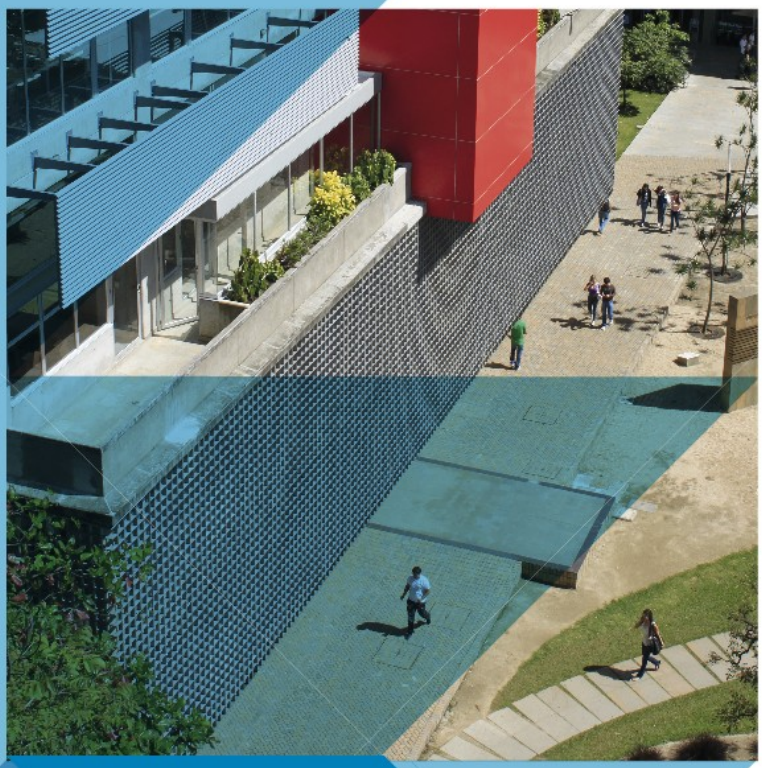

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Can IPR Affect MNE's Entry Modes? The Chilean Case

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Abstract

This paper analyzes the effect of stronger Intellectual Property Rights (IPR) on the entry modes chosen by MNEs in the Chilean market. MNEs can choose between exporting, introducing Foreign Direct Investment (FDI) and licensing to a domestic firm in Chile. We use plant-level data for the 2001–2007 and exploite the exogenous reform of IPR in Chile in 2005 to examine the effect of the change in IPR on the overall foreign presence in Chile, controlling for the activities of industries where high levels of technology transfer and imitation are important factors. The main results show that stronger IPR change the mode of entry chosen by MNEs. In this case, FDI is replaced by licensing. This is explained by Chile's high absorptive capacity during this period. Moreover, we test whether this effect differs across high-tech and low-tech industries and conclude that the displacement of FDI is less severe in high-tech industries.

JEL: O34, O44, C5, K2

Keywords: Technology Licensing, Productivity, Spillovers, Chile

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I. Introduction

The importance of Foreign Direct Investment (FDI) to economic growth due to the technology transfers has been documented in many studies[1]. Technology transfer should help reduce the gap between developed and developing countries, since there is a lack of innovation in the latter group.

In a recent trend, developing countries have introduce different measures in order to attract FDI. Many factors affect the level of FDI in a country: political stability, labor market regulations, institutional framework, and market size can all attract or deter FDI. In the current state of economic globalization, with the increasing importance of intangible assets, Intellectual Property Rights (IPR) play an important role in the decision to invest abroad[2].

There is still some controversy as to the effect of stronger IPR on the welfare of the host economy. On the one hand, people advocate for stronger IPR on the grounds that they provide the protection necessary for production to shift to a developing country and thus release resources from developed countries to advance the technological frontier. On the other hand, stronger IPR's also reduce the ability of local firms in the host economy to be exposed to new technologies, and they create a *monopoly effect* that reduces the need to increase R&D in the foreign affiliate.

Awareness of the importance of IPR has increased in the last fifteen years due to the implementation of the Trade-Related Intellectual Property Rights (TRIPS) agreement in 1995 by the World Trade Organization (WTO). As stated by the WTO, *"it (the agreement) establishes minimum levels of protection that each government has to give to the intellectual property of fellow WTO members"*.

In Chile, the first industrial property legislation was approved in 1991. There were a few modifications to the law, the most important being the approval of a new law in 2005 that made significant changes to IPR, starting with the creation of a court specific to industrial property issues.

This study analyzes the effect of strengthening IPR on inward FDI in Chile during the 2001–2007 period. In an important contribution, this paper validates and complements previous empirical studies, especially as most of them analyze a cross-section of countries rather than the evolution of firms over time. Moreover, since the study period is very recent, the implications of a change in the IPR framework could be different from the those of previous studies.

During the past two decades, Chile has been growing at a fast and steady pace. Hence, it is important to analyze the effect of stronger IPR not only on the flow of FDI

[1]Throughout the paper, FDI refers to inward FDI, that is, investment by a Multinational Enterprise (MNE) in a subsidiary in a host country.

[2]For example, Mansfield (1994) conducts a survey of 100 U.S. firms to determine the extent to which the level of IPR affects their decisions to invest in six different industries.

but also on the imitative activity of the country. Stronger IPR tend to deter imitative activities and to increase the market power of MNEs in the host country.

Regarding FDI, as has been noted in many studies, once an MNE decides to service a market abroad, this can be done using three different channels: i) it can export, ii) it can shift its production (FDI), and iii) it can license its knowledge to another firm.

In a very complete survey, Park (2008) reviews the different issues related to IPR and innovation. One way to model FDI flows from developed countries (the North) to developing countries (the South) is through product-cycle models. In the basic framework, innovation occurs in the North, while there is a level of imitation in the South. Once the good is standardized, this leads to investment in and product-shifting to the South to obtain rents from lower wages. These types of models are still relevant, and a key aspect of their validity is the imitative ability of the South. Thus, any factor that affects the imitative ability of the South is likely to affect the level of FDI in the country[3].

The results obtained from purely theoretical models are ambiguous and depend on the initial assumptions. Helpman (1993) and Glass and Saggi (2002) develop models that conclude that stronger IPR in the South lead to lower rates of innovation in the North, while Lai (1998) and Yang and Maskus (2001) conclude that stronger IPR in the South lead to higher levels of innovation in the North.

