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Abstract

Foreign direct investment is claimed to positively affect firms in the host country through a number of growth-enhancing effects, generally termed "productivity spillovers." However, the empirical evidence for developing economies is quite controversial. This paper investigates the impact of foreign acquisition on the performances of a sample of Slovenian manufacturing firms subject to takeover in 1997. The "propensity score-matching" estimation technique, also combined with the "difference-in-differences" approach, is used with the purpose of controlling for the potential bias arising from the non-random selection of acquired firms. Our analysis confirms that foreign investors acquire only the most productive firms, while finds no convincing evidence that the performances of such firms improve in the post-acquisition period as a result of foreign acquisition.

Keywords: Foreign acquisition, productivity, propensity score, matching estimator.
JEL Classification: F23, D21, C14

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1 Introduction

Over the last twenty years, developing countries have increasingly opened their economies to foreign direct investment (FDI). Especially, in the 1990s FDI has become the main source of external financing for developing economies, largely overshadowing other capital flows like official development assistance, portfolio flows and commercial banks loans (UNCTAD, 2004). Most importantly, the relevance of developing countries as FDI recipients has significantly increased compared to the past: according to UNCTAD (2001), the number of developing countries receiving an annual average of more than $1 billion rose from 6 in the mid-1980s to 23 at the end of the 1990s.

Governments in the emerging markets offer a number of incentives to foreign investors like reduced income taxes, import duty exemptions and subsidies for infrastructures [see Blomström and Kokko (2003) for a discussion on FDI incentives]. By encouraging FDI, these countries hope to enjoy those benefits extolled by a boundless literature and generally called "productivity spillovers" [see Blomström and Kokko (1998)]. These benefits include technology transfer through imitation and labour turnover, efficiency gains spurred by competition and other growth-enhancing effects like "market access spillovers."

Despite the presence of a diffused optimism towards the effects of FDI, empirical evidence on spillovers is still mixed and sometimes inconclusive. Past studies focus on intra-industry spillovers, finding a positive correlation between foreign presence and labour productivity in a given sector [see, for instance, Caves (1974); Globerman (1979); Blomström and Persson (1983)]. However, these studies neglect to tackle an important selection problem: FDI may in fact gravitate towards the most productive sectors rather than being the cause of their higher productivity. More recent studies on spillovers make use of detailed microdata (firm or plant-level datasets) to control for the different attractiveness of the sectors to foreign investors [see, for example, Haddad and Harrison (1993); Aitken, Harrison and Lipsey (1995); Aitken and Harrison (1999)]. These studies find either the absence of horizontal spillovers from FDI (that is, spillovers from foreign firms to domestic firms operating in the same sector) or the existence of negative spillovers, thus casting doubts on the beneficial effects of foreign capital in developing countries.[1] Nonetheless, the selection problem may show up at the firm level:

[1] According to Aitken and Harrison (1999), for example, a "market stealing" effect may arise if foreign firms increase production and monopolise local markets, drawing demand from domestic firms. Other firm-level studies casting doubts on the presence of FDI-related spillovers are Djankov and Hoekman (2000), and Konings (2001).

it is logical to think that foreign investors monitor carefully firms' performances, and acquire only the most productive establishments. Neglecting to take this non-random selection process into account may result in potential bias of the empirical estimates of the impact of foreign acquisition.

This paper is aimed at measuring the impact of foreign acquisition on the economic performances of a sample of Slovenian manufacturing firms acquired in 1997. The performances studied, which include total factor productivity (TFP) growth, output growth and employment growth, are observed in the two years immediately following takeover. The impact of foreign capital, referred to as the causal effect of foreign acquisition, is represented by the difference between the average performance of acquired firms and the average performance the same firms would have experienced had they not been acquired. Since the latter is not observable [this is the so called "evaluation problem" (see Blundell and Costa Dias (2000, 2002)], we need to infer it from the observed performance of those firms which remain domestically owned.

In a natural experiment, we could consider acquired firms as those randomly drawn from the entire population of firms. In this case, the difference between the average performance of the acquired firms and that of those staying domestically owned would provide us with the correct measure of the causal effect of foreign acquisition. However, the selection problem discussed above may be plaguing our dataset: the firms acquired in 1997 by foreign investors may in fact be those presenting higher productivity levels before takeover took place. In this case, using the available information on domestic firms to estimate the hypothetical performance of acquired firms had they not been acquired may lead to a biased estimation of the causal effect of foreign acquisition.

To deal with the selection problem discussed above, we follow the "evaluation strategy" [see Blundell and Costa Dias (2000, 2002)] and use the "matching" estimation technique [see Heckman, Ichimura and Todd (1997, 1998)]. This technique aims at re-establishing the conditions for a random experiment by constructing a new sample in which each firm (either acquired or domestic) is a potential target of the foreign investor. It is done by selecting, from the set of firms staying domestically owned, those firms with the same probability of being acquired by foreign investors as that of the acquired firms. This probability, called the "propensity score" [see Rosenbaum and Rubin (1983)], is a function of the firms' observable pre-acquisition characteristics. These characteristics, which summarise the productivity structure of the firms, hopfully capture the preference of foreign investors for some firms rather than others. The selected firms constitute the counterfactual needed to construct the hypothetical performance trajectories of acquired firms had they not been acquired, and thus correctly measure the causal effect of foreign acquisition. Empirical results are also improved by combining the matching approach with the "difference-in-differences" (DID) estimation technique, as suggested by Blundell and Costa Dias (2000, 2002).

The rest of the paper is organised as follows. Section 2 illustrates the empirical methodology, namely the matching and the combined matching-DID estimation approaches. Section 3 presents the dataset and describes the two samples used in the analysis. Section 4 proceeds to building the counterfactual group by using the matching technique. Section 5 shows the empirical results from the matching and the combined matching-DID approaches. Finally, section 6 concludes.

2 Empirical methodology

The main issue is the measurement of the impact (the "causal effect") of foreign acquisition on the performance (or outcome) y for any firm i in the population of interest. Let us assume acquisition has taken place at t, and the performance $y_{i,t+s}$ is observed for each firm i in the post-acquisition period $t+s$ (with $s>0$). The causal effect of foreign acquisition is then given by

$$\alpha_{i,t+s} = y^1_{i,t+s} - y^0_{i,t+s} \tag{1}$$

where $y^1_{i,t+s}$ is the performance observed if firm i is foreign owned at time period $t+s$, and $y^0_{i,t+s}$ that if the same is domestically owned. The measurement of $\alpha_{i,t+s}$ is obviously complicated by a missing-data problem, since both the performances cannot be observed simultaneously for each firm. Hence, following the evaluation strategy [see Heckman, Ichimura and Todd (1997)], we estimate the causal effect at the subpopulation level. We thus define the average effect of the treatment on the treated (ATT) as

$$\begin{aligned} ATT &= E(\alpha_{i,t+s}|d_i = 1) = E\left(y^1_{i,t+s} - y^0_{i,t+s}|d_i = 1\right) \qquad (2)\\ &= E\left(y^1_{i,t+s}|d_i = 1\right) - E\left(y^0_{i,t+s}|d_i = 1\right) \end{aligned}$$

where d_i is an indicator of the treatment status, that is, a dummy variable taking value 1 if firm i has been acquired at t, and 0 otherwise. ATT represents the expected impact of foreign acquisition on a firm from the acquired group.

