

# Does Licensing Induce Technological Spillovers to Domestic Firms?

Luis Castro\*

Version: September 15, 2011

## **Abstract**

There is an unclear way in which foreign presence could affect domestic productivity. In the case of licensing, it is important to see how does licensing affects domestic plants in the same industry and in related industries. This is important because in contrast to pure Foreign Direct Investment (FDI), it is possible that there are spillover effects not only intra industry but also inter-industry. This should spread out the spillover effects that are due to foreign licensing in the economy.

Using Chilean plant level data for the 2001-2007 period I find that there are positive inter-industry effects which results in higher productivity for domestic plants. However, there are negative spillovers when the licensing is in done in the same industry. I also test for the effect of stronger Intellectual Property Rights finding that stronger IPR reduces intra-sector spillovers while increases inter-industry spillovers.

---

\*Department of Economics  
University of Colorado at Boulder  
Boulder, Colorado 80309-0256  
*E-mail address:* Luis.Castropenarrieta@colorado.edu

# 1 Introduction

Many authors have recognized that productivity differences can explain differences in economic growth across countries. Numerous studies have demonstrated the importance of technology transfer in order to reduce the productivity gap between developed and developing nations. As Montalvo and Yafeh (1994) note:

*“Japan’s economic growth in the postwar period has been characterized by a very rapid growth in productivity, achieved, to a great extent, through massive borrowing of technology from more advanced countries.”*

However, the best way to attract new technology into a developing country is not entirely clear. There are many channels that this phenomenon can use in order to reach the host country. Among others, Yasar and Morrison Paul (2007) identify FDI, exports, licensing and imports as possible channels of technology transfer from a Multinational Enterprise (MNE) to a host country. Moreover, the institutional framework of the host country is also key to attracting MNE’s presence. In this sense, Intellectual Property Rights (IPR) also play an important role regarding foreign presence in a country.

Therefore, it is important to analyze the effect of different modes of entry and also IPR on the productivity of firms - between and within industries. More specifically, foreign presence could affect *upstream* sectors (mainly the providers of inputs for a given industry) or *downstream* sectors (the buyers of production). If there is a large positive effect for either upstream or downstream industries, that can provide the grounds for a more open policy toward foreign presence (either through FDI or through licensing).

However, if the effect to other industries is small or there is a negative effect, then that could cause the country to be more restrictive in pursuing foreign presence since that would hurt domestic firms more than helping them. This issue is crucial in order to decide economic policy toward foreign presence in the country.

In order to analyze this, I use Chilean manufacturing data for the period 2001-2007. First I examine the effects of foreign presence in terms of FDI and licensing within and between manufacturing industries.

Then I introduce the IPR measure to see how does it affect the relationship and if there is any improvements in some transfer of technology once this change in IPR is implemented.

There are a lot of studies that have dealt with foreign presence and the linkages and spillover effects that could have into domestic firms. There are some studies at the industry level that find positive effects of Foreign Direct Investment (FDI) and productivity in the sector. On the other hand, most firm-level studies find a negative effect of FDI in the process of technology transfer within the same industry. Among the most important firm level studies are Aitken and Harrison (1999) which uses data from Venezuela, Javorcik (2004) with data from Lithuania, and Javorcik and Spatareanu (2008) which looks at Romania.

Some people argue that Foreign Direct Investment (FDI) is the most efficient way to transfer technology. Others would say that FDI harms domestic firms in the sense that they cannot have access to that technology because of proprietary rights over it.

The reasoning done by an MNE before choosing any of the channels to service a market abroad is extremely peculiar, depending in things like institutional context in the host country, complexity of the production process, imitative capacity of the host country, regulation, etc.

Moreover, since the MNE can choose the mode of entry into the host country, it is important to determine which channel best diffuses technology. For instance some countries have been notorious for having policies directed to attract FDI while others introduce policies to deter or reduce it.

This paper tries to analyze if there is diffusion of technology in Chile during the period 2001 to 2007. In this period there has been an important policy change regarding Intellectual Property Rights (IPR) in 2005, increasing its overall strength.

There are a few studies like this done in the past. The closest one in spirit being Lopez (2008). He analyzes the effects of licensing on productivity in Chile during 1990-1999. Another

influential study is the one done by Javorcik (2004) where she analyzes the effect of FDI on productivity through backward linkages.