Therefore, it is important to validate different theoretical approaches with empirical studies in order to determine the effect of IPR on FDI, especially when there is a high volume of data with which to conduct this type of analysis.

II. FDI in Chile

FDI in Chile has fluctuated considerably over the last decade. This can be seen in the following figure. It is clear that there was an important inflow of FDI in the late 90s due to the privatization process in Chile.

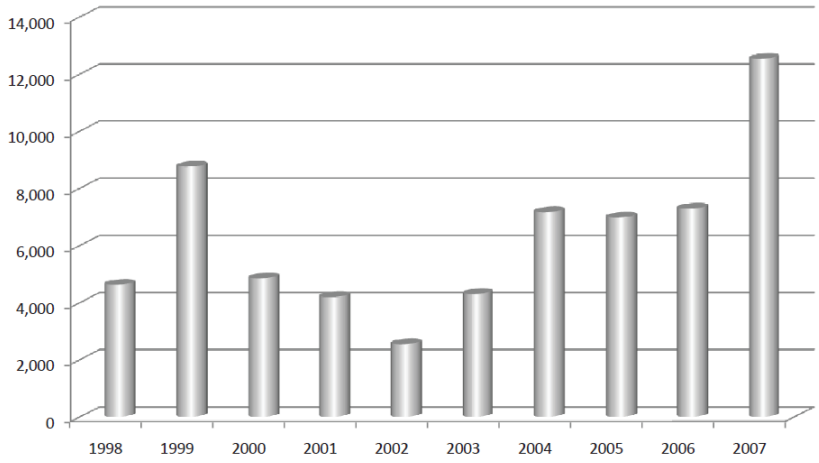
After peaking in 1999, FDI started to decline, reaching a minimum of $2,500 million (3.8% of GDP). However, after this minimum, FDI started to increase again, reaching another peak in 2007 at $12,500 million (7.6% of GDP).

It is important to note that even though the increases in FDI that occurred after 2002 seem to be of great magnitude, as a percentage of GDP, the only large increase happened in 2004 when FDI reached 7.5% of GDP. In the other years, it averaged 5.5% of GDP.

Another important point is that Figure 1 is taken from the Balance of Payments (BOP) data, and there is no decomposition of these values by economic sector. Thus,

[3]For a more thorough discussion of these types of models, see, for example, Vernon (1966); Grossman and Helpman (1991); and Park (2008).

Figure 1: FDI in Chile 1998–2007 (Million of US dollars)

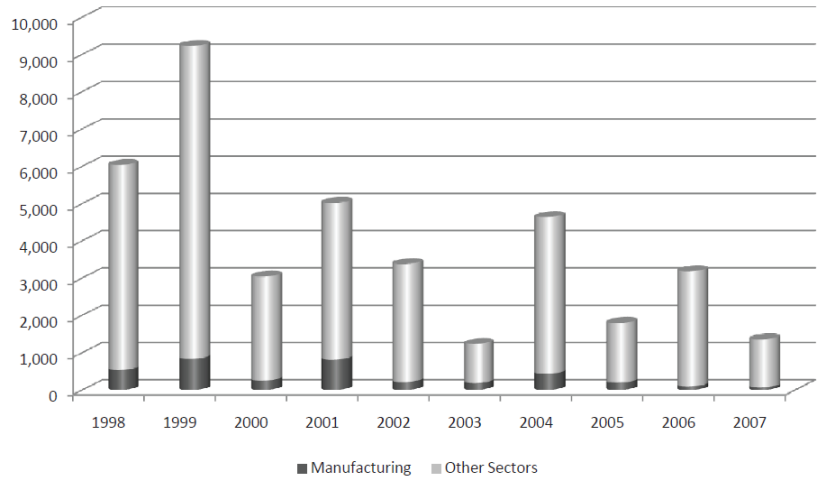


Source: World Bank. *World Development Indicators.*

it is possible that the changes represented in Figure 1 do not reflect FDI in the manufacturing sector, which is the focus of this paper.

Nevertheless, a government institution, the Foreign Investment Committee (FIC) addresses the portion of investors who choose to use the Foreign Investment Statute (DL600) as a means to invest in Chile[4]. The following figure shows the amount of FDI in Chile under DL600 by sector.

Figure 2: FDI in Chile 1998-2007 (By Sector, in Million of US dollars, under DL600)



Source: Chilean Foreign Investment Committee (FIC).

As can be seen in Figure 2, FDI in Chile shows a similar pattern under DL600 and

[4]DL600 allows foreign investors to choose this regime when investing in Chile. Thus, investment under DL600 constitutes only part of recorded FDI in the BOP data. The difference between DL600 investment and investment in the BOP includes other capital and reinvestment.

the BOP in the late 90's and early 2000s. However, the similarities end by the mid-2000s. Importantly, FDI under DL600 starts to decrease after 2004. Regarding the manufacturing sector, it is very clear that FDI has significantly decreasing in the last few years, which is also shown in Table 6 (see the appendix). This suggests either that there are fewer foreign plants in the manufacturing sector or that the existing plants have significantly decreased in size.

III. Related Literature

Empirical studies have shed some light on the effect of stronger IPR on trade flows and FDI[5]. Most studies examine FDI outflows from a developed country at the firm level (most studies use U.S. data). The greatest weakness of these studies is that, due to data constraints, they focus on cross-sectional analysis of FDI flows to different countries in a single year.

In recent years, as more data have became available, higher quality studies on FDI as the source of innovation have emerged. However, work analyzing the evolution of FDI remains scant. In particular, the existing work has been on FDI flowing out of a country (outward FDI) rather than on FDI flows into a given country (inward FDI). Moreover, there is debate about which measure of IPR strength in best[6].

In one of the first attempts to study the relationship between international patent affiliation (the Paris Convention or the Berne Convention) and the affiliate level of sales, Ferrantino (1993) finds no significant evidence that affiliation affects trade or FDI.