The term $E\left(y^0_{i,t+s}|d_i = 1\right)$ in equation (2) represents the average performance of acquired firms had they not been acquired, which is clearly a hypothetical outcome. Constructing a valid counterfactual for this term and using it to estimate ATT is the basic concern of the evaluation strategy. The central issue in our context is whether we can use the average outcome observed for firms which remained domestically owned, $E\left(y^0_{i,t+s}|d_i = 0\right)$, as the required counterfactual. If our dataset was the result of a pure randomised social experiment, the firms subject to takeover would be those randomly chosen by foreign investors. In this case, d_i would be statistically independent of $y^0_{i,t+s}$, and thus $E(y^0_{i,t+s}|d_i = 0)$ could be used in the place of $E(y^0_{i,t+s}|d_i = 1)$ to estimate ATT.[2] Unfortunately, it is unlikely that foreign investors choose randomly which firms to acquire. As we already discussed, FDI is generally attracted by those firms characterised by higher levels of productivity.

The approach used here to deal with the selection problem is the matching methodology, which is aimed at re-establishing the conditions for a random experiment in case non-experimental datasets are available.[3] The key assumption of matching is that the differences in the outcomes between acquired firms and firms which remained domestically owned are captured by a vector of observable pre-acquisition characteristics. Once we control for such observables, the outcome in the untreated status is independent of program partecipation, and the difference in the average outcomes between acquired and domestic firms gives back the genuine effect of foreign acquisition.[4]

The matching approach proceeds by pairing each acquired firm with a domestically-owned firm presenting similar pre-acquisition characteristics, thus reflecting a similar productivity structure. Since it is almost impossible in practice to match firms on the basis of a number of covariates higher than one (the "curse of dimensionality"), we follow the solution proposed by Rosenbaum and Rubin (1983), and match firms by using a single index, the "propensity score." The propensity score is the probability of a firm being acquired by a foreign investor conditional on a set of characteristics X_i observed at $t-1$:

[2] In fact, the assumption that d_i is statistically independent of $y^0_{i,t+s}$ implies that $E\left(y^0_{i,t+s}|d_i = 1\right) = E\left(y^0_{i,t+s}|d_i = 0\right)$, which means the absence of selection bias.

[3] Alternative methods to account for the selection problem are the Instrumental Variables estimator and the Heckman two-step estimator. However, both of them are more demanding on the assumptions at the bottom of the model.

[4] This assumption is known as the CIA (Conditional Independence Assumption) and is generally expressed as $(y^0_{i,t+s} \perp d_i)|X_{i,t-1}$. It is also called "selection on the observables."

$$p(X_{i,t-1}) = P(d_i = 1|X_{i,t-1}) \quad (3)$$

Matching is practically implemented by pairing each acquired firm i with the domestic firm j presenting the closest propensity score. In this way, a valid counterfactual (C) for the acquired group (A) is built by means of the available observations on domestic firms. Hence, ATT is empirically estimated as the difference between the mean performance of the acquired firms and the (weighted) mean performance of those firms included in the counterfactual group:

$$A\hat{T}T_M = \sum_{i \in A} \left(y_{i,t+s} - \sum_{j \in C} W_{ij} y_{j,t+s} \right) w_i \quad (4)$$

where W_{ij} is the weight placed on the firm j used as the counterfactual for the acquired firm i, and w_i accounts for the reweighting that reconstructs the distribution of the outcome for the treated sample.[5]

The matching estimator described above solves the evaluation problem by assuming that selection is on the observables. However, this solution does not take into account selection on the unobservables. When longitudinal data are available, we can combine the matching estimator with the difference-in-differences (DID) estimator to partially take this problem into account, as suggested by Blundell and Costa Dias (2000). The combined matching-DID estimator is given by

$$A\hat{T}T_M^{DID} = \sum_{i \in A} \left((y_{i,t+s} - y_{i,t-n}) - \sum_{j \in C} W_{ij} \left(y_{j,t+s} - y_{j,t-n} \right) \right) w_i \quad (5)$$

where $t - n$ is a pre-programme period (with $t - n < t < t + s$).[6] This estimator accounts for unobservable determinants of the selection process as long as they concern firm and time-specific effects affecting the outcomes. Such effects, in fact, cancel out in sequential differences.

[5] In practice, w_i is equal to the ratio of one to the number of acquired firms, while the value of W_{ij} depends on the number of domestic firms we match to each acquired firm. In the "single nearest neighbour matching," for example, each acquired firm is matched with one domestic firm, and therefore W_{ij} is equal to one. When the propensity score of one acquired firm and that of its potential counterfactual are not very similar, matching can be performed with replacement (that is, one domestic firm is used as the counterfactual for more acquired firms), in which case W_{ij} is greater than one. In the "kernel matching," all the domestic firms are used as counterfactuals for each acquired firm, and W_{ij} is a kernel weight that accounts for the closeness of the propensity score of i to that of each j.

[6] In this case, the assumption of conditional independence is stated as $(y^0_{i,t+s} - y^0_{i,t-n} \perp d_i)|X_{i,t-1}$. Note that ATT^{DID}_M in (5) measures the causal effect in period $t + s$.

3 Data description and construction of the sample

The dataset used here is provided by the William Davidson Institute, Michigan, at the University of Michigan Business School. It consists of a large unbalanced panel (22,466 observations) of 6,020 Slovenian manufacturing firms observed over the time interval 1994-1999.[7] Despite the availability of such an inclusive dataset, not all the observations in the file can be used, mainly due to data limitations and to technical issues related to the Olley and Pakes (1996) methodology used to calculate TFP.[8] The final dataset includes only two types of firms, where each type is defined according to the ownership status over the interval 1995-1999. According to this five year-based criterion, we identify:

- Domestic firms (DOMs): firms which stay domestically owned over the interval 1995-1999;
- Switching firms (SWs): firms switching status in year 1997 from domestically owned to foreign owned (that is, domestically owned in 1995 and 1996, acquired by foreigners in 1997, and staying foreign owned in 1998 and 1999).[9]

We can view these observations as a cross-section of firms in 1997, for which we dispose of the performances (growth rates of TFP, output and employment) in the two post-acquisition periods 1998 and 1999 (that is, we set $t = 1997$ and $s = 1, 2$ in equation (2)). Also, we have detailed information on some firms' characteristics for the years 1995 and 1996. This approach is different from other previous works, which carry out the analysis on a panel basis [see, for example, Girma, Kneller and Pisu (2003); Barba Navaretti and Castellani (2003)]. We do not proceed to a panel analysis due to the strong unbalancedness of the acquisition phenomenon in Slovenia, which is almost absent in years other than 1997.