An important contribution of this study is to validate and complement the previous study done by Lopez (2008). This can be achieved in three ways. First, the time frame of this study is more recent. This is important since Chile has been growing steadily in the last decade; thus, it is quite plausible that the imitative capabilities in the country have changed. Second, Lopez (2008) cannot include the change in IPR that occurred in 2005, which might affect the choice of entry mode of MNE's. Third, it is important to see the effect of licensing taking into account the type of industry where the firm is (high-tech vs. low-tech).

Moreover, to the best of my knowledge, aside Lopez (2008) there has been a lack of studies that pin down licensing as the source of spillovers that affect the productivity of firms. Specially in a case like Chile where it is the case that licensing is replacing FDI after the strengthening of IPR.

## 2 Related Literature

There are two strands of literature that are relevant for this study. First, studies that relate IPR reforms to licensing. The second strand is the effect of licensing on firm productivity as means of technology transfer.

Regarding the first strand, there are some empirical studies that reveal the importance of IPR strength on licensing.<sup>1</sup> Yang and Maskus (2001) study licensing by U.S. firms in 23 countries. They do not find a significant effect of IPR on licensing for affiliated firms, while they find a U-shaped relation for non-affiliated firms. That means that for low levels of IPR host countries have limited imitative capabilities, thus the *market power* effect would dominate while at higher levels of strength the *market expansion* effect would dominate.<sup>2</sup>

---

<sup>1</sup> Park (2008) reviews issues behind IPR strength and innovation.

<sup>2</sup> The market expansion effect refers to higher production (either through exports, sales, or licenses) in the foreign market since the technology being transferred is better protected. The market power refers to the fact that stronger IPR confers more market power to the MNE in the host country, reducing the level of production in the foreign market.

In another study, Smith (2001) examines the effect of foreign patent rights on U.S. exports, sales in the host country and licenses. The approach used is new since the effect of IPR on the three forms of decisions for the MNE (export, sales by affiliate, and licensing) are examined simultaneously. The data represents 50 countries in 1989.

Smith (2001) tests whether or not stronger IPR increase exports; sales via affiliate; or licenses in order to determine whether the *market expansion* or the *market power* effect is stronger. Another tests examined are whether strong IPR leads to transfer of knowledge to the host country and if the transfer of knowledge occurs within the same firm or not.<sup>3</sup>

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

Also, stronger IPR's increase the location advantage for the MNE since there is a larger effect in licenses than in affiliate sales. Thus, this would mean that it is possible that MNE's reduce the level of FDI and use licensing instead.

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. Also, 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.

Moreover, some studies focus on the effect of IPR on different modes of entry. Nicholson (2002) emphasizes that different IPR regimes affect industries in different ways. He points out that depending on the effect on the industry, MNE's will react by changing the mode of

---

<sup>3</sup> If sales done by the affiliate are highly affected by the reform, then the knowledge transfer occurs within the same firm while if the reform affects licenses, then the knowledge is given to an external firm.

entry to the host country. He concludes that firms with high risk of imitation will tend to enter through FDI; while firms with low risk will tend to license the production.

Saggi et al. (2005) propose a model in which MNE's have the choice to transfer technology through FDI or licensing. Increasing IPR raises the cost of imitation in the host country, thus, it increases both modes of entry. Moreover, they point out that increasing IPR's opens the possibility of higher levels of licensing since it is easier to enforce the contracts in place.

The second strand of literature is related to the effect of licensing on productivity. Kathuria (2000) stress the point that most studies that look at spillover effects might be underestimating the effect of foreign presence if they only take FDI as a channel of spillovers. They find positive spillover effects depending on the nature of the industry of the firm.

Alvarez et al. (2002) find that local spending on licensing has a high level of return. Thus, the "investment" done in licensing improved the performance and productivity of Chilean firms during the 1990's.

Moreover, as noted by Lopez (2008) the effects of licensing transcends to not only the same industry but also there are some interindustry effects. Therefore, it is important to account that the total spillover is not only in the same industry.

Javorcik (2004) presented a very important paper in order to understand the effect of multinational activity on interindustry spillovers. She studies FDI spillovers across industries. Using Lithuanian data, she examines the correlation of FDI in downstream industries (potential buyers) and in upstream industries (potential suppliers), thus providing evidence of vertical spillovers.

