WORKING PAPER

No 10/2015

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Economics

ISSN 1403-0586

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# Effects of foreign acquisitions on R&D and high-skill activities

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November 17 2015

**Abstract**

Using Swedish micro data we find no evidence for the concerns circulating in the public debate that foreign acquisitions lead to reductions in R&D expenditures and high-skilled activities in targeted domestic firms, neither in MNEs nor in non-MNEs. Previous studies have only focused on larger firms. In this paper we are able to study the impact on smaller firms (less than 50 employees). This is important since 90 percent of the firms acquired by foreign enterprises have less than 50 employees. For this group of firms there is no information on R&D, but by using the register of educational attainment we have data on the share of high-skilled labor in all Swedish firms, irrespective of size. Interestingly, we find that among smaller firms foreign enterprises tend to acquire high-productive, skill-intensive firms (cherry-picking) and after the acquisitions skill upgrading appears in acquired smaller, non-MNE firms.

Keywords: foreign acquisitions, skill upgrading, R&D intensity, propensity score matching
JEL: F23, J24, O32, O33

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# 1. Introduction*

In the late 1990s, foreign ownership in the Swedish business sector increased quite dramatically. Indeed, this was part of an international wave of mergers and acquisitions (M&A), but it raised concerns in the debate about what would happen to research and development (R&D) and other high-skilled activities located in Sweden. One reason for the strong sentiments was that some flagship Swedish multinational enterprises (MNEs) – such as Astra and Volvo Cars – were acquired by foreign enterprises. As a contribution to such discussions that have taken place in Sweden and in other countries, we provide evidence that "national" MNEs acquired by foreign MNEs are not affected when it comes to R&D and skill intensities, whereas the share of high-skilled labour actually increases in smaller non-MNEs acquired by foreign MNEs.

From a theoretical point of view, the effect of M&A on R&D in the targeted firm is ambiguous.[1] On the one hand, if the acquirer and the acquired firm are performing similar R&D − they are substitutes for each other − then a plausible outcome of a foreign acquisition would be for the foreign investors to exploit scale economies in R&D and centralize R&D activity in their home country and to cut back on R&D activities performed abroad. Other reasons for moving R&D to the home country might be to avoid duplication of R&D inputs or to reduce costs associated with coordinating R&D units in different countries. On the other hand, if the R&D activities in the home country and in the acquired firm abroad are complementary to each other, one might expect the R&D activities in the foreign affiliate to be continued or even increased.[2] The motive for acquisition in this case then is to access, exploit, and develop already existing knowledge in the acquired firm (technology sourcing), i.e. to tap into the expertise of the host country.[3]

* Financial support from Swedish Research Council for Health, Working Life and Welfare is gratefully acknowledged. We have benefited from comments in a seminar at Örebro University.

[1] Cassiman et al. (2005) and Bertrand (2009) present more elaborate discussions on how M&A affect R&D in the acquired firms.

[2] There are economies of scope in R&D, and combining different R&D programs within the same company leads to higher R&D output than if the R&D is performed in separate firms.

[3] Dunning and Lundan (2009) assert that generating new knowledge and competences by locating R&D abroad in places that are outstanding in the fields that an MNE wants to develop (*home-base augmenting*) has been growing in importance in recent years relative to the other reason often put forward to why MNEs carry out R&D in other countries, i.e., to adapt its products and processes to the individual needs and preferences in overseas markets (*home-base exploiting*).

Many of the early studies evaluating the impact of M&A on R&D focused on domestic M&A, mostly in the US. Those studies often found negative impacts on post-acquisition R&D in the acquired firms; however, the results were not robust.[4] Two other studies more in the vein of this paper are those of Bertrand (2009) and Bandick et al. (2014); they both investigated the effects of foreign acquisitions on the R&D activities in domestic targeted firms. Bertrand (2009) covered international acquisitions of French innovative[5] manufacturing firms from 1995 to 2001, and Bandick et al. (2014) covered international acquisitions of Swedish manufacturing firms with at least 50 employees from 1994 to 1999. In both studies, the firms were followed from one year before to three years after the acquisition. In contrast to the earlier studies of domestic M&A, these two studies found that acquisitions by foreign companies boost R&D spending in the domestic targeted firms.

Our paper also examines the effects of foreign acquisitions on R&D in acquired domestic firms. In expanding on the work of Bandick et al. (2014), we have extended our study to include the entire Swedish business sector. The foreign acquisitions in our study took place between 2000 and 2006, a period with no spectacular increase in foreign ownership. Because we believe that the restructuring process after the acquisition takes time, we used a larger window of time to study the firms, and the post-acquisition period was five years instead of three years as in the earlier studies. Our outcome variables are, like in the previous analyses, absolute R&D expenditure and R&D intensity, i.e. R&D expenditure as a share of the firm's output.

However, the great majority of the firms in the Swedish business sector assert that they do not have any expenditure on R&D, and R&D expenditures are heavily concentrated to a few firms.[6] An alternative way to investigate whether foreign acquisitions affect the localisation of highly skilled activities in targeted firms is to examine the impact on the share of highly skilled labour. In our analysis, we define highly skilled labour as employees with three years or more of post-secondary education.

[4] For a review of this literature, see Cassiman et al. (2005).
[5] Innovative firms are not defined in the paper, and the author admits that "the construction of our database could lead to an over-representation of large and technology-driven mergers. All firms in our sample do innovation."
[6] Among firms with at least 50 employees in the Swedish business sector, 86 percent have no R&D, and Eliasson et al. (2014) show that the top 14 percent of the firms that report R&D account for 90 percent of the total R&D expenditures in the Swedish business sector.

Similar arguments as for R&D apply for the effects of foreign acquisitions on the share of highly skilled labour. In other words, if the motive for foreign acquisition is technology sourcing, the share of highly skilled labour in the acquired firms will be constant or increase. If R&D and other highly skilled activities are, as a result of the foreign acquisition, relocated to the home country of the acquiring firm then the skill share will decrease in the acquired firms.