Using U.S. data for almost 100 firms, Lee and Mansfield (1996) study the volume and composition of FDI in different countries in which there are different perceptions of IPR strength[7]. Their study encompasses six manufacturing industries in fourteen countries. They examine the volume of total U.S. investment in the manufacturing sector. They find that perceptions of weaker IPR lead to lower levels of FDI. Moreover, when they analyze the composition of FDI, they only use fourteen chemical firms and the ratio of FDI that was used sales and distribution to FDI used in manufacturing products. Using a Tobit model, they find that the percentage devoted to sales and distribution is positively related to weak IPR.

Braga and Fink (1998) criticize the results obtained by Lee and Mansfield (1996) based on the fact that the perception index used as a proxy for IPR strength includes other factors, such as the imitative capacity of the host country. To resolve this issue, they use a measure of IPR strength developed by Rapp and Rozek (1990) and a larger sample of countries; nevertheless, their results are in line with those ofLee and Mansfield (1996).

[5]For a discussion of the relation between trade and IPR, see Maskus and Penubarti (1995).
[6]The different measures of IPR will be discussed in the empirical approach section.
[7]They use the perceptions of IPR strength collected by Mansfield (1994).

Nunnenkamp and Spatz (2004) use U.S. data disaggregated at the industry level for more than one hundred countries and different measures of IPR strength. The hypothesis they test relies on the fact that FDI flows to different countries depend on industry and host- country characteristics. They also consider different dependent variables to test whether stronger IPR affect the quantity and quality of FDI.

They use the industry FDI stocks of 166 countries. They also have data on sales, value added, employment, total employee compensation, exports and imports, local R&D expenditures and license fees paid to the U.S. for a subsample of countries (58).

A new feature of this study is that they compare two different years, 1995 and 2000. They focus on seven manufacturing industries in 1995 and five in 2000[8]. They supplement these data with country characteristics (GDP per capita and average years of schooling).

To measure IPR, they follow Ginarte and Park (1997), and IPR strength is measured by the *World Economic Forum*(WEF)[9]. The specifications include traditional FDI determinants as controls, such as GDP per capita, population, distance from the U.S. and two institutional indicators. To analyze FDI quality, they examine host R&D expenditures, value added and exports of the affiliate.

They find that IPR are not significant when host-country characteristics are not taken into account. They then interact host-country characteristics with the IPR measures and find that IPR are only significant when host-country characteristics are taken into account. Moreover, they find no significant differences when using different IPR measures. They find that stronger IPR increase the quality of FDI in the host countries (as measured by R&D, value added, and exports of the affiliate).

In another study, Smith (2001) examines the effect of foreign patent rights on U.S. exports, sales in the host country and licenses. A new approach is used, since the effect of IPR on the three modes used by MNEs (exports, sales by affiliates, and licensing) are examined simultaneously. The data include 50 countries in 1989.

Smith (2001) tests whether stronger IPR increase exports, sales via affiliates and licenses in order to determine whether the *market expansion* effect or the *market power* effect is stronger[10]. Other tests examine whether strong IPR lead to knowledge transfer to the host country and whether the transfer of knowledge occurs within the same

[8]In 1995, the industries are food, chemicals, metals, machinery, electronic equipment, transport equipment and other manufacturing. In 2000, the industries are food, chemicals, metals, machinery and electronic equipment, and transport equipment.

[9]The Ginarte-Park IPR strength measure is constructed quinquennially using five categories of patent laws to form an index that ranges from 0 to 5. The WEF measure will be explained in more detail later.

[10]The market expansion effect refers to higher production (through exports, sales, or licenses) in the foreign market, since the technology being transferred is better protected. The market power effect refers to the fact that stronger IPR confer more market power on the MNE in the host country, reducing the level of production in the foreign market.

firm[11].

The findings show a positive relation between IPR strength and the sales of U.S. affiliates in a host country. There is also a positive effect of IPR on licenses granted to foreign firms. However, the level of exports is not significantly affected by IPR. This leads to the conclusion that strong IPR exert a *market expansion* effect in the host country rather than a *market power* effect. Moreover, the effect is larger in countries that have high imitative capacity.

Additionally, stronger IPR increase the location advantage for the MNE, since there is a stronger effect on licenses than on affiliate sales. Thus, it is possible that MNEs reduce their level of FDI and use licensing instead.

The most relevant study using foreign data is Javorcik (2004b), which focuses not only on the effect of stronger IPR on inward FDI but also on the composition of FDI in twenty-four economies in Eastern Europe and the former Soviet Union.

To test these hypotheses, they examine the effect of stronger IPR in tech-intensive sectors – the same sectors used in Mansfield (1994). The second hypothesis tests whether the investor sets up production facilities or only engages in distribution/advertising activities, thus differentiating between "productive" FDI and FDI that does not increase productivity and is solely used to increase sales.

She finds that weaker IPR have two effects, one direct effect deterring FDI and a compositional effect increasing the investment in distribution projects rather than local production or R&D.

In a more recent study, Branstetter et al. (2006) analyze the effect of IPR reforms in sixteen countries during the 1982–1999 period. Using U.S. firm-level data, they analyze the effects of stronger IPR measures on international technology transfer.

They conclude that royalty payments for technology transferred increased at the time of the reform. Additionally, R&D expenditures in the host country increased, especially for firms that use patents extensively. This study represents a breakthrough in the literature, since panel data is required to perform a competent analysis.

A more complete study by Branstetter et al. (2007)followed[12]. Using the same data as Branstetter et al. (2006), this study is the closest in spirit to the hypotheses tested for the Chilean economy in this paper.

They develop a theoretical model that predicts that stronger IPR measures lead to higher FDI due to the shifting of production to affiliates in developing countries. This, in turn, frees resources in developed countries so that more innovation can take place.

They test the model empirically by examining production-shifting to developing countries (increasing the scale of production by affiliates). They approach this problem

[11]If sales by affiliates are highly affected by the reform, then knowledge transfer occurs within the same firm, whereas if the reform affects licenses, then knowledge is transferred to an external firm.

