fixed effects and Eastern European countries are added.

When we do not take into account the degree of spillover risks, strengthen of IPR regimes seem to stimulate FDI flows more than licences. The level of income thus influences the impact of the IPR protection, confirming the theoretical literature (Helpman 1993; Glass and Saggi 2002b). However, we should consider the impact of imitation and knowledge dissipation risks, before drawing any further conclusions.

#### 4.1.2 IPR Protection and Imitation Skills

Table 2 gives us a survey of the effects resulting from interactions between IPR and our dummies controlling for imitative or technological skills.

First group of dummies indicate the intensity of technological skills by the host country as measured by the relative number of R&D researchers and engineers (HR, high and WI, weak technological abilities). Results (column 1) suggest that licensing contracts are not affected by stronger technical skills interacted with IPR protection, whilst for the other entry modes, there's no difference between the two country groups.

The following set of dummies are built up using the high technology export intensity of recipient countries. First group of dummies (column 2) distinguish four level of home countries (VH, very high; H, high; MH, middle-high; L, low imitative capacity), while second group (column 3) show a more aggregated classification, restricted to only two groups: IPR interacted with a dummy reflecting a weak imitative capacity (WI), and with a dummy reflecting a strong imitative capacity (SI), using the same criteria.

It appears that licensing is not affected by the level of imitative skills and in a more general way, is non-sensitive to the IPR regime, regardless of the level of technical capacity. Whereas the results for exports and FDI are not clear-cut across country groups, we can identify that coefficients in both specifications are larger for exports than for FDI.

Contrary to the previous results where no effect was found for the solely impact on exports, now it turns out that trade flows do react to stronger levels of protection in countries with high and medium imitative skills, whereas for very high and low imitative countries IPR remains non pertinent.

Table 2: **Relative Impact of IPR Strength and Imitation Threat**

| | Imitation Effects 1 | | | Imitation Effects 2 | | | Imitation Effects 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Licences | Exports | FDI | Licences | Exports | FDI | Licences | Exports | FDI |
| Market Size | 2.123*** | 0.719*** | 0.862*** | 2.102*** | 0.745*** | 0.798*** | 2.154*** | 0.812*** | 0.767*** |
| | [0.264] | [0.239] | [0.263] | [0.282] | [0.262] | [0.278] | [0.269] | [0.247] | [0.264] |
| Labor | -0.748*** | -0.311 | -0.818*** | -0.782*** | -0.210 | -0.945*** | -0.822*** | -0.260 | -0.918*** |
| | [0.247] | [0.217] | [0.213] | [0.245] | [0.218] | [0.224] | [0.237] | [0.210] | [0.215] |
| High-Tech Export Intensity | -0.032 | | 0.074** | -0.032 | | 0.095*** | -0.024 | | 0.090*** |
| | [0.032] | | [0.031] | [0.036] | | [0.034] | [0.033] | | [0.031] |
| Taxes on Int. Trade | -0.182 | -0.465*** | | -0.185 | -0.433*** | | -0.178 | -0.440*** | |
| | [0.171] | [0.142] | | [0.171] | [0.141] | | [0.171] | [0.141] | |
| FDI Flows (% GDP) | 0.000 | -0.000*** | | 0.000 | -0.000*** | | 0.000 | -0.000*** | |
| | [0.000] | [0.000] | | [0.000] | [0.000] | | [0.000] | [0.000] | |
| High-School Enrollment | -0.020 | -0.045*** | | -0.023* | -0.035*** | | -0.022* | -0.037*** | |
| | [0.013] | [0.011] | | [0.012] | [0.011] | | [0.012] | [0.010] | |
| Sold of Technology Balance | | 0.050 | 0.006 | | 0.049 | 0.019 | | 0.046 | 0.017 |
| | | [0.037] | [0.043] | | [0.037] | [0.043] | | [0.037] | [0.043] |
| IPR*WI | | | | | | | -0.242 | 1.247*** | 1.058*** |
| | | | | | | | [0.291] | [0.256] | [0.291] |
| IPR*SI | | | | | | | -0.335 | 1.131*** | 0.960*** |
| | | | | | | | [0.300] | [0.262] | [0.297] |
| IPR*VHIh | | | | -0.278 | 1.086*** | 1.101*** | | | |
| | | | | [0.341] | [0.294] | [0.322] | | | |
| IPR*HIh | | | | -0.330 | 1.127*** | 0.924*** | | | |
| | | | | [0.299] | [0.261] | [0.296] | | | |
| IPR*MIh | | | | -0.205 | 1.255*** | 1.066*** | | | |
| | | | | [0.297] | [0.260] | [0.293] | | | |
| IPR*Lih | | | | -0.318 | 1.142*** | 1.198*** | | | |
| | | | | [0.332] | [0.289] | [0.331] | | | |
| IPR*HIres | -0.271 | 1.226*** | 1.070*** | | | | | | |
| | [0.290] | [0.254] | [0.288] | | | | | | |
| IPR*WIres | -0.179 | 1.065*** | 1.345*** | | | | | | |
| | [0.321] | [0.281] | [0.328] | | | | | | |
| Observations | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 |
| Years Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| R-squared | 0,64 | 0,45 | 0,57 | 0,38 | 0,45 | 0,45 | 0,37 | 0,45 | 0,44 |
| Breusch Pagan Test of Independence chi2(x) | | | 0,1246 | | | 0,21 | | | 0,22 |