A slightly different argument is if technology transfers from acquiring foreign MNEs to acquired smaller firms (non-MNEs) are particularly pronounced, then this might have significant effects on skill upgrading in the acquired firms. The acquiring firms in foreign acquisitions are by definition already MNEs, or are becoming foreign MNEs through the acquisition, and it is well known that MNEs are important conveyers of technology internationally.[7] Transferring technology to the acquired firms abroad has an effect on technical change in these firms, and if this change is skill-biased, the demand for skilled labour will increase and a higher skill share will appear in the acquired firm. Because the level of technology might be considerably lower in smaller non-MNEs, we expect to observe the largest technology transfers if such firms are acquired, and thus that the largest positive effects on skill shares will be seen in these firms.

Much of the concerns in the Swedish public debate have been about how large Swedish MNEs are affected when they become foreign owned. In both the public debate and in the academic literature, less interest has been directed towards the impact of foreign acquisitions on smaller firms, and such firms are quite often non-MNEs. An advantage with using the share of highly-skilled labour instead of R&D expenditure as an outcome variable is that we have access to data for all firms and for every single year for the whole Swedish business sector without constraint on firm size. R&D expenditure in Sweden is surveyed every other year, and for many years during our studied period such expenditures were only measured for firms with 50 employees or more.[8]

[7] Keller (2010).
[8] The cut-off firm size in Statistics Sweden's R&D survey has until 2005 been 50 employees.

Former empirical analyses on Swedish firm-level data give somewhat contradictory results with regard to skill levels in acquired firms.[9] Bandick and Hansson (2009) examined the impact of foreign ownership on skill upgrading in Swedish manufacturing firms with 50 employees or more between 1993 and 2002. They found some evidence that the relative demand for skilled labour rose in non-MNEs – but not in MNEs – that became foreign-owned. Nilsson Hakkala et al. (2014) presented results suggesting that a conventional measure using educational attainment as an indicator failed to capture any impact of foreign ownership, whereas they observed positive effects of foreign ownership on occupation-based task measures. They found that non-routine and interactive job tasks increase in non-MNEs that are acquired by foreign MNEs. We will argue that the most likely reason why they did not find any effects of foreign ownership in non-MNEs using a skill measure based on educational attainment is that they used a sample of firms where small- and medium-sized firms were strongly underrepresented, and such firms are also to a great extent non-MNEs.

To preview our results, we find, in contrast to Bertrand (2009) and Bandick et al. (2014), no effect of foreign acquisitions on R&D in targeted firms, neither in MNEs nor in non-MNEs. On the contrary, in small non-MNEs the share of highly skilled labour increases in firms acquired by foreign enterprises.

The structure of the paper is as follows. Section 2 contains a general presentation of the structure of the Swedish micro data we used and a discussion of how we constructed our dataset. It also gives some descriptive facts on R&D expenditure, skill intensities, and foreign ownership in the Swedish business sector. Section 3 discusses our econometric strategy. Section 4 reports the results from the analysis, the propensity scores, and the matching estimates. Section 5 concludes the report.

[9] Two other studies using panel data at the firm or establishment level in the 1990s are Almeida (2007) on Portuguese data and Huttunen (2007) on Finnish manufacturing. Both found small positive effects on wages after foreign acquisitions, whereas the impact on skill upgrading was less clear-cut. None of the above studies separated the targeted firms into MNEs and non-MNEs.

# 2. Data and description

## 2.1 Swedish micro data

The data in our microeconomic database are from Statistics Sweden (SCB) and the Swedish Agency for Growth Policy Studies (Growth Analysis). Unique identification numbers for the firms enable us to link information on financial accounts, R&D expenditure, and register-based labour statistics (in this case, the education levels of employees).

In 1997, Statistics Sweden started to use administrative data to compile its Structural Business Statistics. This means that from 1997 data on variables in the balance sheets and the income statements are available for all non-financial[10] Swedish firms. An annual register on the level of education of the Swedish population has existed since 1985.

The Swedish R&D survey is carried out every second year (odd years). It started in the mid-1960s, and at the beginning the survey only covered firms in mining and manufacturing with 50 employees or more. Gradually, it has been extended. From 1995 all non-financial firms with 50 employees or more are included, and from 2001 the survey has also included financial firms. From 2005, a sample of firms with 10-49 employees has also been included. In parallel with the Swedish R&D survey, Statistics Sweden has until 2002 collected annual data on R&D expenditures on the firm level for the Structural Business Statistics. These are the R&D data used by Bandick et al. (2014).

From 1993 onwards, it has been possible to identify and by that classify firms in the Swedish business sector into foreign-owned firms (foreign MNEs), Swedish MNEs, and other Swedish firms (non-MNEs). Foreign MNEs are firms where foreigners possess more than 50 percent of the voting rights, and Swedish MNEs are firms that are part of an enterprise group with at least one employee abroad.[11] Non-MNEs are firms that are neither classified as Swedish MNEs nor as foreign MNEs.

[10] Firms in industries ISIC Rev. 3.1 01-93 exclusive of 65-67, 75.
[11] Growth Analysis is the official provider of statistics on foreign-controlled enterprises (foreign MNEs) in Sweden and Swedish-controlled enterprise groups with subsidiaries abroad (Swedish MNEs). See www.tillvaxtanalys.se.