[7]The file consists of statistics mainly drawn from three different sources. The official financial records of the firms provide data on the capital stock, material inputs, and revenues from domestic and foreign sales. The Slovenian Business Register includes information on the year the firm initiated production and the firm's ownership structure. Finally, data on the number of employees for each firm come from the Public Pension Fund.

[8]Data limitations concern missing values for some variables of interest and the impossibility to retrieve the 2-digit NACE sector for some firms. On the other hand, the Olley and Pakes algorithm requires investment to be strictly positive, and thus negative values have to be dropped from the dataset. Also, the investment variable cannot be calculated for 1994, since data on capital assets refers to the stock reported at the end of the year. More detailed explanations on this methodology can be found in Appendix A.

[9]A firm is defined as foreign owned if 10% or more of its equity share is owned by a foreign investor. In this paper, we use the terms "acquired firms" and "switching firms" as synonyms.

Nonetheless, the use of a five-year based classification criterion to define SWs offers some advantages. First of all, we can observe the change in Slovenian firms' performances for two consecutive years following acquisition. Since spillovers need time to materialise, observing a single post-acquisition period may not be enough to capture the real effects of FDI, leading to misleading conclusions on the impact of foreign acquisition. Furthermore, in unbalanced panel data analysis the composition of the group of switching firms changes every year, and consequently the performance trajectories are built by means of annual averages computed using different firms in each year. This makes difficult to interpret and generalise the empirical results to all the acquired firms. On the contrary, in our analysis the average performance trajectories and the post-acquisition effects are calculated for a fixed set of switching firms. Our classification criterion has another advantage compared to most of the studies on the issue, which neglect to consider the history of the firm previous to takeover.[10] Attributing the status of switching firms to only those firms that were domestically owned during the two years preceding acquisition, we reduce residual influences, where they exist, of previous foreign ownerships.[11]

Although firms are classified as SWs and DOMs on a five year-based criterion, not all the needed information is available for each of the five years. Many firms defined as SWs present in fact missing values for some variables in 1995. Hence, in order to exploit at the best our dataset, we decompose it into two samples, and base the analysis on both of them. The first sample, Sample 1 henceforth, contains only those firms with non-missing observations on the variables in levels (log values) over the interval 1996-1999. This time period is long enough to perform matching on the pre-acquisition characteristics of each firm ($X_{i,t-1}$ in equation (3)) by means of a probit estimation, and for calculating the growth rates of variables in two post-acquisition periods (growth rates for 1998 and 1999). The second sample, Sample 2 henceforth, is obtained by considering only those firms in Sample 1 for which the variables in levels are also available for 1995, so that the growth rates for 1996 can be computed, and the combined matching-DID estimator in equation (5) can be implemented. Table 2 summarises the composition of Sample 1 and Sample 2 by ownership type.

[10] In fact, whereas Barba Navaretti and Castellani (2003) make sure that each firm switches status for the first time at t, other studies generally consider the acquisition at time t as analogue to a "first" takeover.

[11] It may happen that some switching firms were foreign owned in 1994. However, the privatisation process in Slovenia is quite recent a phenomenon. According to Orazem and Vodopivec (2003), the privatisation process (and so foreign ownership) started to be underway by 1991 for small firms, and began in earnest 1994 for large state enterprises. Hence, the existence of a previous ownership in 1994 is not expected to affect significantly our results.

Table 2: Number of firms by ownership type

Ownership type	Sample 1	Sample 2
Domestically owned firms (DOMs)	952	678
Switching firms in 1997 (SWs)	28	19
Total	1,005	713

4 Finding the appropriate counterfactual

The first step to implement the matching technique exposed in section 2 is to calculate the probability of each Slovenian firm being acquired in 1997 based on some observable characteristics in 1996. This probability is the propensity score given by equation (3). It is calculated by means of the following probit model:

$$\mathrm{P}(\mathrm{d}_{i,1997}{=}1){=}\mathrm{F}(\mathrm{TFP}_{i,1996},\ \mathrm{Exp\ int}_{i,1996},\ \mathrm{Age}_{i,1996},\ \mathrm{Size}_{i,1996},\ \mathrm{D}_s)$$

where F is a standard normal cumulative distribution function, and its arguments are some potential firm-level determinants of foreign acquisition. TFP_i is firm's total factor productivity, which according to the "operating efficiency" theory is positively related to the probability of acquisition [see McGuckin and Nguyen (1995), and Harris and Robinson (2002)]. $\mathrm{Exp\ int}_i$ is firm's export intensity, as measured by the ratio of firm exports to total sales. As reminded by Girma, Kneller and Pisu (2003), this variable is used by potential investors to infer the level of a firm's productivity when explicit information on productivity is unobservable or observed only with error.[12] Age_i is the difference between 1996 and the year the firm is established. Three different measures of size (capital assets, the number of employees and the number of plants) are included in the probit estimation.[13] Finally, we use two-digit industry dummies (D_s) to account for the different attractiveness of the sectors to foreign investors.

[12] Export firms are found to be more productive than non export ones [see Bernard and Jensen (1999); Girma, Greenaway and Kneller (2002)]. They are also likely to be more similar to foreign acquirers, this implying lower costs of assimilation in the post-acquisition period.

[13] Eddey (1991) argues that aggressive corporate raiders may find large firms attractive, since they would increase the value of their "personal empire." On the contrary, according to Palepu (1986), the probability of a firm being acquired decreases as its size becomes larger. A large size, in fact, entails high transaction costs, including the cost of integrating the firm into the structure of the acquiring firm.

Table 3: Probit for the probability of switching in 1997

Variable	Sample 1		Sample 2	
	Coefficient	(std. err.)	Coefficient	(std. err.)
(Log) TFP_{1996}	1.1655***	(0.3989)	2.4320***	(0.7707)
Export $intensity_{1996}$	1.2783***	(0.3732)	1.0691**	(0.4983)
(Log) Age_{1996}	-0.5827***	(0.1830)	-0.5477**	(0.2184)
(Log) Capital $assets_{1996}$	0.0288	(0.0873)	0.2264	(0.1576)
(Log) N. of $employees_{1996}$	0.0420	(0.1109)	-0.0557	(0.1720)
(Log) N. of $plants_{1996}$	0.1014	(0.2243)	0.0143	(0.2479)
Sector dummies	Yes		Yes	
N. of observations	802		494	
Pseudo R-squared	0.2045		0.2725	

***: significant at 1%; **: significant at 5%.

Table 3 shows the results of the probit estimation for both Sample 1 and Sample 2.[14] The results reported in the table confirm that foreign investors acquired the most productive firms, since the coefficients are highly significant for the variables TFP and Exp int.[15] Furthermore, the age of the firm turns out to be inversely related to the probability of the same being acquired.[16] This result may be explained resorting to the argument that young firms have a more flexible structure than old ones, and can therefore be more easily (that is, at lower costs) incorporated in the organisation of the acquiring firm. The variable capital assets, measuring the size of the firm, is not significant, and so are the other variables capturing scale effects (number of plants or employees). Finally, the probability of changing status from domestic to foreign owned also depends on the sector in which the firm operates: the coefficients of the sectorial dummies (not reported) are significant for manufacturing of chemicals, chemical products and man-made fibres, manufacturing of rubber and plastic products, manufacturing of transport equipment, manufactoring of electrical and optical equipment and manufacturing

[14]The results refer to those firms for which the computer package calculated the probability of a positive outcome. There are 802 firms (774 DOMs and 28 SWs) showing a positive probability in Sample 1, and 494 firms (475 DOMs and 19 SWs) in Sample 2.