*Significant at 1 % level, ** Significant at 5 % level. *** Significant at 10% level. All variables are in log except IPR index and IPR-Dummy interacted variables
Seemingly unrelated estimates, standard errors corrected for heteroscedasticity and autocorrelation.
Dummies to account for country and year fixed effects and Eastern European countries are added.

As argued previously, developing countries' arm's-length markets do not automatically react to stronger level of patent protection, even if the country in question enjoys a certain level of technical or imitative capacity. Furthermore, we note that regardless to the group, its impact is negative. Such findings suggest that licensing flows can be deterred, or rather, a monopoly power effect can emerge. Licensing flows can be reduced either because a smaller number of contracting, and/or a higher royalty and licensing fees charged by the innovating firm, following the IPR reforms (Maskus 2000; McCalman 2001).

Contrary to the preceding studies (Smith 2001), we do not find a difference in the strategies of the German firms vis-a-vis the degree of spillovers risks. Licence contracts, which are regarded as the riskiest mode of entry in terms of knowledge dissipation, seem insensitive to the degree of IPR protection, while exports, where the intellectual capital remains within the country of origin and the innovating firm, positively respond to the patent system reinforcement. There are two possible explanations to this result: either technological spillovers do not constitute a relevant risk for the innovating firms of the industrialized countries; or the intellectual property rights are not an adequate protection measure, and consequently, the analysis of their impact does not enable us to evaluate the effects of the technological spillovers on MNF' strategies. Before concluding for one from these two potential explanations, we will look further into the process of localization and internalization decisions.

## 4.2 Identifying Localization and Internalization Effects by Stronger IPR

This section examines our last hypothesis about the pertinence of IPR regime relative to the localization and internalization of production by innovating firms. We are asking whether strong IPR increases localization advantages such that firms transfer knowledge assets outside the source country. We also want to know at the mean time, whether stronger IPR increase externalization of production, such that firms transfer knowledge assets outside the firm. In other words, do tight patent protection decrease internalization through FDI and exports relative to licensing contracts?

For this purpose, we modify our econometric specification so that we can have parameter deviations across the equations for exports, FDI and licensing flows (Smith 2001). We adapt equation (3)

by pooling the data across the three forms of bilateral exchange and introduce interaction-dummy variables to allow parameter deviation in the effects of the explanatory variables on selected forms of bilateral transactions. This method allow us to identify which explanatory variables contribute to localization and internalization effects. This specification is as follows:

$$\begin{aligned} ln(BT) &= \delta_0 + \delta_1 ln(GDP) + \delta_2 ln(LAB) + \delta_3 ln(OP) + \delta_4 ln(TAX) + \delta_5 IPR + \delta_6 IPRSQ \\ &+ \delta_7 ln(GDP^*D) + \delta_8 ln(LAB^*D) + \delta_9 ln(OP^*D) + \delta_{10} TAX^*D \\ &+ \delta_{11} IPR^*D + \delta_{12} IPRSQ^*D + \varepsilon \end{aligned} \quad (4)$$

$BT$ refers to bilateral exchanges (all entry modes pooled), $\delta$ is a vector including an intercept and intercept-shift terms for each one of the entry modes. Parameters on the initial explanatory variables take in this specification the role of control variables. They indicate the average impact through all the forms of bilateral exchange, while the parameters on the interaction terms describe the impacts for each particular form of bilateral transaction.