[12]Hereafter, BFFS.

using the following equation:

$$S_{ilt} = \alpha_0 + \alpha_{il} + \alpha_t + \beta_0 y_{jt} + \beta_1 P_{it} + \beta_2 H_{jt} + \beta_3 R_{jt} + \beta_4 R_{jt} * Tech_{il} + \varepsilon_{it} \quad (1)$$

where i indexes the affiliate's parent firm, l the affiliate, j the host country, and t the year. The dependent variable is a measure of the scale of the affiliate S_{ilt}; they use capital stock, employment compensation, use of technology from the parent firm and R&D expenditures. They control for affiliate fixed effects, time fixed effects and country-specific time trends. P and H are parent characteristics and host-country characteristics, respectively[13].

In equation 1, R_{jt} is a reform dummy variable that takes the value zero before the reform and one afterward. $Tech - il$ is a dummy variable that equals one for affiliates with high technology transfer from the parent and zero for low technology transfer[14].

They find that MNE's increase their capital stock and employment compensation but reduce royalties paid after IPR reforms. These results are compatible with the idea that there is production-shifting to developing countries.

Another hypothesis tested in their study is whether the increase in production by MNEs offsets the reduction in the production of imitators in developing countries. This is done by examining industry-level outcomes before and after the reform. The specification in this case is:

$$VA_{ijt} = \alpha_0 + \alpha_{ij} + \alpha_t + \beta_0 y_{jt} + + \beta_1 H_{jt} + \beta_2 R_{jt} + \beta_3 R_{jt} * IndTech_i + \varepsilon_{it} \quad (2)$$

In this case, the dependent variable is the value added in industry i in country j and year t. The $IndTech$ dummy is equal to one for technologically intensive industries[15]. Using this specification, they find that "output expansion is concentrated in technology intensive industries"[16].

Both studies, (Branstetter et al., 2006, 2007), include the Chilean IPR reform of 1991. However, they do not take into account the more recent reform in 2005. Moreover, a limitation of their analysis is that they use only statutory measures of changes in IPR[17]. This method does not allow for lagged implementation of new regulations.

[13] Their results can be viewed in appendix C (Table 8).

[14] To assign a value for $Tech$, they use the median license payments from affiliates to parent firms over four years prior to a particular reform. Affiliates with license payments above the median are assigned a value of one; those below the median, zero.

[15] The industries included are electrical machinery, industrial chemicals, other chemicals, professional and scientific equipment, and transportation equipment.

[16] The results can be viewed in appendix C (Table 9).

[17] This means that they use a dummy variable for reform, implying that regulatory changes and enforcement occur instantaneously.

The main contribution of this paper is to clarify the relevance of a change in IPR on FDI flows in Chile. Thus, it is important to validate the results found by BFFS after more than a decade of rapid economic growth. Moreover, it is important to determine the reaction of the economy as a whole to stronger IPR, since imitative activity may have increased in the past decades. It is also possible that MNEs now prefer granting licenses to investing abroad.

It is important to validate the results of other empirical studies because, in most cases, they examine older data from before the implementation of TRIPS by WTO members. Thus, the results of BFFS come from economies in which a full IPR structure was not yet implemented.

Another important feature of this study is the use of a very extensive survey of the Chilean manufacturing sector. The data come from the Chilean Annual Manufacturing Census (ENIA), which includes all establishments with 10 or more workers. This allows for a thorough analysis of the manufacturing sector using panel data. This dataset also allows the assessment of entry-exit decisions by foreign firms. This type of survey has not yet been used extensively, since most previous studies have conducted only cross-sectional analyses.

IV. Data

The plant-level data used in this series of studies come from the Chilean *Encuesta Nacional Industrial Anual* (ENIA)[18]. The survey is conducted by the National Statistics Institute (INE) of Chile and covers all establishments (plants) with ten or more workers. The years covered by this study are 2001–2007.

Previous versions of this census have been used by Pavcnik (2002) and Lopez (2008), among others. However, they use previous waves of the census. One study that uses the census for the 2001–2006 period is Gibson and Graciano (2011).

The unit of observation is the establishment's (plant). There are firms that only have one plant; however, other firms have multiple plants that are integrated either vertically or horizontally (multi-plant and multi-activity firms).

In the case of multiple plants, the survey includes each plant that belong to a firm. Each plant has its own ID number for statistical secrecy reasons; thus, it is not possible to identify which plants belong to a given firm[19]. Thus, each plant has a unique ID number that allows its performance to be tracked over time, permitting longitudinal studies. In the present paper, the terms "plant" and "firm" will be used interchangeably.

To classify the economic activity of each plant, the *International Standard Industrial Classification of All Economic Activities* (ISIC) revision 3 produced by the United

[18]This is a national survey of the manufacturing sector.

[19]This could be a problem if the majority of firms are multi-plant; however, as noted by Pavcnik (2002), in a previous version of this dataset, approximately 90% of firms have one plant.

Nations was used[20]. Economic activities are considered at the four-digit level[21].

IV.I Data Cleaning

The original dataset contains 37,307 observations. The first thing to note about the dataset is that starting in 1974, Chile was divided into 13 regions. However, in 2007, two regions were split, *Tarapacá* became *Arica* y *Parinacota* and *Tarapacá*; and *Los Rios* became *Los Rios* and *Los Lagos*. In order to maintain the consistency of the dataset, the 1974 division is maintained throughout the study period.

Next, since all the monetary variables in the dataset are in current pesos, it is necessary to deflate them into real pesos. Two different deflators are used. This study relies on the estimation of Total Factor Productivity (TFP); thus, for all variables that enter into the estimation of TFP, such as sales, we use a 4-digit deflator specifically designed by the INE for this survey. For variables that have a broader macroeconomic meaning, such as the value of licenses paid or wages, it makes more sense to use a more general deflator. For these variables, we use a more encompassing deflator, the GDP deflator, provided by the Central Bank of Chile[22].

Some observations were purged in the data cleaning process. First, we dropped one observation for which the value added for the firm was extremely high in one year. It is also important to note that even though there might be some negative value added figures (due to the fact that it is calculated as the production value minus intermediate goods), those observations remain in the dataset. This could be a concern for the TFP estimation; however, as will be clear in the estimation section, we use revenue (sales) for TFP estimation instead of value added.

The rest of the observations that are excluded are firms that change industries or regions (locations) during the study period. Even though it could be argued that there is a loss of information in this case, the counter argument is twofold. First, the number of observations lost is not extremely high, and second, when estimating a model using fixed effects, the main assumption is that these fixed effects capture all the characteristics of a firm that do not change over time. Thus, a change in industry or region would invalidate the interpretation of the results[23]. The final dataset has 36,026 plant-year observations in 111 industries.