[15]Girma and Görg (2002) find that high productivity growth increases the probability of takeover. We tried to use the growth rates of TFP instead of log(TFP) in the probit estimation, but the variable turned out to be not significant.

[16]The same result has been obtained by Girma and Görg (2002), who find that the probability of takeover increases for younger and larger (in terms of capital assets) firms, although in a non-linear way.

of other non-metal mineral products.

Now that we have found the propensity score for each firm, we can proceed to the second step, which consists of pairing each acquired firm with one (or more) domestic firm(s) with a similar propensity score. In this way, the counterfactual group C is constructed and used to recover the causal effect by means of the estimators presented in equation (4) and (5). Different types of matching estimators can be used for this purpose. Asymptotically, these different types produce the same results, but in small samples the type used can make a difference.

The nature of the datasets used is crucial in determining the most appropriate version of the matching estimator. In general, if domestic firms were many compared to acquired ones, and were also evenly distributed across them, pairing each acquired firm with more than one domestic firm (multiple matching) would allow for using a richer dataset, thus reducing the variance of ATT.

Fig. 2(a) and Fig. 2(b) show the frequency distributions of the propensity score for domestic and acquired firms in Sample 1 and Sample 2, respectively.

Figure 2(a): Frequency distribution of the propensity score by ownership type (Sample 1)

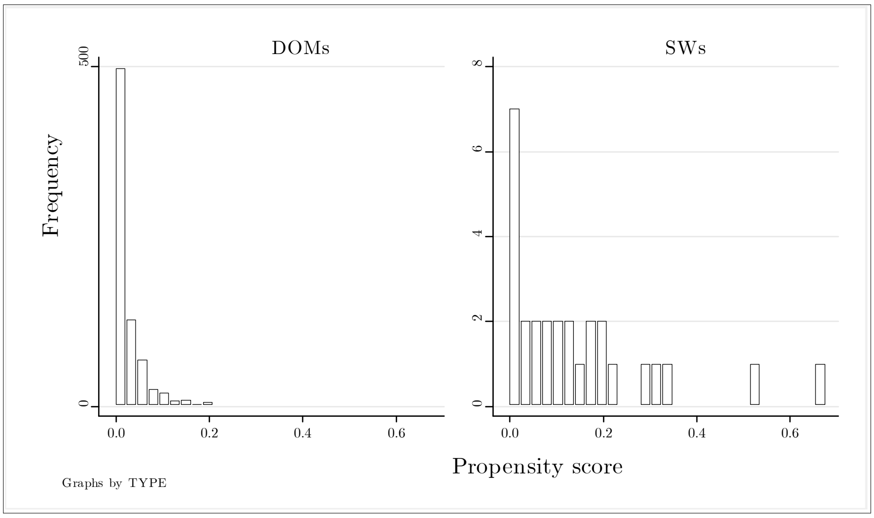
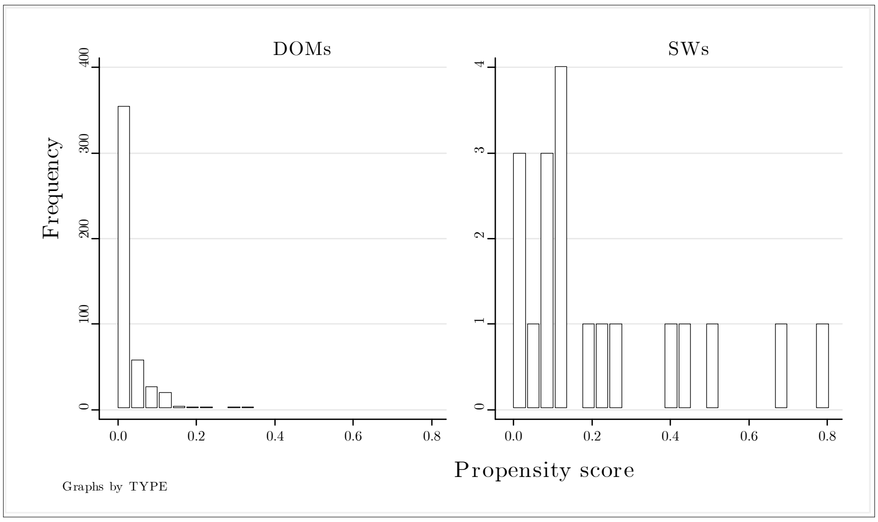


Figure 2(b): Frequency distribution of the propensity score by ownership type (Sample 2)



It is clear from the graphs that the two samples present an uneven distribution of the domestic firms across the switching firms. While the acquired firms with propensity scores close to zero potentially have many comparison firms to be matched with, the number of domestic firms to use as counterfactuals for each switching firm decreases as the value of the propensity score gets higher.[17] Hence, in order to avoid many bad matches, we prefer using single nearest neighbour matching rather than multiple nearest neighbour matching.[18]

The already small number of switching firms to be used in this work is furtherly reduced, due to the accuracy in the choice of the counterfactuals. Unfortunately, in fact, some acquired firms

[17]Not only acquired firms with higher propensity scores have very few potential comparison firms to be matched with. These potential comparison firms also turn out to be poor candidates for the purpose of matching. In fact, the difference between the propensity score of each acquired firm and that of its closer counterfactual tends to increase as the value of the propensity score increases, as we can see from the values of PS_{diff} and $\frac{\mathrm{PS}_{diff}}{\mathrm{PS}_{sw}}$ in the next Tables 4(a) and 4(b).

[18]We also have the option to match each acquired firm i with a domestic firm j only if the difference in their propensity scores falls within a pre-defined range ξ. This method, called "Caliper matching," and its "Radius matching" variant (in which more domestic firms are used as counterfactuals) are also excluded because they would imply the discretionary imposition of a value of ξ higher than 0.0062 to exploit a reasonable number of switching firms. This would allow for extremely bad matches for acquired firms with propensity scores close to zero (again, see the next Table 4(a) and 4(b)). Estimates obtained with the kernel-based matching have also been used to exploit better that part of the dataset in which the symmetry of data holds. However, the results are not reported because they are never statistically significant.

do not have a good match with any domestic firm, and therefore we decide to drop them from the dataset. The matching procedure finds a match for 26 switching firms in Sample 1 and for 13 switching firms in Sample 2. However, since matching has been performed with replacement, two switching firms have been paired to the same domestic firm in Sample 1. Therefore, the counterfactal group (COUNTs) in Sample 1 ends up with a total of 25 domestically owned firms.