These parameters are calculated using the dummy variables, in accordance with each decision of entry. To examine localization effects, we define $DUM = 1$ for FDI flows and licenses and $0$ otherwise, since this decision concerns whether to produce outside of the source country. To examine internalization effects, we define $DUM = 1$ for licenses alone since this decision concerns whether to produce outside the source firm. To examine "joint" localization and internalization effects, we define $DUM = 1$ for FDI flows alone. FDI reflects the joint decision to "locate production outside" and at the same time, "internalize" produce within the multinational network (Smith 1999; Smith 2001).

Table 3: **Predicted Responsiveness to IPR Protection by Bilateral Exchanges**

| | **Localization Decision** | | **Internalization Decision** | | **Localization and Internalization Decision** | | |
|---|---|---|---|---|---|---|---|
| | Inside country | Outside country | Inside firm | Outside firm | Inside Firm and Country | Outside country and Inside firm | Outside country and firm |
| Exports | LOW | | LOW | | LOW/LOW | | |
| FDI | | HIGH | LOW | | | HIGH/LOW | |
| Licensing | | HIGH | | HIGH | | | HIGH/HIGH |

Table 3 summarizes the predicted responsiveness of bilateral exchange to foreign IPR regimes, under the alternative localization and internalization decisions. According to theory, we expect the relative magnitude of the parameters on the deviation versus control variables to reflect the "high/low" responsiveness according to the hypothesis. We can illustrate our approach as following: if IPR protection confers a localization advantage to german firms, we expect the deviation parameter for affiliate sales and licenses to be statistically larger than the control parameter. When stronger IPR decreases the need to internalize knowledge assets, we expect the deviation parameter on licenses to be statistically larger than the control parameter. Finally, when IPR confers a localization advantage but increase internalization of knowledge assets, we expect the deviation parameter on FDI not to statistically differ from the control variable[30].

Table **??** reports estimates by pooled regression on bilateral exchanges, as described in equation 4. Baseline model shows the average effects of the explanatory variables across all forms of bilateral exchange. Remaining columns provide respectively localization, internalization, and the joint localization and internalization effects.

The results show that stronger IPR have a positive market expansion effect on all forms of bilateral exchange on average (first column). Stronger IPR regime confers a localization advantage. German firms tend to produce more in the host country following a reinforcement of patent system. We also find an externalization effect, an increase in flows of the licences relative to flows of investment and trade. Specifically, a 1% increase of the Park and Ginarte index involves a rise of 1.89% of the bilateral exchanges on average, and an increase of 2.73% of the delocalization effects of delocalization and 4.41% of internalization effects.

These results enable us to affirm a positive impact of intellectual property rights protection, by a market expansion effect. We can deduce from it that the technological spillovers are perceived correctly by the German multinationals, who require an effective protection of the knowledge stocks when transferring their technology out of the country and firm of origin.

The results for the joint effect (column 4) confirms these conclusions. Investment flows are not statistically sensitive to the IPR reinforcement, relatively to exports. This finding suggests that pro-

[30]This is because we expect FDI to be more responsive to foreign IPR by host countries than exports, but less responsive than licensing flows.

Table 4: **Pooled Transactions; Distinguishing Localization and Internalization Effects**