[20] See http://unstats.un.org/unsd/cr/registry/regcst.asp?cl=2 for more details.

[21] The covered industries, in terms of ISIC (Rev.3) codes, are 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36. The ISIC (Rev.3) codes for the manufacturing sector range from 15 to 36. Industries 16 (tobacco) and 23 (coke, refined petroleum products and nuclear fuel) have no observations in the dataset.

[22] The deflator used in this series of studies is the 4-digit deflator for TFP estimation, although we compare the results obtained from using the GDP deflator, the 2-digit deflator and the 4-digit deflator for variables such as license payments.

[23] A more detailed explanation will be provided in the empirical section.

IV.II Descriptive Statistics

Table 1 presents descriptive statistics for the key variables. It is important to note that most of the capital stock is held by domestic plants, while foreign firms hold only 31% of the capital stock, on average[24]. However, this is a very high percentage compared to the percentage of foreign firms.

Table 1: Descriptive Statistics for Key Variables (36,026 Obs.)

Variable	Mean	SD	Min	Max
Capital Stock	2,611	26,352	0	2,140,000
% Domesic Capital	95	20	0	1001
% Foreign Capital	5	20	0	100
Value Added	3,052	26,766	118,000	1,860,000
Sales Of Production	4,960	37,206	0	1,810,000
Payments for Licenses And Foreign Assistance	8	152	0	11,864
Income Due To Exports	1,779	17,771	0	1,020,000
Number of Skilled Workers	15	58	0	2,691
Skilled/Unskilled workers ratio	1	4	0	287
Skilled/Total workers ratio	0	0	0	1

Note: All monetary values are in 2003 Million Pesos. Value added has negative values due the calculation method, the difference between gross production value and intermediate consumption.

To determine which firms are considered foreign, we used a 10% capital rule (i.e., if the foreign capital holdings of the establishment exceed 10%, it is considered foreign). The resulting differentiation is presented in table table 2.

Table 2: Number of Firms by Type of Ownership (10% capital rule)

Owner	Freq.	Percent	Cum.
Domestic	33,992	94.	94.
Foreign	2,034	6.	100
Total	36,026	100	

Moreover, it is possible to analyze the number of firms that operate only in the domestic market, those that sell to the domestic market and export, and those that only export. This distribution is depicted in table table 3.

When analyzing the dynamics of foreign presence in Chile, one striking feature is depicted in the figure below. There is a drastic decline in the number of foreign plants after 2004, and the 2007 level is even lower than that in 2001.

[24]This calculation is not shown in table table **??**, but it is available upon request.

Table 3: Distribution of Firms according to Market Service

Market	Freq.	Percent	Cum.
Non-exporter	28,641	79.5	79.5
Domestic and Ecporter	7,101	19.71	99.21
Exporter	284	0.79	100
Total	36,026	100	

Figure 3: Number of Foreign Plants

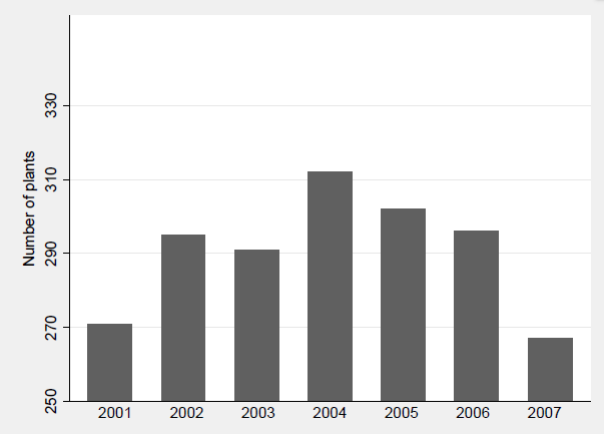


Figure 3 above also illustrates this fact: it seems that FDI in the manufacturing sector has been decreasing steadily in the last few years.

To estimate TFP, the data have been grouped at the 2-digit ISIC level. To better understand the distribution of the data, consider the number of observations and the description of each 2-digit ISIC group presented in table table 7 of the appendix.

To better analyze the dynamics of domestic and foreign firms, as well as of entry and exit, it is possible to construct transition tables to quantify the entry and exit of foreign plants. The average transition matrix for any two years in the 2001–2007 period is depicted in table table 4.

This matrix is interpreted as follows. Say we take the Domestic-Domestic cell in the matrix, which shows that for the entire period, 25,592 firms were domestic in period t and remained domestic in period t + 1. The Foreign-Domestic cell shows how many plants changed from foreign to domestic, and so on. The Enter row shows how many plants entered the Chilean market in t + 1, while the Exit column shows how many plants exited in period t.

There are a few important things to note from this transition table. First, it is clear that the number of domestic firms has decreased in this period (this is due mostly to a decrease in the number of firms in 2007). At the same time, the number of foreign firms has stayed relatively constant (1,767-1,763). Second, the previous comment is

Table 4: Transition Matrix for 2001–2007

2001-2007					
		Period t+1			
		Domestic	Foreign	Exit	Total
Period t	Domestic	25,592	129	3,695	29,416
	Foreign	167	1,419	181	1,767
	Enter	3,546	215	0	3,761
	Total	29,305	1,763	3,876	

confirmed by the number of exits for domestic firms (3,695) and the number of entrants (3,546).

However, a note of caution is needed here, since the total number of plants (domestic and foreign) has decreased since 2004. Therefore, the previous conjecture should be tested more rigorously.

It is possible to decompose the above transition matrix into the periods before and after the IPR reform in 2005. The resulting transition matrices are depicted in table table 5.

Table 5: Transition Matrices (Before and After IPR Reform)

2001-2004 (BEFORE)					
		Period t+1			
		Domestic	Foreign	Exit	Total
Period t	Domestic	16,981	83	2,571	19,635
	Foreign	117	937	115	1,169
	Enter	3,546	215	0	3,761
	Total	20,644	1,235	2,686	

2005-2007 (AFTER)					
		Period t+1			
		Domestic	Foreign	Exit	Total
Period t	Domestic	8,611	46	1,124	9,781
	Foreign	50	482	66	598
	Enter	690	35	0	725
	Total	9,351	563	1,190	

The most important thing to note from these matrices is the change in the entry/exit ratio. Before the IPR reform, this ratio was 1.87, while after the reform, the ratio decreased substantially to 0.53. Thus, after the reform, more foreign firms were exiting

the market than before. This finding was also reflected in figure 3.