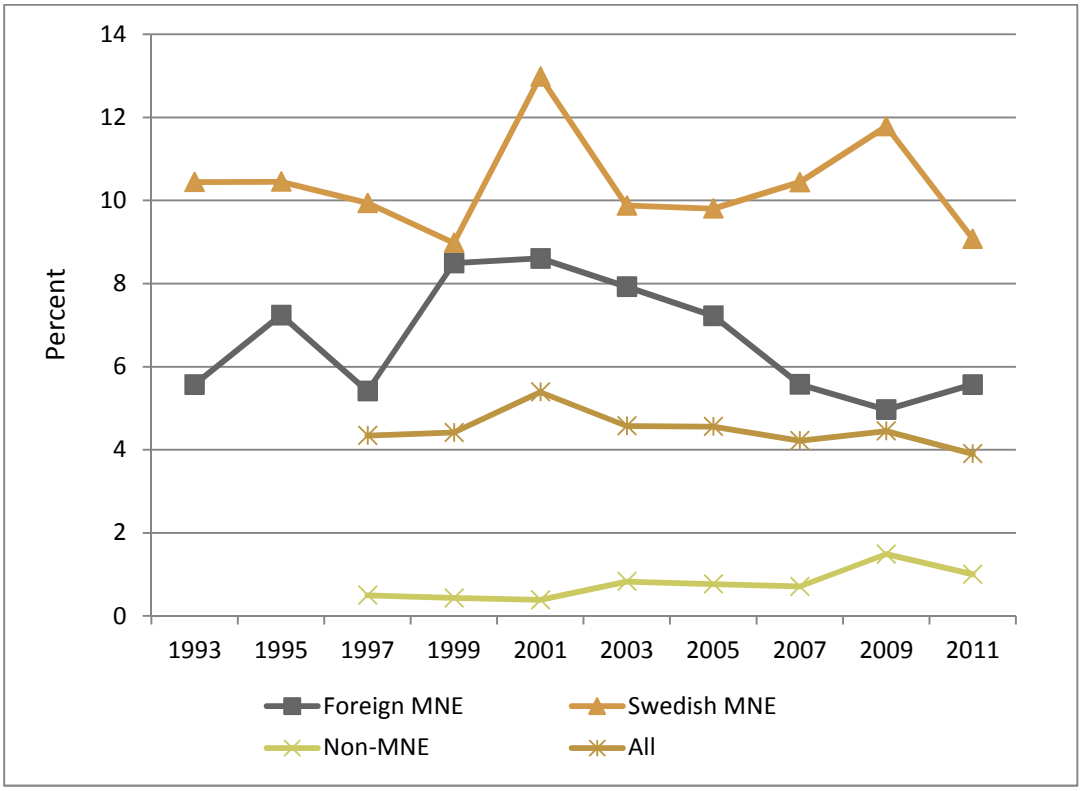
Some recent studies have created measures for the various tasks performed within firms.[12] For such purposes there is a need for data on occupations on the firm level. A complete register of occupations for all individuals 16 years or older in Sweden at the firm level has been available annually since 2001.

## 2.2 R&D, skill intensity, and foreign ownership

As our measure of R&D, we use the intramural costs, i.e. the expenditure for R&D performed within the firm and that primarily consists of labour costs for R&D personnel. The R&D expenditures in the Swedish business sector are very much concentrated to MNEs. This is shown in Figures 2.1 and 2.2. In Figure 2.1, we can see that since 1997 the R&D intensity – R&D expenditures as a share of value added − in the Swedish business sector has been more or less constant at around 4 percent and this is high in comparison to other OECD countries.[13] When we divide the firms into Swedish MNEs, foreign MNEs, and non-MNEs, we observe that the R&D intensity is significantly higher in both Swedish MNEs and foreign MNEs than in non-MNEs.

[12] See, e.g. Becker et al. (2013), Baumgarten et al. (2013) – both on German data – and Nilsson Hakkala et al. (2014) on Swedish data.
[13] Among the OECD countries, the R&D intensity in Sweden in 2013 was higher than in Israel, Korea, Japan, and Finland.

**Figure 2.1.** R&D intensities in Swedish MNEs, foreign MNEs, and non-MNEs.

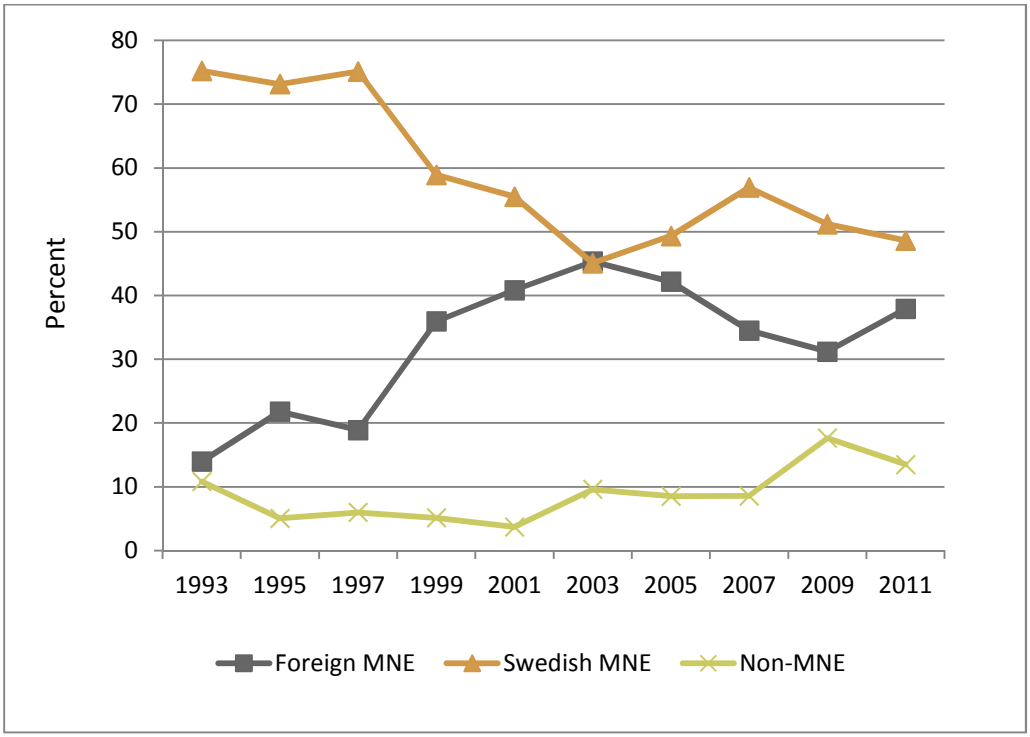



*Notes*: In our data, the total value added for non-MNEs in 1993 and 1995 is underestimated, and thus these observations have been excluded. From 2001, the survey on R&D was expanded to include financial firms (credit institutions, banks, and insurance companies), and moreover, from 2001 the respondents were obliged to reply. From 2005, the R&D survey also includes a sample of firms with 10 to 49 employees. Before 2005, only firms with 50 employees or more were covered. To determine whether R&D intensities are higher in Swedish MNEs and in foreign MNEs than in non-MNEs, we estimated a regression on a pooled dataset for the whole period controlling for industry and time, and we found that the R&D intensities are significantly higher than in non-MNEs.