Table 4(a) and Table 4(b) report the statistics on the propensity score for those firms, in Sample 1 and Sample 2, respectively, involved in single nearest neighbour matching. In the first column of each table, switching firms are sorted in descending order by propensity score, and the correspondent values of their propensity score (PS_{sw}) are shown in the second column. The third column shows the propensity score for the domestic firm matched with each acquired firm (PS_{count}). In the fourth column, we specify whether the switching firm falls within the common support region.[19] The fifth column reports the absolute value of the difference between the propensity score of each acquired firm and that of its domestic counterfactual, denoted by PS_{diff}. The sixth column shows the ratio of this difference to the propensity score PS_{sw}. This ratio, expressed as a percentage, represents the range of variation allowed to the propensity score of each acquired firm to find its domestic counterfactual. For example, in Table 4(a) acquired firm 1 is paired to a domestic firm whose propensity score is 0.95% greater than its own propensity score.

We can see from the tables that, in terms of the propensity score, we find a very good counterfactual for all of the switching firms in Sample 1 and Sample 2. In fact, the value of $\frac{\mathrm{PS}_{diff}}{\mathrm{PS}_{sw}}$ is generally very small, with the highest value being 2.80, which is reasonably low.[20]

[19] The common support region is the set of observables simultaneously observed among acquired and domestic firms. The Stata command "PSMATCH2" imposes a common support by dropping the acquired firms whose propensity score is higher than the maximum or less than the minimum propensity score of the domestic firms [see Leuven and Sianesi (2003)].

[20] We also performed the test proposed by Rosenbaum and Rubin (1985) to calculate the bias reduction resulting from single nearest neighbour matching for the variables included in the probit estimation. The results of the test (not reported) confirm that the matching process makes the likeness between the two groups (DOMs and SWs) more marked, reducing the unbalancedness for all the variables except Log (N. of plants).

Table 4(a): Single nearest neighbour matching (Sample 1)

SW firm identifier	PS_{sw}	PS_{count}	On comm. support	PS_{diff} (abs. value)	$\frac{PS_{diff}}{PS_{sw}}$ (%)
1	0.0037	0.0038	Yes	0.000035	0.95
2	0.0048	0.0048	Yes	0.000004	0.09
3	0.0093	0.0092	Yes	0.000086	0.92
4	0.0175	0.0175	Yes	0.000011	0.06
5	0.0205	0.0204	Yes	0.000116	0.56
6	0.0210	0.0210	Yes	0.000018	0.09
7	0.0222	0.0221	Yes	0.000099	0.45
8	0.0384	0.0384	Yes	0.000013	0.03
9	0.0439	0.0437	Yes	0.000151	0.34
10	0.0652	0.0657*	Yes	0.000522	0.80
11	0.0655	0.0657*	Yes	0.000188	0.29
12	0.0710	0.0709	Yes	0.000080	0.11
13	0.0861	0.0854	Yes	0.000618	0.72
14	0.0985	0.0994	Yes	0.000917	0.93
15	0.1142	0.1139	Yes	0.000359	0.31
16	0.1211	0.1214	Yes	0.000258	0.21
17	0.1358	0.1326	Yes	0.003216	2.37
18	0.1510	0.1553	Yes	0.004229	2.80
19	0.1782	0.1791	Yes	0.000908	0.51
20	0.1868	0.1881	Yes	0.001241	0.66
21	0.1919	0.1918	Yes	0.000045	0.02
22	0.2063	0.2055	Yes	0.000825	0.40
23	0.2299	0.2357	Yes	0.005758	2.50
24	0.2950	0.2911	Yes	0.003906	1.32
25	0.3049	0.3111	Yes	0.006171	2.02
26	0.3453	0.3538	Yes	0.008513	2.47
27	0.5191	0.4295	No	0.089629	17.27
28	0.6544	0.4295	No	0.224869	34.36

* The same domestic firm has been matched with two acquired firms

Table 4(b): Single nearest neighbour matching (Sample 2)

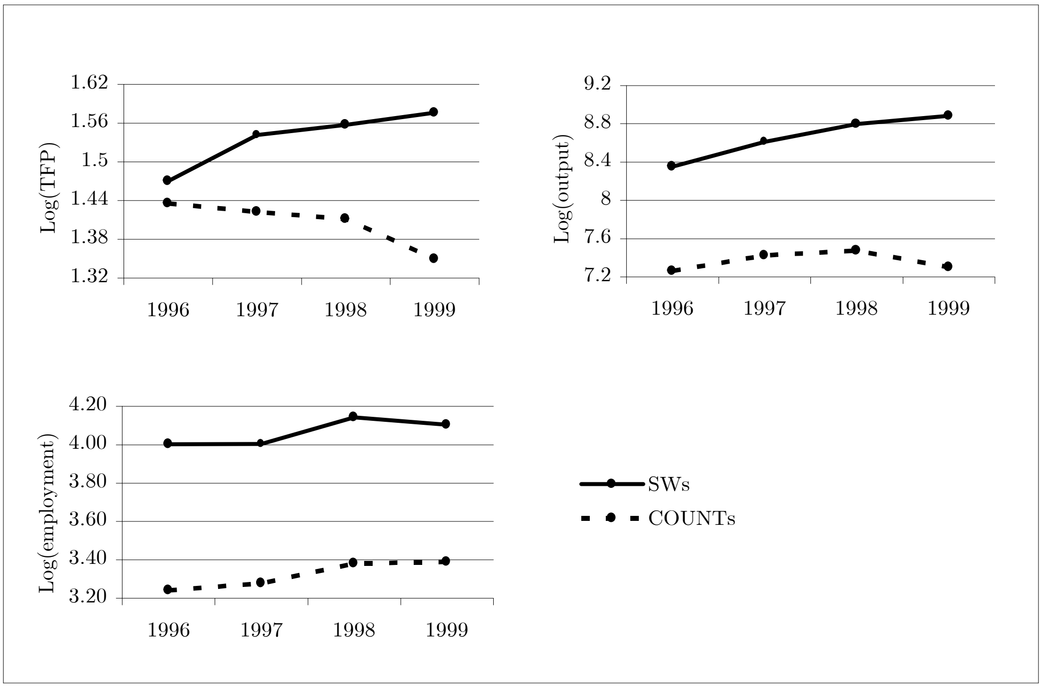
SW firm identifier	PS_{sw}	PS_{count}	On comm. support	PS_{diff} (abs. val.)	$\frac{PS_{diff}}{PS_{sw}}$(%)
1	0.0030	0.0030	Yes	0.000016	0.53
2	0.0046	0.0046	Yes	0.000012	0.26
3	0.0104	0.0104	Yes	0.000042	0.41
4	0.0444	0.0442	Yes	0.000265	0.60
5	0.0746	0.0745	Yes	0.000121	0.16
6	0.0759	0.0761	Yes	0.000141	0.19
7	0.0866	0.0872	Yes	0.000610	0.70
8	0.1059	0.1081	Yes	0.002197	2.07
9	0.1174	0.1176	Yes	0.000156	0.13
10	0.1319	0.1325	Yes	0.000605	0.46
11	0.1366	0.1365	Yes	0.000155	0.11
12	0.1788	0.1740	Yes	0.004715	2.64
13	0.2119	0.2001	Yes	0.011844	5.59
14	0.2490	0.2305	Yes	0.018569	7.45
15	0.3917	0.3440	Yes	0.047699	12.18
16	0.4560	0.4527	No	0.003277	0.72
17	0.4915	0.4527	No	0.038779	7.89
18	0.6816	0.4527	No	0.228871	33.58
19	0.7721	0.4527	No	0.319341	41.36