V. Measures of IPR

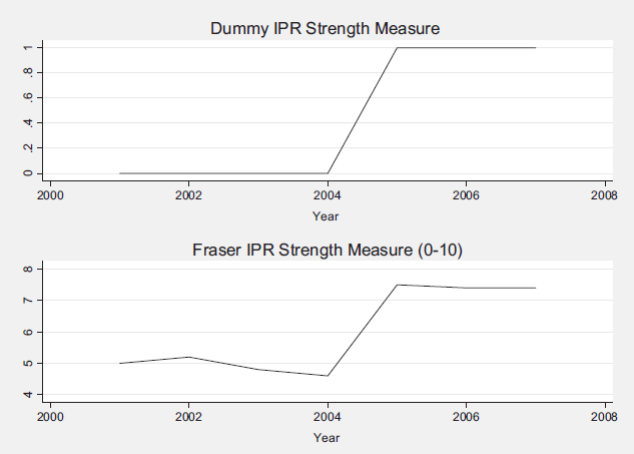
Two different measures of IPR are used in this study, a dummy variable at the time of the change and the Fraser index.

The dummy variable takes the value one on and after the year of the reform (2005) and zero otherwise. This is the type of measure used by Branstetter et al. (2007).

However, since this change does not happen overnight, it is also useful to take into account a survey measure related to IPR and property rights in general. Thus, the second measure of protection comes from the Fraser Institute's *Economic Freedom in the World* report. In this case, the following question is asked: "Property rights, including over financial assets, are poorly defined and not protected by law (= 0) or are clearly defined and well protected by law (= 10)[25]".

The two different measures can be viewed in the graph below. Note that the Fraser index and the dummy measure follow the same trend, so we should not expect differences to stem from using either measure.

Figure 4: IPR Strength Measures



VI. Empirical Approach

Since the IPR law change constitutes a treatment-effect type of estimation, we use a Difference-in-Differences (DD) approach, where the main assumption is that firms that

[25]The formula used by the Fraser Institute is based in the index created by another institution, the World Economic Forum, in its *Global Competitiveness* report. The relation used is: $EFWi = [(GCRi - 1)/6] * 10$.

were technologically intensive before the reform exhibit the same pattern in inward FDI as firms that were not "technologically intensive" in the absence of a reform.

As stated above, changes in FDI can occur at either the extensive or the intensive margin. Regarding the intensive margin, it is possible to analyze the expansion of the production of foreign plants in the entire period in a given industry. As explained in the data section, when talking about the extensive margin, changes come from two sources: *i*) new foreign or domestic firms that enter the Chilean economy and *ii*) firms that were domestic at the beginning of the sample and, at some point, started to have foreign holdings.

VII. Testable Hypotheses

VII.I Foreign Presence

The first testable hypothesis follows Branstetter et al. (2007) in the sense that it is important to capture whether stronger IPR lead to an increased overall presence of foreign firms in Chile at the industry level.

Thus, some measure of the foreign presence, such as the capital stock, in the industry is needed. In this sense, an indicator in the spirit of import penetration would be the *"foreign penetration"* of a given industry, which can be constructed for each industry as follows:

$$fdikstock_j = \frac{\sum_j^f}{\sum_j^{f+d}} = \frac{\text{Sum of capital stock for foreign plants}}{\text{Sum of capital stock for all plants}} \tag{3}$$

Therefore, the specification that could be used in order to test for changes in the *"FDI penetration"* could take the following form:

$$fdikstock_{jt} = \alpha_j + t + \beta_0 IPR_t + \beta_1 IPR_t * Tech_j + \beta_2 X_j + \varepsilon_{jt} \tag{4}$$

where j indexes each industry and t the year; α_i captures industry fixed effects, and t is a time trend; IPR_t is the strength of IPR; $Tech_j$ is a dummy variable that takes the value one if the firm is technologically intensive and zero otherwise; and X_j are the controls.[26]

Moreover, since the transition matrices and the overall data on FDI in the manufacturing sector seem lower after 2005, it is plausible that the foreign presence is being replaced by domestic firms. This would lead more foreign plants to exit the market and could increase the amount that plants pay for licenses and foreign technical assistance. This can be tested using the following specifications:

[26]The generation of the $Tech_i$ dummy will be explained later. The controls include average size and the market where the industry sells its product.

$$kstock_{jt} = \alpha_j + t + \beta_0 IPR_t + \beta_1 IPR_t * Tech_j + \beta_2 X_j + \varepsilon_{jt} \quad (5)$$

where the subscripts are similar to those in equation (4).

VII.I.1 Generating the test and comparison groups

To obtain a valid interaction term in equation 4, it is crucial to have valid test and comparison groups. Thus, it is necessary to distinguish between technologically intensive and non-technologically intensive plants to form the $Tech_i$ dummy in equation (4).

This can be done by letting each plant be technologically intensive if it belongs to industries that are considered high-tech in other countries. In this case, the *Compendium of Patent Statistics* elaborated by the OECD is used to define high-tech industries.[27] The technologically intensive industries using the ISIC Rev.3 classification (at the 2-digit level) are medical, precision and optical instruments; radio, television and communication equipment; office accounting and computing machinery; and pharmaceuticals.[28]

The descriptive statistics for each group of foreign plants are presented in table 8 in the appendix. First, note that the stock of capital and value added are lower for tech-intensive plants. This could be due to size issues with the plants (e.g., non-tech plants might need more buildings in the manufacturing sector). Nevertheless, it is clear that payments for licenses, skill intensity and skill ratio are higher for high-tech plants, which is expected. Second, regarding the remaining variables, the values are similar for both groups, which is also expected.