She finds positive spillover effects from FDI on upstream industries (backward linkages) but no significant evidence in downstream industries (forward linkages) nor in the same industry. The strategy that she proposes is quite innovative and is very close to the one used in this paper.<sup>4</sup>

Blalock and Gertler (2008) use Indonesian data to find that MNE's transfer technology to

---

<sup>4</sup> The estimation strategy in Lopez (2008) is closely related to the one used by Javorcik (2004). The strategy will be explained in detail.

suppliers in less developed countries (LDC). They also point out that the transfer of technology to upstream sectors has to be to the sector as a whole in order to prevent a hold-up problem.<sup>5</sup>

Moreover, if there is more technology in upstream sectors, then there is lower prices for inputs; which in turn increases the incentives for other firms to enter the sector. They find out that this increased competition results in lower prices in the sector and is thus Pareto improving.

More recently, Keller (2009) examine spillovers to U.S. firms through two channels: imports and FDI. They find that FDI leads to productivity gains for domestic firms. Moreover, they find that spillovers are stronger in high-tech sectors compared to low-tech sectors. They also find that small firms benefit more from FDI than larger firms.

As mentioned above, the closest study to this one is Lopez (2008), where he studies if plants benefit from foreign technology licensing by plants in either the same industry or other industries. He finds that licensing has a positive effect on productivity in upstream sectors, while it has a negative impact on downstream sectors.

Using Chilean data for 1990-1999, he estimates the effect of licensing on productivity using:

$$\log(TFP_{ijrt}) = \alpha_0 + \beta' \Theta_{jt} + \lambda' X_{ijrt-1} + \theta' Z_{jt} + \varepsilon_{ijrt} \quad (1)$$

Where  $i$  is the plant,  $j$  is the sector,  $r$  is the region and  $t$  is the time.  $\Theta_{jt}$  measures foreign licensing in the same industry  $S_{jt}$  and upstream  $U_{jt}$  and downstream  $D_{jt}$  industries.  $X_{ijrt-1}$  is a vector of controls (exporter, foreign owned, and level of licenses).  $Z_{jt}$  includes the Herfindahl index to control for concentration, the export to sales ratio of the sector and measures of foreign presence in the same industry as well in downstream industries and upstream industries.

Note that the measurement of each of these variables entails a lot of detail.  $\log(TFP_{ijrt})$  is calculated assuming a Cobb-Douglas production function using the value added  $y_{ijrt}$ , the

---

<sup>5</sup> The technology transfer cannot be to to the supplier alone becausee then the suplier could potentially benefit from charging higher prices to the MNE. Thus the technology has to be made widely available.

plant's capital stock  $k_{ijrt}$ , the number of non-production workers  $l_{ijrt}^{NP}$  and the number of production workers  $l_{ijrt}^P$ . Thus,  $\log(TFP_{ijrt}) = y_{ijrt} - (\alpha_1 k_{ijrt} + \alpha_2 l_{ijrt}^{NP} + \alpha_3 l_{ijrt}^P)$ . He estimates this using the semi-parametric method proposed by Olley and Pakes (1996).

In order to calculate the vector  $\Theta_{jt}$  he uses two methods, one uses the stock of licenses while the other uses the flow of licenses.<sup>6</sup>

$$\text{The flow variable is calculated as: } S_{jt}^F = \frac{\sum_{i \in j} Li_{ijt}}{\sum_{i \in j} Sales_{ijt}}$$

Where the assumption is that the larger the share of license payments, the potential spillover effect. The upstream and downstream variables are calculated as:

$$D_{jt}^F = \sum_{k, k \neq j} \alpha_{jk} S_{kt}^F$$

$$U_{jt}^F = \sum_{k, k \neq j} \sigma_{jk} S_{kt}^F$$

Where  $\alpha_{jk}$  is the proportion of sector  $j$  output supplied to sector  $k$ , while  $\sigma_{jk}$  is the share of inputs purchased by sector  $j$  from sector  $k$ .

Finally, the vector  $Z_{jt}$  includes measurements of foreign presence:

$$FDI \text{ Same Sector}_{jt} = \frac{\sum_{i \in j} Foreign \ Share_{ijt} * Y_{ijt}}{\sum_{i \in j} Y_{ijt}}$$

$$FDI \text{ Downstream Sector}_{jt} = \sum_{k, k \neq j} \alpha_{jk} * FDI \text{ Same Sector}_{kt}$$

$$FDI \text{ Upstream Sector}_{jt} = \sum_{k, k \neq j} \sigma_{jk} * FDI \text{ Same Sector}_{kt}$$

Moreover, since there could be plant unobserved characteristics he follows Javorcik (2004) and estimates equation (1) in first differences and also using instrumental variables.<sup>7</sup>

The results are reported in the appendix, he finds out that licensing in upstream sectors increases productivity of plants that purchase intermediate inputs from them; while there is a

<sup>6</sup> In this case only the flow method is described, for a detailed explanation of both methods see Lopez (2008).