*Source*: Statistics Sweden, Research and Development in the Business Enterprise Sector and Structural Business Statistics.

Figure 2.2 presents the total business sector R&D expenditures split among MNEs and non-MNEs. We find that the MNEs account for around 90 percent of the R&D expenditures in the Swedish business sector. Hence, by far most of the R&D is conducted in MNEs. From 1993 to 2003, there was a shift from Swedish MNEs towards foreign MNEs until the share of R&D was about the same in both groups. After 2003 the gap between Swedish MNEs and foreign MNEs has grown; the share in Swedish MNEs has increased while the share in foreign MNEs has decreased.

**Figure 2.2.** Share of total R&D expenditures in Swedish MNEs, foreign MNEs, and non-MNEs.



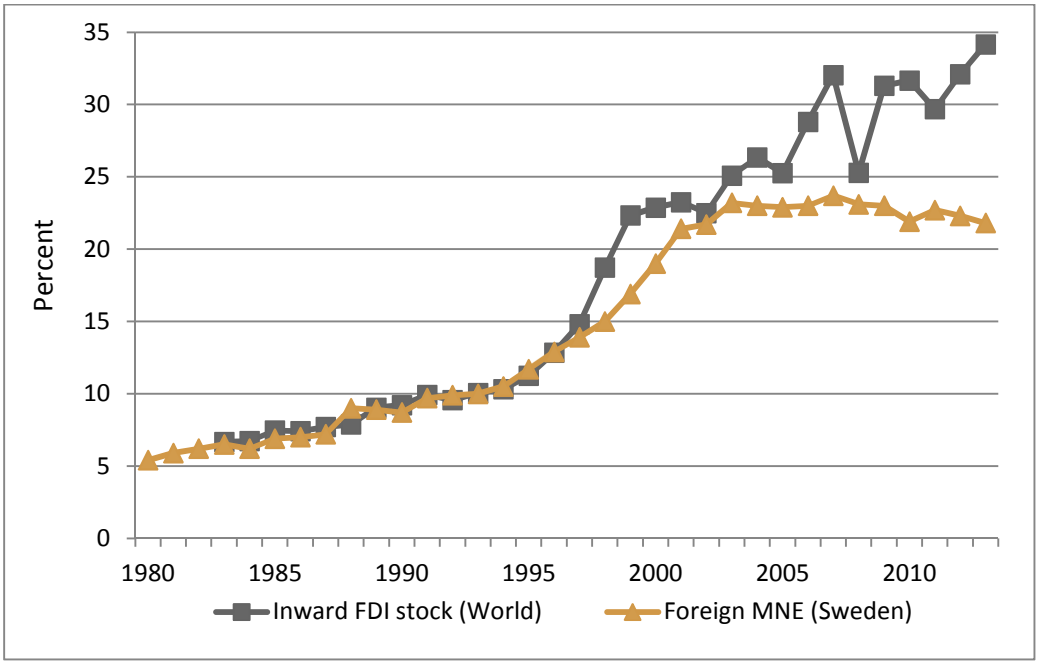

*Source*: Statistics Sweden, Research and Development in the Business Enterprise Sector.

An important explanation for the growing share of R&D expenditures in foreign MNEs in the late 1990s and in the beginning of the 2000s is that at this point in time several large Swedish MNEs were acquired by foreign MNEs.[14] This is indicated in Figure 2.4 where the share of employees in foreign MNEs increased from 10 percent in 1993 to over 23 percent in 2003.

Figure 2.3 shows that the growing foreign ownership in Sweden in the late 1990s seems to have been an international phenomenon. The inward foreign direct investment stock as a share of GDP in the world increased from 11 percent in 1995 to 23 percent in 2000.[15] After 2005 this share continued to grow, and in 2013 it was 34 percent; worldwide foreign ownership appears to have grown even after 2005. However, after 2003 in Sweden, the trend towards increased foreign ownership ceased, as can be seen in Figure 2.3, and the share of employees in foreign MNEs in Sweden has been more or less stable since then.

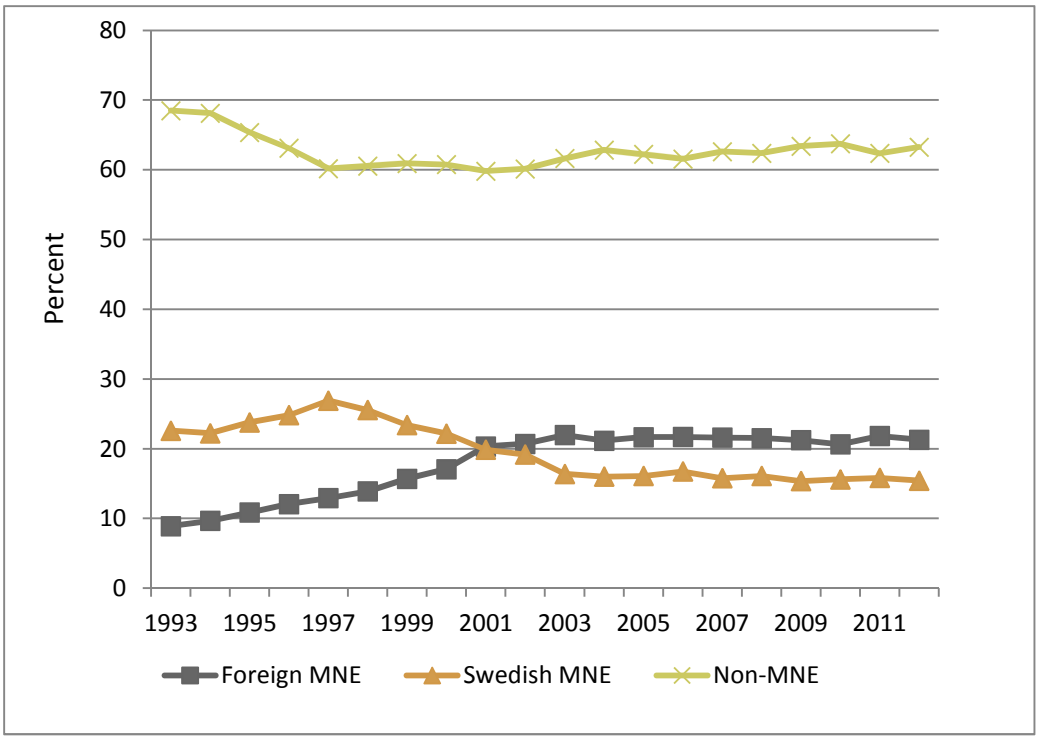
[14] The list is long, and includes Nobel and Akzo 1994 (the Swedish MNE Nobel was acquired by the foreign MNE Akzo in 1994), Pharmacia and Upjohn 1995, Saab Automobile and General Motors 1998, Stora and Enso 1998, Enator and Tieto 1999, Volvo Car and Ford 1999, Astra and Zeneca 1999, Aga and Linde 2000, and Arla and MD Foods 2000.
[15] See www.unctadstat.org.