VII.II Ownership of Firms

The second testable hypothesis concern the effect of stronger IPR on the probability of foreign ownership of the plant. In this case, it is possible to use a random effects probit model to examine the effects of the level of IPR as well as the effects on technological intensive plants. Ownership, as previously defined, relies on a 10% capital rule, providing a categorical variable that equals one when the plant is foreign and zero when it is domestic. The specification in this case would take the form:

$$owner_{it} = \alpha_0 + \beta_1 IPR_t + \beta_2 IPR_t * Tech_i + \beta_3 Tech_i + \beta_4 X_{it} + \varepsilon_{it} \quad (6)$$

where i indexes each plant and t the year; IPR_t and $Tech_i$ are defined as in equation equation (6); and X_t is a set of controls at the country level, such as the exchange rate

[27] It is important to note that the patent classification is not fully compatible with the ISIC industry classification, but the OECD based their classification on the comparison of Scmoch et al. (2003).

[28] Since there is no pharmaceuticals industry in the ISIC Rev.3, this category is replaced by industrial chemicals and other chemicals.

and inflation. Controls at the plant level, such as plant size in the market of service, are also included.

VIII. Preliminary Results

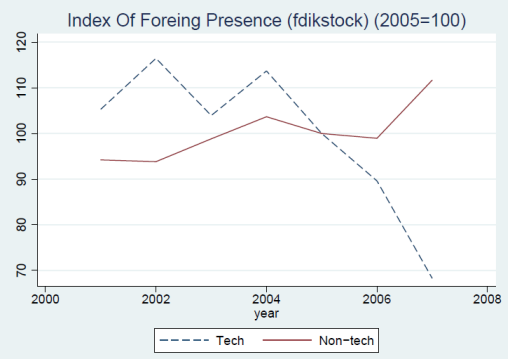
VIII.I Foreign Presence

The first test is conducted with the full sample. To understand intuition behind the results, we can consider the total *"foreign penetration"* index (see figure 5). We observe that foreign presence decreases after 2005 in the tech-intensive sectors and increases slightly for the remaining sectors. This is in line with the hypothesis that foreign plants are being replaced with domestic ones, especially in the tech-intensive sectors, resulting in more licensing payments.

This should be reflected by a negative coefficient on the interaction term in equation 4. In a similar fashion, when looking at the Index of License Payments (figure 6), the upward trend in the technological sector suggests that there is more licensing after 2005 in the high-tech sectors. Thus, we would expect a positive sign on the interaction term in equation equation (5).

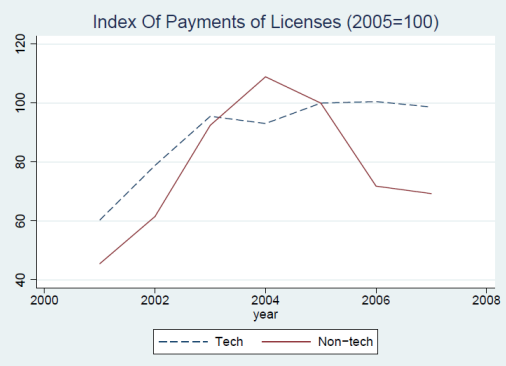
The results obtained after using specifications 4 and equation (5) are depicted in Table 9 (see the appendix). As expected, the interaction term with IPR has a negative effect on the level of foreign presence. Moreover, the effect on the level of licensing is positive and significant. This supports the hypothesized reduction in the number of foreign plants and increase in licensing in Chile after the reform[29].

Figure 5: Foreign Presence Index



[29]It is important to note that no controls have been included in this specification, since the industry and time dummies control for anything that happens at the industry or country level. However, the results are robust to the inclusion of variables that vary at the country level. Additionally, the number of observations is not a multiple of the number of industries because the panel is unbalanced such that some industries are not present in some years.

Figure 6: License Payments Index



When using the random effects probit (table 10), it is possible to show that higher levels of IPR have a negative effect on the probability of being a foreign plant. This is highly significant for the Fraser Institute index and the dummy measure of IPR.

Moreover, the effect tends to be lower for high-tech plants, since all the interaction terms are positive and significant. This supports the hypothesis depicted in the transition matrix that with stronger levels of IPR, the probability of being a foreign-owned plant is significantly reduced. Additionally, foreign owners tend to 'stay' in the high-tech sectors relative to low-tech sectors. This could be due to the fact that Chilean plants are capable, at least in the last few years, of reproducing whatever the foreign plant was producing.

IX. Conclusions

The importance of FDI for economic growth has been emphasized throughout the economics literature. Moreover, developing countries rely on FDI as a source of technology transfer and innovation. Thus, it is important to clarify the most effective channels through which a developing country can benefit from the technology advancements of developed countries.

In the present state of globalization, IPR affect the decisions of MNEs to invest abroad. This has been shown in previous studies that find that stronger IPR lead to higher FDI and higher quality FDI being sent abroad.

However, not many studies focus on inward FDI. In that sense, the present study constitutes a contribution to the literature. Moreover, we use different measures of IPR in order to validate the results, and the extensive nature of the data allows for the testing of hypothesis that could previously only be partially performed.

Preliminary results show that, despite previous studies, stronger IPR led to lower levels of FDI in Chile during the 2001–2007 period. One of the main causes for the reversal of the results presented in Branstetter et al. (2007), for example, is that Chilean

firms have changed considerably in the last decade, increasing their imitative capabilities and being able to produce goods that were not previously produced by local firms.

When taking these factors into account, it is possible to test whether foreign firms have left the market since the reform. The results are consistent with the body of literature arguing that licensing overtakes FDI once an IPR threshold is reached.

The relevant IPR threshold and the effects of IPR reform on licensing do not depend entirely on the IPR level per se but depend most importantly on the level of development of the host country and its ability react to changes in IPR. Moreover, it is possible to examine whether spillover effects from foreign firms to domestic firms occurred after the reform and whether the remaining domestic firms benefitted from greater access to technology that could possibly be imitated.