5 Empirical results

In this section, we summarise the basic results obtained from the matching estimation for Sample 1 and from the combined matching-DID estimation for Sample 2.[21] For what concerns Sample 1, the only estimate of the causal effect ($A\hat{T}T_M$) which is statistically significant relates to output growth in the second post-acquisition period. $A\hat{T}T_M$ calculated in 1999 is in fact equal to 0.27, with a standard error of 0.12. The causal effect of foreign takeover is therefore significant at the 5% significance level.

[21] These results are extensively reported in Appendix B by Tables B.1, B.2 and B.3.

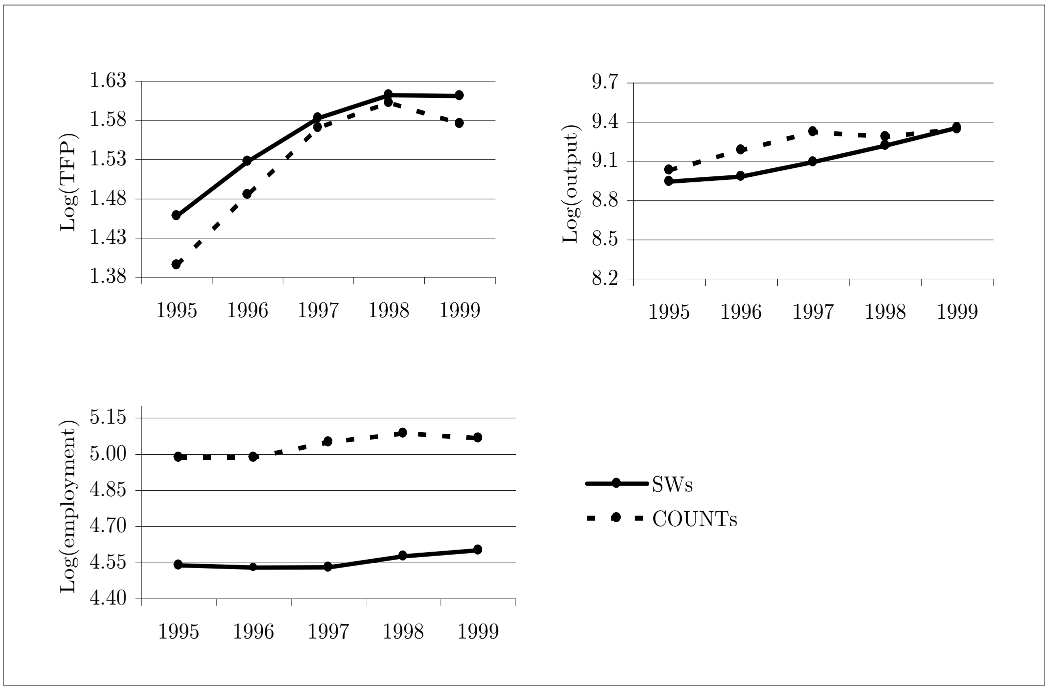
Figure 3: Average trajectories of TFP, output and employment for the matched Sample 1



It means that output growth in 1999 for firms subject to foreign acquisition in 1997 (SWs) would have been 27% lower if the same firms had not been acquired by foreign investors. Figure 3 shows the average performance trajectories of SWs and those of COUNTs. The latter are a proxy for the hypothetical trajectories acquired firms would have experienced had they not been acquired. We have to note that the value of the causal effect on output growth for 1999 calculated as a simple difference-in-means (difference between the average output growth for SWs and the average output growth for DOMs) is only 6%. Therefore, the presence of selection bias in our dataset leads to underestimate the causal effect of foreign acquisition on output growth by 21%.

The results for Sample 2 show that the only significant estimate of the causal effect is obtained for output growth in 1998. Here, the combined matching-DID estimator (ATT_M^{DID}) is equal to 0.28, with a standard error of 0.15. Therefore, it is statistically significant at the 10% significance level. It means that output growth in 1998 for firms acquired in 1997 (SWs) would have been 28% lower if the same firms had not been acquired by foreign investors. The average performance trajectories for the matched Sample 2 are reported in Figure 4.

Figure 4: Average trajectories of TFP, output and employment for the matched Sample 2



In this case, the value of the causal effect on output growth for 1998 calculated as a simple difference-in-means (difference between the average output growth for SWs and the average output growth for DOMs) is only 12.3%. Therefore, the presence of selection bias leads to underestimate the causal effect of foreign acquisition on output growth by 15.7%.

6 Conclusions

There are good reasons to believe that local firms in developing countries enjoy productivity spillovers from the presence of FDI [Blomström and Kokko (1998)]. Nonetheless, empirical evidence on spillovers casts some doubts on this claim. In fact, using detailed microdata (firm or plant-level datasets), some recent studies find either the absence of horizontal spillovers from FDI or the existence of negative spillovers [see Haddad and Harrison (1993); Aitken, Harrison and Lipsey (1995); Aitken and Harrison (1999); Djankov and Hoekman (2000); Konings (2001)]. The sore point of these studies is related to the possibility that empirical results are plagued by a selection problem. FDI is in fact expected to be attracted by the most productive firms or plants, this biasing the estimates of the impact of FDI.

This paper uses firm-level data on Slovenian manufacturing firms with the purpose of measuring the causal effect of foreign acquisition on the performances of those firms subject to takeover in 1997. We control for the non-random selection of domestic firms by foreign investors following the "evaluation literature." Specifically, we employ the "matching" and the "difference-in-differences" estimators suggested by Heckman, Ichimura and Todd (1997, 1998) and Blundell and Costa Dias (2000, 2002), respectively.