**Figure 2.3.** Employment share in foreign MNEs in the Swedish business sector and the inward foreign direct investment FDI stock as a share of GDP in the world.




*Source*: Growth Analysis, Foreign Controlled Enterprises in Sweden; and UNCTAD, Statistical Database (unctadstat.org).

**Figure 2.4.** Employment shares in Swedish MNEs, foreign MNEs, and non-MNEs.

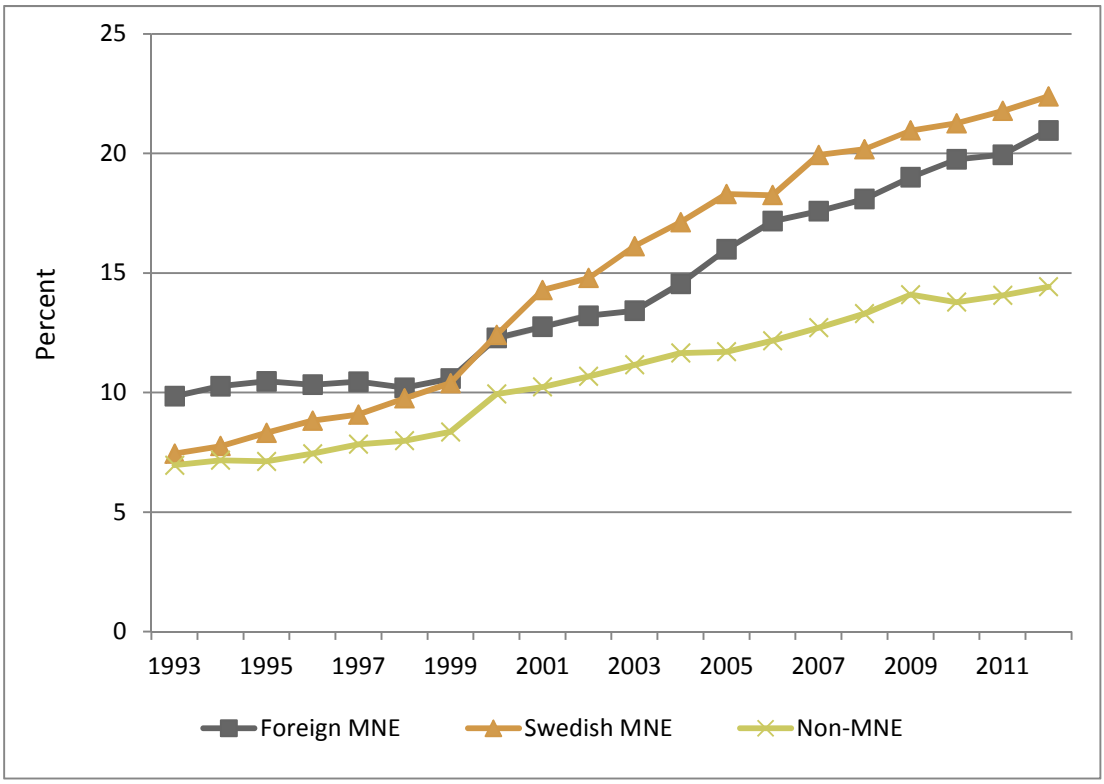



*Source*: Statistics Sweden, Register-based Labor Market Statistics (RAMS).

To put the shares of R&D in Figure 2.2 into perspective, we present in Figure 2.4 the corresponding shares for employment in the different groups of firms. In contrast to R&D, most of the employment is in non-MNEs (63 percent 2012), and at the end of the period the employment share in foreign MNEs (21 percent 2012) was larger than in Swedish MNEs (16 percent 2012). In other words, in comparison to the R&D in the Swedish business sector, employment is clearly dominated by non-MNEs.

Another reasonable indicator for the extent to which advanced activities are carried out within a firm is the share of highly skilled labour. We define highly skilled labour as employees with three years or more of post-secondary education. Figure 2.5 shows the development of the shares of highly skilled labour in MNEs and non-MNEs. In the econometric analysis, we will use this variable as an alternative to R&D.

**Figure 2.5.** Shares of highly skilled labor in Swedish MNEs, foreign MNEs, and non-MNEs.




*Notes*: We define highly skilled labour as employed with three years or more of post-secondary education (ISCED 6-8). By estimating a regression on a pooled dataset for the whole period controlling for industries and time, we find that the share of high-skilled labour is significantly higher in MNEs than in non-MNEs.

*Source*: Statistics Sweden, Register-based Labor Market Statistics (RAMS).

Not surprisingly, we find that the share of highly skilled labour is greater in Swedish MNEs (22 percent 2012) and in foreign MNEs (21 percent 2012) than in non-MNEs (14 percent 2012). Interestingly, we also notice that the share of skilled labour has appeared to grow faster in MNEs than in non-MNEs. To put it differently, Figures 2.1 and 2.5 reveal what many other studies have shown, namely that MNEs are quite different from non-MNEs.[16] The higher R&D intensity and skill intensity in MNEs might indicate that they are more technically advanced than non-MNEs, and thus there is a potential for transfers of technology from acquiring MNEs to acquired non-MNEs.