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Appendix

A. FDI in Chile

Table 6: FDI by Economic Sector 1998-2007 Under DL600 (US Millions of dollars)

Sub-Sector/period	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Agriculture and fanning	13	21	23	10	2	0	0	1	3	1
Forestry and logging	38	16	4	1	1	1	0	7	17	108
Fishing and aquaculture	8	0	92	5	0	10	0	0	0	11
Coal mining	0	0	0	0	0	0	0	0	0	0
Petroleum and natural gas production	0	0	0	0	0	0	0	0	0	0
Metal ore mining	2,308	1,244	161	1,043	1,854	313	334	507	317	68
Other mining	161	92	73	94	149	80	16	82	809	236
Food, beverages and tobacco	67	407	44	273	29	55	56	186	70	20
Textiles and leather industries	6	19	4	4	2	0	18	1	0	0
Wood and wood products	30	24	27	7	12	6	1	3	2	7
Paper products, printing and publishing	56	23	2	51	37	119	81	1	2	16
Chemical, rubber and plastics	308	232	94	344	32	0	271	1	0	7
Non-Metallic mineral products	16	60	9	24	1	1	2	1	21	3
Basic metal industries	21	37	58	86	99	1	0	0	0	0
Metal products, machinery and equipment	27	30	14	19	6	1	0	6	0	16
Other manufacturing industries	1	0	0	3	0	0	0	0	0	0
Electricity, gas and steam	481	3,971	858	861	223	114	2,193	33	1,141	64
Water works and supply	14	569	1	47	250	36	0	65	65	105
Construction	279	211	29	164	138	29	119	8	9	2
Wholesale and retail trade	190	86	120	114	72	43	17	3	19	263
Restaurants and hotels	31	3	32	51	4	5	0	5	2	1
Transport and storage	132	26	15	35	5	55	24	55	172	16
Communication	91	388	856	1,246	331	283	1,402	515	65	66
Banking	393	787	189	60	31	13	0	7	13	84
Investment companies	391	143	74	40	16	28	7	105	107	110
Investment funds	0	0	2	13	3	3	1	4	3	2
Risk capital investment funds	8	0	0	0	0	0	0	12	1	5
Other financial services	29	20	8	8	9	0	3	5	0	47
Insurance	702	208	90	265	20	4	49	107	23	10
Real estate activities	37	24	8	21	3	0	19	7	57	13
Engineering and business services	69	26	66	60	39	21	15	55	93	71
Sewage, sanitation and similar services	20	471	2	3	1	1	0	2	0	0
Social and related community services	0	0	11	44	7	10	0	0	167	3
Recreation and cultural services	88	81	68	25	5	2	5	16	3	2
Other services	25	8	4	2	0	0	0	0	0	0
Total Manufacturing sector	530	833	253	812	218	184	430	199	95	69
As % of total	9.	9.	8.	16.	6.	15.	9.	11.	3.00	5.
Total per period	**6,038**	**9,229**	**3,039**	**5,023**	**3,381**	**1,236**	**4,637**	**1,799**	**3,181**	**1,359**

Table 7: Distribution of Firms according to Sector

!SIC rev.3 at 2-digit level	Observations	Description
15	11,217	Manufacture of food products and beverages
17	1,724	Manufacture of textiles
18	1,841	Manufacture of wearing apparel; dressing and dyeing of fur
19	938	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	2,432	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	1,050	Manufacture of paper and paper products
22	1,796	Publishing, printing and reproduction of recorded media
24	2,127	Manufacture of chemicals and chemical products
25	2,219	Manufacture of rubber and plastics products
26	1,913	Manufacture of other non-metallic mineral products
27	920	Manufacture of basic metals
28	2,567	Manufacture of fabricated metal products, except machinery and equipment
29	1,953	Manufacture of machinery and equipment n.e.c.
30	12	Manufacture of office, accounting and computing machinery
31	515	Manufacture of electrical machinery and apparatus n.e.c.
32	55	Manufacture of radio, television and communication equipment and apparatus
33	212	Manufacture of medical, precision and optical instruments, watches and clocks
34	512	Manufacture of motor vehicles, trailers and semi-trailers
35	323	Manufacture of other transport equipment
36	1,700	Manufacture of furniture; manufacturing n.e.c.

B. Descriptive Statistics and Results

Table 8: Descriptive Statistics (Tech Vs. Non-tech Firms)

Variable	Non-Tech Plants (33,620 plants)				Tech Intensive plants (2,406 plants)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Capital Stock	2255.	24182.	0	2.E+06	7593.	46920.	0	1.E+06
% Domesic Capital	96.	17.	0	100	81.	38.	0	100
% Foreign Capital	4.	17.	0	100	19.	38.	0	100
Value Added	2566.	21593.	-1.E+05	2.E+06	9848.	64529.	-6443.	2.E+06
Sale Of Production	4230.	27287.	0	2.E+06	15164.	1.E+05	0	2.E+06
License And Foreign Assistance	5.	83.	0	5578.	59.	497.	0	11864.
Income Due To Exports	1696.	17559.	0	1.E+06	2930.	20472.	0	4.E+05
Number of Skilled Workers	14.	56.	0	2691	22.	72.	0	1057
Skilled/Unskilled workers ratio	0.69	4.	0	287	0.97	5.	0	139
Skillid/Total workers ratio	0.24	0.3	0	1	0.24	0.29	0	1

Table 9: Foreign Presence and Licensing

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	fdikstock	fdikstock	fdikstock	license	license	license
WEF IPR. x Tech			-0.17*			0.
			(0.)			(0.)
Fraser IPR x Tech		-0.03***			0.11**	
		(0.)			(0.)	
Dummy IPR. x Tech	M.09***			0.31**		
	(0.)			(0.)		
Observations	748	748	748	748	748	748
R.-squared	0.74	0.74	0.74	0.88	0.88	0.87
Time Dummies	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Random Effects Probit

	(1)	(2)	(3)
Variables	owner	owner	owner
WEF IPR x Tech	0.84***		
	(0.)		
Fraser IPR x Tech		0.76***	
		(0.)	
Dummy IPR x Tech			0.70***
			(0.)
iprwef	0.73		
	(1.)		
iprf		-0.35***	
		(0.)	
] dipr			-0.69***
			(0.)
Real Exchange Rate	0.	M.04**	M.04**
	(0.)	(0.)	(0.)
Average Size	0.79***	0.80***	0.86*”
	(0.)	(0.)	(0.)
Inflation	0.	0.09	0.06
	(0.)	(0.)	(0.)
Observations	37,254	37,254	37,254
Number of id	8,287	8,287	8,287
Time Dummies	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1