<sup>7</sup> He also includes dummies for the sector, year and region. He takes into account the Moulton problem by clustering the error terms at the three digit sector-year level.

negative effect on the productivity of suppliers. The latter result is counterintuitive, and goes against previous results like Javorcik (2004) and Blalock and Gertler (2008) which is another reason why it is important to validate the results.

### 3 Data

The data comes from the Chilean *Encuesta Nacional Industrial Anual* (ENIA).<sup>8</sup> The survey is conducted by the Chilean National Statistics Institute (INE) and it covers all the establishments (plants) with ten or more workers. The years covered by this study are 2001 - 2007.

The unit of observation is the “establishment” (plant). There are many firms that are multi-plant and also multi-activity, but in order to preserve the statistical secrecy of those firms, the INE assigns one “establishment” ID to each plant of a given firm.

The original total number of plant-year observations was 37,307. However, some observations were purged due to different issues like major changes in the industry where the plant was producing or outliers. This leaves 36,775 plant-year observations in 111 industries. Another important feature of the data is that it provides with information related to the size of the plant, the industry classification (ISIC3 - 4 digit level), etc.

### 4 Empirical Approach

The empirical approach used in order to estimate the existence of spillovers from licensing will follow very closely the approach taken by Lopez (2008) since it is important to confirm the results obtained and also introduce the effect of a change in IPR in 2005.

The first step is to estimate productivity in order to evaluate changes in productivity due to licensing. In order to measure productivity, it is possible to use a semi-parametric method proposed by Olley and Pakes (1996) and later modified by Levinsohn and Petrin (2003) in order to

---

<sup>8</sup> This is a national survey of the manufacturing sector.

correct the simultaneity bias that arises when the firm knows its own productivity but it is unknown to the econometrician. Thus the first step is to estimate total factor productivity (TFP):

$$\log(TFP_{ijrt}) = y_{ijrt} - \alpha_1 k_{ijrt} - \alpha_2 l_{ijrt}^s - \alpha_3 l_{ijrt}^u \quad (2)$$

Where  $y_{ijrt}$  is the log of value added of the firm  $i$  in sector  $j$  and region  $r$  at time  $t$ ;  $k_{ijrt}$  is the log of capital stock; while  $l_{ijrt}^s$  and  $l_{ijrt}^u$  are the logs of the number of skilled and unskilled workers respectively.

After estimating equation (2) we can go back and re-estimate equation (1) for the new period of data. As noted by Lopez (2008), some other issues have to be taken into account. There could be firm-level time-invariant characteristics that are not captured and make some firms more productive. Thus it is necessary to estimate the equation in first differences. Moreover other effects affecting the spillover effects should be controlled by including a set of industry and region dummy variables and a time trend.

Also, there could be some endogeneity problem (more productive sectors spend more on licensing). Thus we need to use Instrumental Variables (IV); the three licensing variables are instrumented with their first and second lags. The final issue that we have to correct the standard errors because of the possibility of underestimating standard errors due to the estimation with firm-level data but including sector varying variables.

It is important to note that there are crucial differences in the estimation when compared to Lopez (2008). First, the estimation of productivity is done for each 2-digit industry instead of each 3-digit industry. The results are robust to changing to a specification with 3-digit industry but some industries are dropped due to insufficiency of observations. Second, the input-output table used in the calculation of the backward and forward coefficients is the 2003 input-output table.

## 5 Preliminary Results

The results are presented in the tables in the appendix. There are four tables that show the estimations for a given model using four different estimation techniques. Each of the four tables depicts the results of estimating equation (1) using Pooled OLS, Pooled OLS in first differences (FD); Panel Instrumental Variables (IV) and Panel Instrumental Variables in first differences.

Table 1 is the re-estimation of the results obtained by Lopez (2008) (see the appendix). The first difference with his results is that there is a strong negative effect of licenses in the same sector on the productivity of firms. This can be explained by the fact that licenses normally hinder the diffusion of technology within the same sector of the economy. A typical example of this effect is licensing in the pharmaceutical sector.