### 2.3 The dataset of analysis and descriptive statistics

In the econometric analysis to follow, we use data from Statistics Sweden's R&D survey, Structural Business Statistics, and register-based labour statistics together with data on international enterprises from the Swedish Agency for Growth Policy Analysis. As mentioned earlier, the latter allows us to divide firms into foreign MNEs, Swedish MNEs, and other Swedish firms (non-MNEs). The dataset includes all firms in the Swedish business sector with at least one employee, and it covers the period 1999-2011.[17]

To be included in the analysis we require that a firm can be observed in the data each year during a seven-year time window. Based on the information on ownership status, we define foreign acquisition of a domestic firm (Swedish MNE or non-MNE) as a change in ownership status from domestic to foreign between years $t-1$ and $t$. In the econometric analysis, acquired firms are compared to non-acquired firms, the latter being firms classified as domestically owned in both year $t-1$ and $t$. Both groups of firms are observed each year over the interval $t-1$ to $t+5$. With this allocation of the seven-year time window, we are able to study the effects of foreign acquisition over a fairly long time period.[18] Given that our data cover the period 1999-2011 and that R&D data are only available for odd years, we are able to construct four cohorts of firms that we follow during the seven-year window. The first

[16] See, e.g. Doms and Jensen (1998) for the US and Table 3 in Bandick et al. (2014) for Sweden.
[17] As previously mentioned, firms in industries ISIC Rev. 3.1 65-67 (financial firms) and 75 (public administration) are excluded. Firms in these industries are not covered by the Structural Business Statistics and financial firms are not included in the Swedish R&D survey prior to 2001. We also exclude firms in industry 73 (R&D). These are "pure" R&D companies, generally with extremely high R&D intensities.
[18] Bertrand (2009) and Bandick et al. (2014) studied the effect of foreign acquisition up to three years after acquisition. One could argue that the effects of foreign acquisitions on R&D and the skill mix in targeted firms are slow processes that might take time to materialize. Therefore, in our analysis we extended the post-acquisition period to five years.

cohort observed during the period 1999-2005 with potential acquisitions occurring between 1999 and 2000, and the last cohort is observed during the period 2005-2011 with potential acquisitions occurring between 2005 and 2006.

**Table 2.1.** Frequencies of foreign acquisitions by cohort, firm type, and size.

| | non-MNEs | | Swedish MNEs | | Total | |
|---|---|---|---|---|---|---|
| | 1-49 | 50+ | 1-49 | 50+ | 1-49 | 50+ |
| 2000 | 762 | 55 | 7 | 18 | 769 | 73 |
| 2002 | 492 | 74 | 7 | 7 | 499 | 81 |
| 2004 | 317 | 46 | 2 | 4 | 319 | 50 |
| 2006 | 426 | 81 | 26 | 9 | 452 | 90 |
| 2000-2006 | 1,997 | 256 | 42 | 38 | 2,039 | 294 |
| | (0.4) | (2.1) | (0.6) | (1.0) | (0.4) | (1.8) |

*Notes:* The share of foreign acquisitions in relation to the total number of firms in each group is presented in parentheses.

Table 2.1 reports the number of foreign acquisitions in the dataset that will be used in the econometric analysis. There are a couple of things to notice. First, foreign acquisition is a fairly rare event in absolute numbers among firms with 50 employees or more (the sample for which R&D data are available). The number of acquisitions is about seven times higher among firms with fewer than 50 employees. Second, foreign firms particularly target Swedish non-MNEs. There are only a handful of Swedish MNEs acquired during the period.[19]

Table 2.2 presents differences in sample means between acquired and non-acquired firms by sector and size. For the larger firms, there seems to be no difference in R&D intensity between acquired and non-acquired firms in the year prior to potential acquisition. However, we do find that the skill intensity is higher among targeted firms in the sample containing smaller firms. This holds for firms in the entire Swedish business sector as well as for firms in the manufacturing industry. There are also other important pre-acquisition differences. Targeted firms are, in general, more productive and younger than non-targeted firms. Acquired firms also tend to operate in industries with a higher degree of foreign presence.

[19] In this respect, our period of study differs from the period in Bandick et al. (2014) and Bandick and Hansson (2009). Here, 13 percent of the acquired firms with 50 employees or more are Swedish MNEs, while in these other two studies 30 percent are Swedish MNEs (see Table 4 in Bandick et al. 2014).

**Table 2.2.** Differences in sample means between acquired and non-acquired firms by sector, and size.

| | All sectors | | Manufacturing | |
|---|---|---|---|---|
| | 1-49 | 50+ | 1-49 | 50+ |
| R&D intensity | | 0.000 | | 0.000 |
| Skill intensity | 0.066*** | 0.003 | 0.060*** | -0.001 |
| Labor productivity | 216*** | 75*** | 288*** | 38.2 |
| Capital intensity | 244 | 122 | 49 | 98** |
| Size | 5*** | 42 | 8*** | 61 |
| Age | -3.4*** | -1.9*** | -2.4*** | -1.7*** |
| Swedish MNE | 0.006** | -0.212*** | -0.015 | -0.322*** |
| Foreign presence | 0.091*** | 0.076*** | 0.070*** | 0.088*** |
| | | | | |
| Acquired firms | 1,608 | 250 | 206 | 104 |
| Non-acquired firms | 383,549 | 7,922 | 47,353 | 3,156 |

*Notes*: All variables refer to year $t-1$. R&D intensity is defined as R&D expenditure as a share of firm sales, skill intensity is measured by the proportion of employees with three years or more of post-secondary education (ISCED 6-8), labour productivity is defined as value added in SEK 1,000 per employee, capital intensity is measured by the book value of machinery and buildings in SEK 1,000 per employee, size is measured by the number of employees, age is defined as the number of years since the firm first became registered, Swedish MNE is a dummy variable indicating whether a firm is part of a Swedish MNE, and foreign presence is defined as the share of employment in foreign firms relative to total employment in an industry (measured at the ISIC Rev. 3.1 3-digit industry level). ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

# 3. Econometric strategy

The main purpose of this paper is to estimate the causal effect of foreign acquisition on R&D activity and skill intensity in targeted domestic firms. The econometric analysis is based on a conditional difference-in-differences matching approach suggested by Heckman et al. (1997, 1998). Various types of matching methods began to appear in economics in the late 1990s and were particularly common in the literature evaluating labour market programmes. Since then, matching has gained in popularity in many other fields of applied economics.