| | Baseline | Localization Effects | Internalization Effects | Joint Effects |
|---|---|---|---|---|
| DUM - FDI | 0.186*** | 0.978*** | 0.966*** | 0.172*** |
| | [0.012] | [0.022] | [0.036] | [0.011] |
| DUM - Licences | 0.346*** | 0.983*** | 0.322*** | 0.996*** |
| | [0.009] | [0.018] | [0.007] | [0.048] |
| Market Size | 1.016*** | 0.654*** | 0.613*** | 1.322*** |
| | [0.192] | [0.111] | [0.116] | [0.134] |
| Labor | -0.511*** | -0.230** | -0.320*** | -0.696*** |
| | [0.169] | [0.096] | [0.101] | [0.126] |
| High-Tech Export Intensity (%) | 0.058*** | 0.112*** | 0.092*** | 0.047*** |
| | [0.017] | [0.016] | [0.015] | [0.017] |
| High School Enrollment | -0.010 | -0.037*** | -0.018*** | -0.024*** |
| | [0.009] | [0.007] | [0.006] | [0.007] |
| IPR Index | 1.145* | 1.491** | 3.473*** | -1.697** |
| | [0.172] | [0.730] | [0.729] | [0.800] |
| DUM – Market Size | | -0.348*** | -0.196*** | -1.092*** |
| | | [0.040] | [0.058] | [0.189] |
| DUM – Labor | | 0.000 | 0.000 | 0.679*** |
| | | [0.000] | [0.000] | [0.216] |
| DUM – High Tech Exp Int. | | -0.111*** | -0.099*** | -0.047 |
| | | [0.019] | [0.024] | [0.029] |
| DUM – High School Enr. | | 0.031*** | 0.012 | 0.021* |
| | | [0.007] | [0.009] | [0.011] |
| DUM – IPR | | 1.256** | 3.538*** | 3.247*** |
| | | [0.626] | [0.827] | [1.119] |
| Constant | -7.890** | -3.687 | -4.309* | -7.558*** |
| | [3.986] | [2.261] | [2.434] | [2.507] |
| Observations | 814 | 814 | 814 | 814 |
| Number of countries | 38 | 38 | 38 | 38 |

* significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors in brackets
All variables are in logarithms, excepting indexes.

duction localization out of the country but within the firm of origin constitute an intermediate choice vis-à-vis the imitation risks.

Nevertheless, the precedents estimates where no impact of the IPR protection has been found on the licence contracts, in particular towards to the host countries' imitation threat prevent us from strict conclusions. Although our results seem robust in various econometric specifications concerning FDI flows, the case of the contracts in technology requires additional analysis.

# 5 Conclusion

The objective of this paper was to evaluate the internationalization strategies of multinational firms in presence of technological spillover risks. For this purpose, we analyzed the entry choice by German firms during the period 1992-1998, towards 38 countries of destination. By taking into account the simultaneity of the decisions, our principal research question was to assess to what extent host countries' technical capacity, economic level, and particularly IPR protection influence the arbitrage between the exports, direct investments and the contracts in technology.

Our results show that the risks of knowledge dissipation influence the choice to serve a foreign market, in a general way. Indeed, as a whole, host countries' intellectual property system affects the decision of internationalization of the products, regardless to the entry mode chosen. However, this impact of the IPR regime depends on the econometric model used and the host countries' endowment.

Estimates by Seemingly Unrelated Regression (SUR) prove to be the most adequate method to study economic flows across countries. Our results suggest that the individual estimates, which do not take into account the simultaneity of the decisions, underestimate the expected effects.

SUR estimates show that countries with a high local demand and a tight patent protection system attract greater volumes of bilateral transactions. However, when we distinguish between different income levels, we find a decline of the market size variable in low income countries. We also observe that market size and the degree of patent protection determine trade and investment flows, whilst technology contracts do not seem to be affected. Furthermore, no impact of the imitation threat on the choice of entry has been identified.

On the other hand, when we distinguish between different decisions concerning localization and internalization of German multinationals, the IPR reinforcement seems to increase the host country' attractiveness, in particular for the licensing, and to a lesser extent investment decisions.

The results of this paper indicates the existence of technological spillovers that the innovating firms should integrate in their internationalization strategy. Consequently, our analysis allow us to put forward the role of IPR protection in the international diffusion of technology. It appears that the patent system does not always stimulate the knowledge dissemination, its impact depending strongly on the host countries' characteristics. In this context, a uniform harmonization of intellectual property is likely to have perverse effects on certain countries. In fact, the reinforcement of IPR protection, *a priori*, would have to stimulate the technology transfer to the detriment of the technological spillovers. However, our analysis do not provide such evidence.