Moreover, when looking at the fourth regression (Panel IV in first differences) there is also a positive effect of licenses in upstream sectors - in line with the results from Lopez (2008). This means that firms in the upstream sector become more efficient and are able to provide inputs for downstream sectors at lower prices or better quality, making firms in downstream sectors more productive.

Another important difference with Lopez (2008) is that foreign presence has a positive effect in the same sector and has a negative effect if it is in upstream sectors. The former can be explained by better imitative characteristics in Chilean firms that might not have been there in the earlier study. The latter shows the *market power* effect that some MNE's could have in the economy; providing inputs at higher prices and thus reducing the productivity of downstream firms.

Table (2) presents the estimation with the inclusion of the Fraser IPR measure. The results confirm the signs found in table (1). More importantly, when looking at the effect of licensing in downstream sectors, it is now positive and significant. This is a result that also contradicts the findings by Lopez (2008). This result reflects the fact that an IPR measure is included because the presence of stronger IPR, means that it is possible for firms to allow for more

technology diffusion to upstream sectors with the certainty that there is better protection for that knowledge with the implementation of IPR measures. This is also reflected by the significance in the interaction term of the IPR measure and the license in downstream sectors.

Table (3) presents results fairly similar to the ones in table (2). One important difference is that the interaction term for the dummy variable and the license in the same sector is negative and significant, meaning that after the reform, there was less spillovers within the same industry, which is a result that we would expect. The other important result is that the interaction term between the dummy IPR and licenses in the upstream sector is positive, meaning that after the reform, it is possible that the *market expansion* effect is larger than the *market power* effect.

## A Lopez (2008) Results

Table 5. *Productivity spillovers from foreign technology licensing*

|                                 | Licenses all plants—stock |                     |                    | Licenses all plants—flow |                    |                    |
|---------------------------------|---------------------------|---------------------|--------------------|--------------------------|--------------------|--------------------|
|                                 | OLS (1)                   | FD (2)              | FD-IV (3)          | OLS (4)                  | FD (5)             | FD-IV (6)          |
| Licenses same sector (S)        | -0.119<br>(3.06)**        | -0.047<br>(1.66)*** | -0.035<br>(0.79)   | 0.005<br>(0.40)          | -0.012<br>(0.95)   | -0.022<br>(1.26)   |
| Licenses downstream sectors (D) | -0.133<br>(2.84)**        | -0.185<br>(4.62)**  | -0.228<br>(5.19)** | 0.002<br>(0.05)          | -0.141<br>(4.65)** | -0.248<br>(5.92)** |
| Licenses upstream sectors (U)   | -0.035<br>(0.53)          | 0.578<br>(6.11)**   | 0.764<br>(6.48)**  | -0.055<br>(1.44)         | 0.237<br>(5.63)**  | 0.400<br>(6.01)**  |
| Herfindahl index                | -0.071<br>(1.31)          | -0.277<br>(6.01)**  | -0.277<br>(6.13)** | -0.130<br>(2.28)*        | -0.275<br>(5.50)** | -0.277<br>(5.64)** |
| FDI same sector                 | 0.008<br>(1.60)           | -0.003<br>(0.67)    | -0.002<br>(0.33)   | 0.012<br>(2.12)*         | -0.005<br>(1.00)   | -0.002<br>(0.43)   |
| FDI downstream sectors          | 0.031<br>(0.78)           | -0.015<br>(0.38)    | 0.024<br>(0.59)    | 0.030<br>(0.67)          | -0.064<br>(2.20)*  | 0.023<br>(0.58)    |
| FDI upstream sectors            | 0.013<br>(0.34)           | 0.229<br>(4.11)**   | 0.177<br>(3.01)**  | 0.046<br>(1.20)          | 0.363<br>(6.64)**  | 0.327<br>(5.46)**  |
| Exports sector                  | 0.032<br>(1.07)           | -0.042<br>(1.04)    | -0.015<br>(0.33)   | -0.004<br>(0.14)         | -0.075<br>(2.01)*  | -0.045<br>(1.09)   |
| Exporter dummy                  | 0.462<br>(16.43)**        | -0.013<br>(0.77)    | -0.012<br>(0.70)   | 0.466<br>(16.51)**       | -0.017<br>(0.98)   | -0.016<br>(0.94)   |
| Foreign ownership dummy         | 0.259<br>(9.50)**         | 0.050<br>(1.28)     | 0.051<br>(1.31)    | 0.278<br>(9.97)**        | 0.050<br>(1.27)    | 0.052<br>(1.29)    |
| Licenses/sales                  | 1.613<br>(7.48)**         | 1.345<br>(2.76)**   | 1.346<br>(2.77)**  | 3.866<br>(2.37)*         | 0.494<br>(1.52)    | 0.465<br>(1.41)    |
| R-squared                       | 0.517                     | 0.098               | 0.096              | 0.515                    | 0.087              | 0.079              |
| Number of observations          | 33,821                    | 26,740              | 26,740             | 33,821                   | 26,740             | 26,740             |