Our findings confirm that foreign investors are likely to acquire the most productive Slovenian firms, that is, those with higher values of TFP and export propensity. With regard to the causal effect of foreign acquisition, we find that it is statistically significant for output growth in 1998 and 1999. Particularly, output growth in 1998 for firms subject to foreign acquisition in 1997 would have been 28% lower if the same firms had not been acquired by foreign investors. In 1999, the causal effect amounts to 27%. However, the impact of foreign acquisition is not statistically significant for TFP growth and employment growth in the two years following takeover. Hence, our analysis does not lend a strong support to the argument that FDI is beneficial to the host developing countries' economic growth through productivity-enhancing effects.

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Appendix A - TFP calculation

We estimate firm's productivity following the methodology developed by Olley and Pakes (1996). This is a semiparametric estimation approach that solves the simultaneity bias problem (endogeneity of input demand) without having to rely on instrumental variables (IV).[22] Hence, it turns out to be a useful tool in the case good instruments are not available.

The simultaneity problem can be explained as follows. Let us assume that each industry produces a homogeneous product with a Cobb-Douglas technology. The production function has the form

$$Y_{it} = A_{it} L_{it}^{\alpha_l} K_{it}^{\alpha_k} M_{it}^{\alpha_m} \tag{A.1}$$

where Y_{it} represents the output (real sales), L_{it} is the labour input (number of employees in the firm), K_{it} the real value of capital assets, M_{it} the real value of material inputs, and A_{it} is the total factor productivity (TFP), known in the economic literature as the Solow residual. The subscript i indexes firm, while t indexes time. Taking the logarithms of both sides of equation (A.1), we obtain:

$$\log Y_{it} = \log A_{it} + \alpha_l \log L_{it} + \alpha_k \log K_{it} + \alpha_m \log M_{it} \tag{A.2}$$

Equation (A.2) can be easily estimated by

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_k k_{it} + \alpha_m m_{it} + u_{it} \tag{A.3}$$

where the lower-case letters are used for logarithms, and $\log A_{it}$ has been decomposed into a constant, α_0, and an error term, u_{it}. The simultaneity problem is that during the current year at least a part of the TFP, say a part of u_{it} in (A.3), can be observed by the firm early enough to modify its decision on the amount of inputs to use for producing output. For example, more productive firms will probably demand more labour to increase production. This positive correlation between labour and productivity will lead to upward-biased coefficients on labour when estimating the above equation by OLS.[23] Basically, firms which face a large

[22]The Olley and Pakes (1996) methodology also allows to control for the bias due to selection. Althought selection is an important aspect characterising transition process of Slovenian firms (less productive firms are replaced by those with higher productivity), we cannot use this option due to the impossibility to distinguish between firms exiting the dataset because of liquidation or due to the fact that they have not been surveyed in a given year.

[23]See Levinsohn and Petrin (2003) on the bias in the coefficient estimates of the production function.

productivity shock may respond by increasing the amount of inputs, which would yield upward-biased estimates of the variable input coefficients and consequently would produce a biased measure of the TFP.[24]

At the beginning of each period the firm chooses the amount of variable factors to use and the level of investment to carry out. Together with the current capital, the latter determine the capital stock at the beginning of the next period. Hence, the capital law of motion is given by

$$K_{i,t+1} = (1 - \delta)K_{it} + I_{it} \tag{A.4}$$

where I_{it} is the level of investment at the beginning of period t, and δ is capital depreciation rate.[25]

Therefore, each firm modifies its input demand according to the level of the observed productivity (hereafter ω_{it}). Consequently, equation (A.3) can be rewritten as

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_k k_{it} + \alpha_m m_{it} + \omega_{it} + e_{it} \tag{A.5}$$

where u_{it} has been disaggregated into two elements: ω_{it}, representing that part of productivity observed by firm i at time t (but not observable by the econometrician), and e_{it}, an i.i.d. component which may denote measurement error or a productivity shock not forecastable during the period in which labor can be adjusted. The important difference between the two terms is that the former is a state variable in the decision problem of the fims. Hence, it affects input demand, while the latter does not.

Several solutions to the simultaneity bias problem have been proposed by the recent empirical literature. A simple way to get rid of the bias generated by the correlation between ω_{it} and the inputs is to assume that the productivity shock is firm-specific and invariant over time, that is, $\omega_{it} = \omega_i$. The fixed-effect (FE) transformation will then lead to consistent estimates of the parameters. However, the FE estimator can be criticised in that it uses only the across time variation, which is generally much lower than the cross section one. Also, the underlying

[24] In the present context, labour and materials are considered as variable factors, meaning that they can be influenced by the current value of ω_{it}. On the other hand, capital is considered as a fixed factor, in the sense that it can only be affected by the distribution of ω_{it} conditional on information at time $t-1$ and past values of ω_{it}.

[25] The depreciation rate in Slovenian manufactoring generally varies between 10 and 15 % according to the sector of interest [see De Loecker and Konings (2004)]. Due to the impossibility to individuate a specific rate for each sector, we use an average value of 12,5 % for all the industries, which seems to be a good approximation. This average rate has been used to obtain the values for investment by equation (A.4).

assumption that productivity is time-invariant is often considered unrealistic.

Mainly due to this reason, and to difficulties in finding good instruments to solve the simultaneity problem with the IV procedure, the use of the semiparametric estimation method proposed by Olley and Pakes (1996) is gaining popularity. The insight of this method is that the unobserved component of TFP can be modelled as a function of some observed variables. More exactly, the authors assume that the investment decision can be formalised as a function of productivity and capital:

$$i_{it} = i_{it}(\omega_{it,} k_{it}) \tag{A.6}$$

Provided that investment is a monotonically increasing function in its arguments, we can invert the investment decision given by (A.6).[26] Therefore, the unobservable productivity can be expressed as a function of two observables, namely capital and investment:

$$\omega_{it} = h_{it}(i_{it,} k_{it}) \tag{A.7}$$

Using (A.7), equation (A.5) can be rewritten as

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_k k_{it} + \alpha_m m_{it} + h_{it}(i_{it,} k_{it}) + e_{it} \tag{A.8}$$

which is the equation to be estimated in the first stage of the procedure. Since $h_{it}(i_{it,} k_{it})$ is an unknown function, the coefficient on capital cannot be estimated at this stage.

Now let us define

$$\phi_{it}(i_{it,} k_{it}) = \alpha_0 + h_{it}(i_{it,} k_{it}) + \alpha_k k_{it} \tag{A.9}$$

Using (A.9), equation (A.8) can be rewritten as

$$y_{it} = \alpha_l l_{it} + \alpha_m m_{it} + \phi_{it}(i_{it,} k_{it}) + e_{it} \tag{A.10}$$

We estimate equation (A.10) by means of a partially linear model, using a third-order polynomial expansion in log-investment and log-capital to approximate the unknown function $\phi_{it}(i_{it,} k_{it})$.[27] Hence, we can obtain consistent estimates for the free inputs, namely labour and

[26] Pakes (1994, Theorem 27) shows that monotonicity of i_{it} holds only if investment is strictly positive, that is $i > 0$. Hence, all the data on investment which present a negative sign or that are equal to zero have to be dropped from the database. This implies a drastic reduction in the number of observations.