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# 6 Appendix

## 6.1 Variables and Descriptive Statistics

Table 5: **Variables and Expected Effects**

| Variable | Definition | Source |
|---|---|---|
| Exports | Bilateral Exports by German Firms | Comtrade Database, WB. |
| Licences | Patent Licensing by German Non-affiliated Firms | Technological Services in the Balance of Payments, Bundesbank. |
| FDI | FDI flows by German Firms | International Capital Links, Bundesbank. |
| Market Size | GDP per capita | World Development Indicators |
| Openness | Market Openness $= \frac{IMP+EXP}{GDP}$ | World Development Indicators |
| IPR | Index of IPR protection | Ginarte and Park |
| Human Skills | Average years of higher schooling in the total population | Barro and Lee Education Dataset |
| Labor Cost | Wages and Salaries | World Development Indicators, WB |
| Export Intensity | High-Technology Exports as a percentage of total manufacture exports | UNESCO |
| Taxes | Taxes on international Trade | World Development Indicators |
| RES | Number of researchers in science and technology | UNESCO |

Table 6: **Summary Statistics on Explanatory Variables**

| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| *Patent Licensing Receipts* | 315 | 7.14e+07 | 1.48e+08 | 0 | 1.14e+09 |
| *Foreign Direct Investment Flows* | 308 | 6.74e+09 | 1.64e+10 | -3.71e+08 | 1.53e+11 |
| *German Exports* | 307 | 7237366 | 1.03e+07 | 3217.893 | 5.15e+07 |
| *IPR strength* | 278 | 3.155146 | .8508149 | 1.17 | 4.86 |
| *GDP per capita* | 302 | 16819.45 | 12964.31 | 329.24 | 46737 |
| *Openness* | 315 | 2.78e+11 | 3.64e+11 | 9.8637 | 2.43e+12 |
| *High Tech Exports (% Manufacture)* | 303 | 14.35028 | 12.5408 | .16556 | 63 |
| *Residents' Patents* | 306 | 19732.94 | 62853.35 | 0 | 388879 |
| *Non-Residents Patents* | 310 | 53476.51 | 48177.7 | 126 | 199565 |
| *Labor* | 315 | 5.26e+07 | 1.36e+08 | 993060 | 7.57e+08 |
| *School Enrollment Ratio* | 315 | 41.00523 | 20.04514 | 3.046 | 89.378 |
| *Tax on Trade* | 301 | 28.43009 | 13.34714 | 3.0213 | 68.132 |

Table 7: **German Economic Flows by Destination Country**

| Country | Licences | Exports | Imports | FDI |
|---|---|---|---|---|
| ARG | 3,E+07 | 3,E+05 | 3,E+05 | 1,E+09 |
| AUS | 3,E+07 | 9,E+05 | 1,E+05 | 2,E+09 |
| AUT | 8,E+07 | 2,E+07 | 6,E+06 | 8,E+09 |
| BLX | 8,E+07 | 2,E+07 | 1,E+07 | 2,E+10 |
| BRA | 2,E+07 | 1,E+06 | 8,E+05 | 6,E+09 |
| CAN | 1,E+07 | 1,E+06 | 7,E+05 | 3,E+09 |
| CHE | 2,E+08 | 1,E+07 | 6,E+06 | 8,E+09 |
| CHN | 3,E+07 | 3,E+06 | 5,E+06 | 2,E+09 |
| CZE | 2,E+07 | 3,E+06 | 3,E+06 | 3,E+09 |
| DNK | 1,E+07 | 3,E+06 | 2,E+06 | 2,E+09 |
| EGY | 4,E+06 | 4,E+05 | 1,E+05 | 1,E+08 |
| ESP | 2,E+08 | 1,E+07 | 6,E+06 | 7,E+09 |
| FIN | 8,E+06 | 2,E+06 | 2,E+06 | 4,E+08 |
| FRA | 2,E+08 | 4,E+07 | 2,E+07 | 2,E+10 |
| GBR | 2,E+08 | 2,E+07 | 1,E+07 | 2,E+10 |
| GRC | 1,E+07 | 2,E+06 | 7,E+05 | 8,E+08 |
| HK | 4,E+06 | n.a. | n.a. | 2,E+09 |
| HUN | 2,E+07 | 2,E+06 | 2,E+06 | 3,E+09 |
| IND | 2,E+07 | 6,E+05 | 1,E+06 | 2,E+08 |
| IRL | 1,E+07 | 8,E+05 | 2,E+06 | 7,E+09 |
| ITA | 1,E+08 | 3,E+07 | 2,E+07 | 1,E+10 |
| JPN | 2,E+08 | 6,E+06 | 1,E+07 | 4,E+09 |
| KOR | 4,E+07 | 1,E+06 | 2,E+06 | 9,E+08 |
| MEX | 5,E+07 | 9,E+05 | 3,E+05 | 2,E+09 |
| NLD | 1,E+08 | 2,E+07 | 1,E+07 | 1,E+10 |
| NOR | 4,E+06 | 2,E+06 | 9,E+05 | 1,E+09 |
| POL | 2,E+07 | 4,E+06 | 3,E+06 | 3,E+09 |
| PRT | 2,E+07 | 2,E+06 | 2,E+06 | 2,E+09 |
| ROM | 3,E+05 | 6,E+05 | 5,E+05 | 2,E+08 |
| RUS | 2,E+07 | 3,E+06 | 2,E+06 | 5,E+08 |
| SGP | 8,E+06 | 1,E+06 | 2,E+06 | 2,E+09 |
| SVK | 2,E+06 | 7,E+05 | 1,E+06 | 7,E+08 |
| SVN | 2,E+06 | 7,E+05 | 1,E+06 | 2,E+08 |
| SWE | 3,E+07 | 5,E+06 | 3,E+06 | 2,E+09 |
| THA | 8,E+06 | 9,E+05 | 8,E+05 | 7,E+08 |
| TUR | 1,E+07 | 2,E+06 | 3,E+06 | 7,E+08 |
| UKR | 3,E+05 | 3,E+05 | 2,E+05 | 1,E+08 |
| USA | 8,E+08 | 3,E+07 | 2,E+07 | 7,E+10 |
| Total | 7,E+07 | 7,E+06 | 5,E+06 | 6,E+09 |