Absolute value of  $t$  statistics in parentheses. \*\*, \*, \*\*\*: significant at 1%, 5%, and 10%. Three-digit sector, region, and year dummy variables were included but not reported. Standard errors were clustered at the sector-year level.

## B Preliminary Results

Table 1: Spillover Effects of Licensing

| Independent variable: log (TFP) | (1)<br>Pooled OLS   | (2)<br>Pooled OLS FD | (3)<br>Panel IV    | (4)<br>Panel IV FD |
|---------------------------------|---------------------|----------------------|--------------------|--------------------|
| Licenses same sector (S)        | -12.46***<br>(0.73) | -0.09<br>(0.37)      | -2.16***<br>(0.51) | -2.74***<br>(0.88) |
| Licenses downstream sectors (D) | 7.32***<br>(0.46)   | 0.20<br>(0.31)       | 1.00***<br>(0.38)  | 1.18<br>(0.77)     |
| Licenses upstream sectors (U)   | 31.04***<br>(1.18)  | -0.06<br>(0.65)      | 2.29***<br>(0.78)  | 3.32**<br>(1.36)   |
| FDI same sector                 | 0.05***<br>(0.01)   | 0.01<br>(0.00)       | 0.01**<br>(0.01)   | 0.01**<br>(0.01)   |
| FDI downstream sectors          | -0.02***<br>(0.00)  | -0.00**<br>(0.00)    | -0.01**<br>(0.00)  | -0.00*<br>(0.00)   |
| FDI upstream sectors            | -0.06**<br>(0.02)   | -0.01<br>(0.01)      | -0.02*<br>(0.01)   | -0.02**<br>(0.01)  |
| Foreign Ownership               | 0.66***<br>(0.04)   | 0.07<br>(0.05)       | 0.41***<br>(0.04)  | 0.07<br>(0.06)     |
| Market presence                 | 0.88***<br>(0.02)   | -0.06**<br>(0.02)    | 0.28***<br>(0.02)  | -0.07***<br>(0.03) |
| Herfindal Index                 | 0.00***<br>(0.00)   | 0.00***<br>(0.00)    | 0.00***<br>(0.00)  | 0.00***<br>(0.00)  |
| Licenses/Sales                  | 2.16<br>(1.33)      | -0.31<br>(0.39)      | 0.23<br>(0.79)     | -0.35<br>(1.21)    |
| Exports/Sales                   | -0.00**<br>(0.00)   | -0.00<br>(0.00)      | -0.00<br>(0.00)    | 0.00<br>(0.00)     |
| Observations                    | 16,818              | 11,721               | 9,771              | 6,431              |
| R-squared                       | 0.94                | 0.02                 |                    |                    |
| Trend & Interaction Terms       | YES                 | YES                  | YES                | YES                |
| Industry and Region Dummies     | YES                 | YES                  | YES                | YES                |
| Number of id                    |                     |                      | 3,193              | 2,430              |

Robust standard errors in parentheses

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table 2: Spillover Effects with Fraser IPR Measure