[27] The polynomial expansion is given by: $\phi_{it}(i_{it}, k_{it}) = \sum_{q=0}^{3} \sum_{s=0}^{3-q} \nu_{qs} k_{it}^q i_{it}^s$

materials, respectively given by $\hat{\alpha}_l$ and $\hat{\alpha}_m$. We can also obtain the estimate of the polynomial expansion, ϕ_{it}, in the following way:

$$\hat{\phi}_{it} = y_{it} - \hat{\alpha}_l l_{it} - \hat{\alpha}_m m_{it} - \hat{e}_{it} \tag{A.11}$$

This expression will turn out to be useful later on. Now we have to consider the expectation of $y_{i,t+1} - \hat{\alpha}_l l_{i,t+1} - \hat{\alpha}_m m_{i,t+1}$, given by

$$\begin{aligned} E[y_{i,t+1} - \hat{\alpha}_l l_{i,t+1} - \hat{\alpha}_m m_{i,t+1} | k_{i,t+1}] &= \\ &= \alpha_0 + \alpha_k k_{i,t+1} + E[\omega_{i,t+1} | \omega_{i,t}] \\ &= \alpha_k k_{i,t+1} + g(\omega_{it}) \end{aligned} \tag{A.12}$$

Assuming that $\omega_{i,t}$ is serially correlated, we can write $\omega_{i,t+1}$ as a function of $\omega_{i,t}$, with $\xi_{i,t+1}$ being the innovation at time $t+1$.[28] Replacing ω_{it} with the expression for $h_t(i_{it,} k_{it})$ that we obtain from equation (A.8), we have

$$y_{i,t+1} - \hat{\alpha}_l l_{i,t+1} - \hat{\alpha}_m m_{i,t+1} = \alpha_k k_{i,t+1} + g(\phi_{it}(i_{it,} k_{it}) - \alpha_k k_{i,t}) + \xi_{i,t+1} + \eta_{i,t+1} \tag{A.13}$$

The unknown function $g(\phi_{it} - \alpha_k k_{i,t})$ in (A.13) can be approximated by a third order polynomial expansion in $(\hat{\phi}_{it} - \alpha_k k_{i,t})$, where $\hat{\phi}_{it}$ is given by (A.11). Hence, we can write equation (A.12) as follows:

$$y_{i,t+1} - \hat{\alpha}_l l_{i,t+1} - \hat{\alpha}_m m_{i,t+1} = \alpha_k k_{i,t+1} + \sum_{r=0}^{3} \beta_r (\hat{\phi}_{it} - \alpha_k k_{i,t})^r + e_{i,t} \tag{A.14}$$

Equation (A.14) constitutes the second stage of the Olley and Pakes procedure, allowing to obtain a consistent estimate of the coefficient on capital, $\hat{\alpha}_k$. The above equation is estimated by nonlinear least squares.

Finally, once we have consistently estimated all input coefficients of the production function, the term $\log A_{it}$ in (A.2) capturing firm productivity can be residually calculated as

$$\log(TFP) = y_{it} - \hat{\alpha}_l l_{it} - \hat{\alpha}_m m_{it} - \hat{\alpha}_k k_{it}$$

[28]The function $g(\omega_{it})$ in Equation (A.12) has a complex representation. For a better understanding of the mathematical passages, see Olley and Pakes (1996).

Appendix B - Results from matching and DID estimation

Table B.1: Post-acquisition effects of foreign takeover (Sample 1) matching estimates ($\hat{ATT}_M$) for 1998 and 1999

Growth rate		1998		1999	
Group		SWs	COUNTs	SWs	COUNTs
N. of observations		26	25	26	25
TFP growth	Mean	0.0156	-0.0141	0.0191	-0.0652
	$\hat{ATT}_M$	0.0297		0.0843	
	(Std. err.)§	(0.0582)		(0.0674)	
Output growth	Mean	0.1844	0.0353	0.0862	-0.1882
	$\hat{ATT}_M$	0.1491		0.2744**	
	(Std. err.)§	(0.1503)		(0.1182)	
Empl. growth	Mean	0.1383	0.0995	-0.0390	0.0090
	$\hat{ATT}_M$	0.0388		-0.0481	
	(Std. err.)§	(0.0825)		(0.1185)	

§ Standard errors are calculated by means of bootstrapping technique (200 replications);

** ATT is significant at 5%.

Table B.2: Post-acquisition effects of foreign takeover (Sample 2) combined matching - DID estimates ($A\hat{T}T_M^{DID}$) for 1999

Growth rate		1999		1996	
Group		SWs	COUNTs	SWs	COUNTs
N. of observations		13	13	13	13
TFP growth	Mean	-0.0010	-0.0265	0.0696	0.0898
	$A\hat{T}T_M$	0.0255		-0.0202	
	(Std. err.)§	(0.0415)		-	
	$A\hat{T}T_M^{DID}$	0.0457			
	(Std. err.)§	(0.0580)			
Output growth	Mean	0.1373	0.0580	0.0376	0.1539
	$A\hat{T}T_M$	0.0793		-0.1164	
	(Std. err.)§	(0.1313)		-	
	$A\hat{T}T_M^{DID}$	0.1957			
	(Std. err.)§	(0.1675)			
Empl. growth	Mean	0.0248	-0.0201	-0.0092	-0.0001
	$A\hat{T}T_M$	0.0449		-0.0091	
	(Std. err.)§	(0.0575)		-	
	$A\hat{T}T_M^{DID}$	0.0541			
	(Std. err.)§	(0.0919)			

§ Standard errors are calculated by means of bootstrapping technique (200 replications).

Table B.3: Post-acquisition effects of foreign takeover for Sample 2 combined matching - DID estimates ($A\hat{T}T_M^{DID}$) for 1998

Growth rate		1998		1996	
Group		SWs	COUNTs	SWs	COUNTs
N. of observations		13	13	13	13
TFP growth	Mean	0.0291	0.0317	0.0696	0.0898
	$A\hat{T}T_M$	-0.0026		-0.0202	
	(Std. err.)§	(0.0536)		-	
	$A\hat{T}T_M^{DID}$	0.0176			
	(Std. err.)§	(0.0729)			
Output growth	Mean	0.1272	-0.0360	0.0376	0.1539
	$A\hat{T}T_M$	0.1632		-0.1164	
	(Std. err.)§	(0.1296)		-	
	$A\hat{T}T_M^{DID}$	0.2795*			
	(Std. err.)§	(0.1534)			
Empl. growth	Mean	0.0452	0.0368	-0.0092	-0.0001
	$A\hat{T}T_M$	0.0085		-0.0091	
	(Std. err.)§	(0.0591)		-	
	$A\hat{T}T_M^{DID}$	0.0176			
	(Std. err.)§	(0.1375)			

§ Standard errors are calculated by means of bootstrapping technique (200 replications);

* ATT is significant at 10%.

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