Table 8: **Summary Statistics on Destination Countries**

| Country | GDP per capita | Labor | High Technology Exports on manufacturing exports | Number of researchers per million population |
|---|---|---|---|---|
| ARG | 8,E+03 | 1,E+07 | 6,E+00 | 3,E+04 |
| AUS | 2,E+04 | 9,E+06 | 1,E+01 | 6,E+04 |
| AUT | 3,E+04 | 4,E+06 | 1,E+01 | n.a. |
| BLX | 3,E+04 | 4,E+06 | 7,E+00 | 3,E+04 |
| BRA | 4,E+03 | 7,E+07 | 8,E+00 | n.a. |
| CAN | 2,E+04 | 2,E+07 | n.a. | 9,E+04 |
| CHE | 4,E+04 | 4,E+06 | 2,E+01 | 2,E+04 |
| CHN | 6,E+02 | 7,E+08 | 1,E+01 | 5,E+05 |
| CZE | 5,E+03 | 6,E+06 | 6,E+00 | 1,E+04 |
| DNK | 4,E+04 | 3,E+06 | 2,E+01 | 2,E+04 |
| EGY | 1,E+03 | 2,E+07 | 3,E+00 | n.a. |
| ESP | 2,E+04 | 2,E+07 | 7,E+00 | 5,E+04 |
| FIN | 3,E+04 | 3,E+06 | 2,E+01 | 3,E+04 |
| FRA | 3,E+04 | 3,E+07 | 2,E+01 | 2,E+05 |
| GBR | 2,E+04 | 3,E+07 | 3,E+01 | 1,E+05 |
| GRC | 1,E+04 | 4,E+06 | 7,E+00 | 1,E+04 |
| HK | n.a. | 3,E+06 | 2,E+00 | n.a. |
| HUN | 5,E+03 | 5,E+06 | 1,E+01 | 1,E+04 |
| IND | 4,E+02 | 4,E+08 | 4,E+00 | n.a. |
| IRL | 2,E+04 | 1,E+06 | 4,E+01 | 7,E+03 |
| ITA | 2,E+04 | 3,E+07 | 9,E+00 | 7,E+04 |
| JPN | 4,E+04 | 7,E+07 | 2,E+01 | 6,E+05 |
| KOR | 1,E+04 | 2,E+07 | 2,E+01 | 1,E+05 |
| MEX | 3,E+03 | 4,E+07 | 2,E+01 | 2,E+04 |
| NLD | 3,E+04 | 7,E+06 | 3,E+01 | 4,E+04 |
| NOR | 4,E+04 | 2,E+06 | 1,E+01 | 2,E+04 |
| POL | 4,E+03 | 2,E+07 | 6,E+00 | 5,E+04 |
| PRT | 1,E+04 | 5,E+06 | 4,E+00 | 2,E+04 |
| ROM | 1,E+03 | 1,E+07 | 2,E+00 | 3,E+04 |
| RUS | 2,E+03 | 8,E+07 | 7,E+00 | 6,E+05 |
| SGP | 2,E+04 | 2,E+06 | 6,E+01 | 9,E+03 |
| SVK | 4,E+03 | 3,E+06 | 4,E+00 | 1,E+04 |
| SVN | 1,E+04 | 1,E+06 | 4,E+00 | 4,E+03 |
| SWE | 3,E+04 | 5,E+06 | 2,E+01 | 4,E+04 |
| THA | 3,E+03 | 4,E+07 | 3,E+01 | n.a. |
| TUR | 3,E+03 | 3,E+07 | 2,E+00 | 2,E+04 |
| UKR | 1,E+03 | 3,E+07 | n.a. | n.a. |
| USA | 3,E+04 | 1,E+08 | 3,E+01 | 1,E+06 |
| Total | 2,E+04 | 5,E+07 | 1,E+01 | 1,E+05 |