| Dependent variable: log (TFP)          | (1)<br>Pooled OLS   | (2)<br>Pooled OLS FD | (3)<br>Panel IV    | (4)<br>Panel IV FD |
|--|---------------------|----------------------|--------------------|--------------------|
| Licenses same sector (S)               | -12.62***<br>(0.97) | -0.05<br>(0.42)      | -1.79***<br>(0.52) | -2.71***<br>(0.87) |
| Licenses downstream sectors (D)        | 9.52***<br>(0.68)   | 0.45<br>(0.39)       | 1.76***<br>(0.59)  | 1.95**<br>(0.87)   |
| Licenses upstream sectors (U)          | 27.86***<br>(1.57)  | -0.45<br>(0.71)      | 1.38*<br>(0.80)    | 2.75**<br>(1.31)   |
| FDI same sector                        | 0.05***<br>(0.01)   | 0.01<br>(0.01)       | 0.01<br>(0.01)     | 0.01*<br>(0.01)    |
| FDI downstream sectors                 | -0.01**<br>(0.01)   | -0.00*<br>(0.00)     | -0.00<br>(0.01)    | 0.00<br>(0.00)     |
| FDI upstream sectors                   | -0.06**<br>(0.02)   | -0.01<br>(0.01)      | -0.02<br>(0.01)    | -0.02**<br>(0.01)  |
| IPR Fraser x License same sector       | -0.02<br>(0.23)     | -0.05<br>(0.07)      | 0.10<br>(0.14)     | 0.04<br>(0.11)     |
| IPR Fraser x License downstream sector | -1.00***<br>(0.21)  | -0.09<br>(0.08)      | -0.30<br>(0.21)    | -0.27*<br>(0.16)   |
| IPR Fraser x License upstream sector   | 1.47***<br>(0.40)   | 0.22*<br>(0.12)      | 0.15<br>(0.18)     | 0.22<br>(0.15)     |
| Foreign Ownership                      | 0.66***<br>(0.04)   | 0.07<br>(0.05)       | 0.41***<br>(0.04)  | 0.07<br>(0.06)     |
| Market presence                        | 0.88***<br>(0.02)   | -0.06**<br>(0.02)    | 0.28***<br>(0.02)  | -0.08***<br>(0.03) |
| Herfindal Index                        | 0.00***<br>(0.00)   | 0.00***<br>(0.00)    | 0.00***<br>(0.00)  | 0.00***<br>(0.00)  |
| Licenses/Sales                         | 2.11<br>(1.34)      | -0.31<br>(0.39)      | 0.22<br>(0.79)     | -0.33<br>(1.21)    |
| Exports/Sales                          | -0.00***<br>(0.00)  | -0.00<br>(0.00)      | 0.00<br>(0.00)     | 0.00<br>(0.00)     |
| Observations                           | 16,818              | 11,721               | 9,771              | 6,431              |
| R-squared                              | 0.94                | 0.02                 |                    |                    |
| Trend and Interaction Terms            | YES                 | YES                  | YES                | YES                |
| Industry and Region Dummies            | YES                 | YES                  | YES                | YES                |
| Number of id                           |                     |                      | 3,193              | 2,430              |

Robust standard errors in parentheses

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table 3: Spillover Effects with Dummy IPR Measure

| Dependent variable: log (TFP)         | (1)<br>Pooled OLS   | (2)<br>Pooled OLS FD | (3)<br>Panel IV    | (4)<br>Panel IV FD |
|---------------------------------------|---------------------|----------------------|--------------------|--------------------|
| Licenses same sector (S)              | -12.16***<br>(0.92) | -0.28<br>(0.41)      | -4.63***<br>(1.16) | -2.94***<br>(1.03) |
| Licenses downstream sectors (D)       | 3.95***<br>(0.80)   | -0.02<br>(0.37)      | 1.48*<br>(0.85)    | 0.80<br>(1.07)     |
| Licenses upstream sectors (U)         | 34.85***<br>(1.58)  | 0.61<br>(0.72)       | 6.50***<br>(1.61)  | 5.07***<br>(1.58)  |
| FDI same sector                       | 0.05***<br>(0.01)   | 0.01<br>(0.00)       | 0.02***<br>(0.01)  | 0.02**<br>(0.01)   |
| FDI downstream sectors                | -0.01***<br>(0.00)  | -0.00*<br>(0.00)     | -0.01**<br>(0.01)  | -0.00<br>(0.00)    |
| FDI upstream sectors                  | -0.06**<br>(0.02)   | -0.01<br>(0.01)      | -0.03***<br>(0.01) | -0.03**<br>(0.01)  |
| Dummy IPR x License same sector       | 0.54<br>(0.70)      | -0.15<br>(0.23)      | -1.91***<br>(0.62) | -0.70*<br>(0.36)   |
| Dummy IPR x License downstream sector | -3.49***<br>(0.71)  | -0.24<br>(0.27)      | 0.53<br>(0.69)     | -0.17<br>(0.56)    |
| Dummy IPR x License upstream sector   | 3.67***<br>(1.20)   | 0.61*<br>(0.36)      | 3.09***<br>(0.82)  | 1.66***<br>(0.49)  |
| Foreign Ownership                     | 0.66***<br>(0.04)   | 0.07<br>(0.05)       | 0.41***<br>(0.04)  | 0.07<br>(0.06)     |
| Market presence                       | 0.88***<br>(0.02)   | -0.06**<br>(0.02)    | 0.28***<br>(0.02)  | -0.08***<br>(0.03) |
| Herfindal Index                       | 0.00***<br>(0.00)   | 0.00***<br>(0.00)    | 0.00***<br>(0.00)  | 0.00***<br>(0.00)  |
| Licenses/Sales                        | 2.11<br>(1.34)      | -0.31<br>(0.39)      | 0.19<br>(0.79)     | -0.37<br>(1.20)    |
| Exports/Sales                         | -0.00***<br>(0.00)  | -0.00<br>(0.00)      | -0.00*<br>(0.00)   | 0.00<br>(0.00)     |
| Observations                          | 16,818              | 11,721               | 9,771              | 6,431              |
| R-squared                             | 0.94                | 0.02                 |                    |                    |
| Trend and Interaction Terms           | YES                 | YES                  | YES                | YES                |
| Industry and Region Dummies           | YES                 | YES                  | YES                | YES                |
| Number of id                          |                     |                      | 3,193              | 2,430              |