The basic idea behind our approach is to choose a comparable untreated (non-acquired) firm for each treated (acquired) firm and use these pairs to calculate the effect of the treatment (foreign acquisition) on the outcomes of interest (R&D activity and skill intensity). Two advantages with matching over conventional parametric estimation techniques is that matching is more explicit in assessing whether or not comparable untreated observations are available for each treated observation and, further, that matching does not rely on the same type of functional form assumptions that traditional parametric approaches typically do. There are numerous papers suggesting that avoiding (potentially incorrect) functional form assumptions and imposing a common support condition can be important for reducing selection bias in studies based on observational data.[20]

The main parameter we are interested in estimating is the average treatment effect on the treated, *ATT*, which in our case corresponds to the average effect of foreign acquisition on the firms that have become acquired. The following set of equations gives the basic intuition behind the estimation strategy:

$$ATT_{t^+} = E(Y_{1t+}|X_{t-}, D_t = 1) - E(Y_{0t+}|X_{t-}, D_t = 0) = ATT + \bar{B} \quad (1)$$

$$ATT_{t^-} = E(Y_{1t-}|X_{t-}, D_t = 1) - E(Y_{0t-}|X_{t-}, D_t = 0) = \bar{B} \quad (2)$$

$$ATT_{t^+} - ATT_{t^-} = ATT + \bar{B} - \bar{B} = ATT \quad (3)$$

[20] See e.g. Heckman, Ichimura and Todd (1997), Heckman, Ichimura, Smith and Todd (1998), Dehejia and Wahba (1999, 2002), and Smith and Todd (2005).

where $t^-$ and $t^+$ denote time periods before and after potential foreign acquisition occurring at time $t$, $D_t = 1$ indicates that a firm is acquired at $t$ and $D_t = 0$ indicates that a firm is not acquired at $t$, $Y_1$ represents, e.g., R&D intensity in the case of acquisition and $Y_0$ represents R&D intensity if not acquired, $X$ denote a set of observed pre-acquisition covariates affecting both the probability of foreign acquisition and R&D intensity, and finally $\bar{B}$ represents possible selection bias in the estimation of *ATT*.

Equation (1) represents a conventional cross-sectional matching estimator. This equation rests on an assumption of mean conditional independence, i.e. $E(Y_{0t+}|X_{t-}, D_t = 1) = E(Y_{0t+}|X_{t-}, D_t = 0)$. This assumption states that if we condition on a sufficiently rich set of pre-treatment covariates, we can use the R&D intensity in non-acquired firms as an approximation of the R&D intensity that acquired firms would have conducted if they had not been acquired (the counterfactual outcome). However, if there are unobservable characteristics affecting both foreign acquisition and R&D intensity, the assumption no longer holds and equation (1) will give a biased estimate of *ATT*. Equation (2) simply states that if we construct a matching estimate for pre-treatment R&D intensity we would expect to find bias only due to unobserved differences between acquired and non-acquired firms (i.e. the effect of a treatment cannot precede the treatment itself). Equation (3) shows that if we take the difference between the post- and pre-treatment matching estimates we can remove the time-invariant portion of the bias.

From the outline above, it follows that the conditional difference-in-differences approach does not rely on the likely implausible assumption that we can observe all factors affecting both foreign acquisitions and R&D intensity. The conditional difference-in-differences matching strategy extends conventional cross-sectional matching methods because it not only takes care of potential selection bias due to observable differences between acquired and non-acquired firms, but it also eliminates bias due to time-invariant unobservable differences between the two. However, this does not suggest that estimates based on this identification strategy are free from possible bias. If there are unobservable differences between acquired and non-acquired firms that vary over time (i.e. they are different in the pre- and post-acquisition periods), this is a potential source of remaining bias with our identification strategy.

In the differencing, we let the R&D intensity in year $t-1$ represent the pre-treatment outcome. We follow the typical procedure in the literature and base the matching on the predicted

probability of foreign acquisition, which is referred to as the propensity score (Rosenbaum and Rubin, 1983), rather than on the pre-treatment covariates themselves. We implement our matching strategy using both single nearest neighbour matching and kernel matching based on the Epanechnikov kernel with different bandwidths (see Section 4.2).

# 4. Empirical results

First, we present in section 4.1 the propensity scores (i.e. the probability of foreign acquisitions) that will be used in the matching analysis to follow. This is an interesting analysis in itself because it tells us about the characteristics of the domestic firms that foreign firms acquire. Second, we show the results from the matching analysis and we report the causal effects of foreign acquisitions on R&D intensity (Section 4.2) and on skill intensity (Section 4.3) in targeted firms.

## 4.1 The probability of foreign acquisition

The first stage of our econometric analysis consists of estimating the propensity score, i.e. the predicted probability of foreign acquisition. The choices of covariates included in the propensity score are variables suggested by previous empirical literature to affect both foreign acquisition and R&D intensity and other types of high-skilled activities.[21] All variables in the propensity score refer to the year prior to potential acquisition ($t-1$).