Table 9: **German Economic Flows on Average**

| Year Year | Licensing Flows | Total FDI | Total Exports | IPR Index | GDP per capita | Openness | High-Tech Exports | Patents by Residents |
|---|---|---|---|---|---|---|---|---|
| **1992** | 52300000 | 401000000 | 8023548 | 3.029502 | 15776.93 | .512524 | 10.66575 | 19122.68 |
| **1993** | 50300000 | 314000000 | 8077806 | 3.021237 | 15557.72 | .5254767 | 12.58875 | 19724.13 |
| **1994** | 91400000 | 337000000 | 6330343 | 3.006963 | 15381.76 | .6439052 | 12.10304 | 18497.59 |
| **1995** | 141000000 | 7280000000 | 7331301 | 2.708585 | 16664.34 | .6520063 | 12.07701 | 18033.21 |
| **1996** | 65300000 | 8330000000 | 8672308 | 3.083463 | 16488.85 | .6952089 | 14.22916 | 18199.5 |
| **1997** | 66300000 | 10600000000 | 8499968 | 3.083463 | 17172.69 | .737151 | 15.00236 | 17409.03 |
| **1998** | 82300000 | 11900000000 | 4928839 | 3.383529 | 17575.76 | .7719813 | 15.95886 | 18043.58 |
| **1999** | 43500000 | 9410000000 | 7954705 | 3.383529 | 18032.62 | .7844906 | 17.05013 | 18417.31 |
| **2000** | 48700000 | 11400000000 | 5433673 | 3.383529 | 18495.92 | .8300386 | 18.51536 | 29784.33 |

## 6.2 Additional Estimation

Table 10: Individual Regressions on Entry Mode: Independence of Decision

| | **Licences** | **Exports** | **FDI** |
|---|---|---|---|
| Market Size | 1.829*** | 0.998*** | 0.336 |
| | [0.427] | [0.303] | [0.362] |
| Labor | -0.658* | -0.402 | -0.316 |
| | [0.386] | [0.271] | [0.320] |
| High-Tech Export Intensity (%) | -0.021 | | 0.086*** |
| | [0.036] | | [0.030] |
| Taxes on International Trade | -0.343** | -0.640*** | |
| | [0.173] | [0.155] | |
| School Enrollment | -0.002 | 0,041*** | -0,004 |
| | [0.019] | [0.013] | [0.015] |
| IPR Index | 3.356 | 0.062 | 3.964*** |
| | [2.090] | [1.683] | [1.008] |
| Soled of Technology BP | | 0.039 | 0.076* |
| | | [0.045] | [0.041] |
| Observations | 272 | 264 | 273 |
| Number of pays | 34 | 34 | 35 |
| Hausman Test: | 7.84 | 20.05 | 32.15 |
| Prob > chi2 | 0.02 | 0.01 | 0.00 |

* significant at 10%; ** significant at 5%; *** significant at 1%.
Standard errors in brackets. All variables are in logarithms, except indexes.