Robust standard errors in parentheses

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

## References

- Aitken, B. J. and Harrison, A. E. (1999). Do domestic firms benefit from direct foreign investment? evidence from venezuela. *The American Economic Review*, 89(3):605–618.
- Alvarez, R., Crespi, G., and Ramos, J. (2002). The impact of licenses on a "Late starter" LDC: chile in the 1990s. *World Development*, 30(8):1445–1460.
- Blalock, G. and Gertler, P. J. (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics*, 74(2):402421.
- Branstetter, L. G., Fisman, R., and Foley, C. F. (2006). Do stronger intellectual property rights increase international technology transfer? empirical evidence from US Firm-Level panel data\*. *Quarterly Journal of Economics*, 121(1):321–349.
- Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? in search of spillovers through backward linkages. *The American Economic Review*, 94(3):605–627.
- Javorcik, B. S. and Spatareanu, M. (2008). To share or not to share: Does local participation matter for spillovers from foreign direct investment? *Journal of Development Economics*, 85(1-2):194217.
- Kathuria, V. (2000). Productivity spillovers from technology transfer to indian manufacturing firms. *Journal of International Development*, 12(3):343–369.
- Keller, W. (2009). International trade, foreign direct investment, and technology spillovers. *National Bureau of Economic Research Working Paper Series*, No. 15442.
- Levinsohn, J. and Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies*, 70(3):317341.
- Lopez, R. A. (2008). Foreign technology licensing, productivity, and spillovers. *World Development*, 36(4):560–574.
- Montalvo, J. G. and Yafeh, Y. (1994). A microeconomic analysis of technology transfer: The case of licensing agreements of japanese firms. *International Journal of Industrial Organization*, 12(2):227–244.

- Nicholson, M. W. (2002). Intellectual property rights, internalization, and technology transfer. *SSRN eLibrary*.
- Olley, G. S. and Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*, 64(6):1263–1297. ArticleType: research-article / Full publication date: Nov., 1996 / Copyright 1996 The Econometric Society.
- Park, W. G. (2008). Intellectual property rights and international innovation. *Frontiers of Economics and Globalization*, 1.
- Saggi, K., Maskus, K. E., and Puttitanum, T. (2005). *Patent rights and international technology transfer through direct investment and licensing*. International Public Goods and the Transfer of Technology under a Globalized Intellectual Property Regime, Cambridge University Press.
- Smith, P. J. (2001). How do foreign patent rights affect U.S. exports, affiliate sales, and licenses? *Journal of International Economics*, 55(2):411–439.
- Yang, G. and Maskus, K. E. (2001). Intellectual property rights, licensing, and innovation in an endogenous product-cycle model. *Journal of International Economics*, 53(1):169–187.
- Yasar, M. and Morrison Paul, C. J. (2007). International linkages and productivity at the plant level: Foreign direct investment, exports, imports and licensing. *Journal of International Economics*, 71(2):373–388.