Two of the primary covariates in the propensity score are pre-acquisition R&D intensity and skill intensity. These two variables allow us to consider whether firms are targeted depending on their R&D resources and high-skill activities or whether acquisitions are explained by other motives. As previously mentioned, data on skill intensity is available for the entire Swedish business sector without restriction on firm size, whereas data on R&D only pertain to firms with 50 employees or more. The propensity score further includes labour productivity and capital intensity. These variables allow us to test whether domestic firms are targeted based on their productive performance. Firm size and age are two variables commonly found in the literature focusing on foreign acquisitions. The former is often used as a proxy for home market share. The specification of the propensity score also includes a dummy variable indicating whether targeted firms are Swedish MNEs (as opposed to non-MNEs). The share of employment in foreign firms relative to total employment is included as a measure of foreign presence in an industry (at the ISIC Rev. 3.1 3-digit industry level). Finally, to control for temporal and sectorial effects, the specification of the propensity score includes dummy

[21] See, for example, Conyon et al. (2002), Harris and Robinson (2002), and Girma and Görg (2007). The covariates are similar to Bandick and Hansson (2009) and Bandick et al. (2014).

variables for year and a full set of industry dummies (at the ISIC Rev. 3.1 3-digit industry level).

We use a probit model to estimate the propensity score. To the extent that higher orders of the covariates improve the balancing between acquired and non-acquired firms, these are included in the specification (more on balancing below). Table 4.1 presents the results. Columns (1) and (3) include estimates for firms with fewer than 50 employees in the entire Swedish business sector and in the manufacturing industry, respectively, whereas columns (2) and (4) report estimates for firms with 50 employees or more in the two sectors.

**Table 4.1.** Propensity score: probability of foreign acquisition.

| | All sectors | | Manufacturing | |
|---|---|---|---|---|
| | 1-49 | 50+ | 1-49 | 50+ |
| R&D intensity | | -0.6562 | | -1.6221 |
| | | (1.0742) | | (1.4416) |
| Skill intensity | 0.1977*** | 0.2067 | 0.3722*** | 0.1430 |
| | (0.0300) | (0.2275) | (0.1095) | (0.7483) |
| Labor productivity | 3.54e-05*** | 0.0002 | 8.30e-05*** | 0.0013** |
| | (1.01e-05) | (0.0001) | (2.90e-05) | (0.0006) |
| Capital intensity | 2.20e-06 | 2.60e-06 | 4.25e-05 | 0.0008*** |
| | (1.90e-06) | (3.17e-05) | (2.74e-05) | (0.0003) |
| Size | 0.0732*** | 0.0004*** | 0.0560*** | 0.0004** |
| | (0.0029) | (0.0001) | (0.0066) | (0.0002) |
| Size squared | -0.0012*** | -5.05e-08* | -0.0007*** | -3.67e-08 |
| | (0.0001) | (2.66e-08) | (0.0002) | (2.45e-08) |
| Age | -0.1233*** | -0.1166*** | -0.1249*** | -0.1717*** |
| | (0.0061) | (0.0218) | (0.0161) | (0.0366) |
| Age squared | 0.0040*** | 0.0039*** | 0.0045*** | 0.0068*** |
| | (0.0003) | (0.0010) | (0.0008) | (0.0017) |
| Swedish MNE | -0.4034*** | -0.8641*** | -0.6098*** | -1.1224*** |
| | (0.0666) | (0.0920) | (0.1767) | (0.1407) |
| Foreign presence | -0.6032*** | -0.6606 | -0.4159 | -0.7693 |
| | (0.1992) | (0.4420) | (0.3156) | (0.5724) |
| Pseudo-$R^2$ | 0.1797 | 0.1663 | 0.1536 | 0.2196 |
| Wald $chi^2$ | 3,718.1 | 339.0 | 508.0 | 198.8 |
| prob>$chi^2$ | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Number of firms | 515,487 | 9,145 | 61,114 | 3,654 |

*Notes:* The propensity scores are estimated using a probit model. The specifications also include squared labor productivity and capital intensity, 3-digit ISIC Rev. 3.1 industry dummies and dummies for the year of potential foreign acquisition. See Table 2.2 for additional definition of variables. Standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Contrary to Bertrand (2009) and Bandick et al. (2014), we find no effect of R&D intensity on the probability of foreign acquisition for the sample of firms with 50 employees or more. An explanation for why Bandick et al. (2014) found higher probability of foreign takeovers of R&D-intensive firms might be that during their period of study − the late 1990s − many large Swedish R&D-intensive manufacturing MNEs became foreign-owned.[22] We do, however, observe that the likelihood of foreign acquisition increases with skill intensity in our sample containing smaller firms. This holds for smaller firms in the entire Swedish business sector as well as for firms in the manufacturing industry. Again, we find no significant effects in the sample restricted to larger firms.[23] Our findings thus indicate that foreign companies tend to target small high-skill firms. Due to the lack of R&D data for small firms, it is difficult to assess whether foreign interest in small skill-intensive firms also reflects an interest in these firms' R&D potential.

Turning to the effect of labour productivity, our results do seem to suggest that foreign companies are cherry-picking high performing firms. For all specifications, the probability of foreign acquisition increases with firm size and decreases with firm age (in both cases there are non-linear effects).[24] Our estimates on the dummy of Swedish MNEs indicate that foreign companies are less likely to acquire Swedish MNEs. This is opposite to Bandick and Hansson (2009) and most likely explained by the fact that in the late 1990s many Swedish MNEs became foreign-owned.[25] Finally, we find no consistent effect of industry specific foreign presence on the likelihood of acquisition.

In sum, particularly among smaller firms foreign enterprises are inclined to acquire high-productive firms that appear to carry out advanced activities. Moreover, the targeted firms tend to be relatively large and fairly young. Unlike in the late 1990s, in the 2000s – our period of study − foreign takeovers have not been directed towards R&D intensive, Swedish MNEs.

[22] See footnote 14 and Figure 2.3 above.
[23] Bandick et al. (2014) found a positive effect of skill intensity on foreign acquisitions. This is not unexpected given the strong correlation between skill intensity and R&D intensity among large manufacturing firms.
[24] In these respects, the results for labour productivity, size, and age are the same as in Bandick and Hansson (2009) and Bandick et al. (2014).
[25] See footnote 19.

## 4.2 Effects of foreign acquisitions on R&D activity

The econometric analysis of the effect of foreign acquisition is based on a conditional difference-in-differences matching approach. Using a specific matching algorithm, we choose, based on the propensity score, a comparable non-acquired firm for each acquired firm and calculate the before-after difference in the outcome of interest for these pairs. As previously discussed, this approach not only takes care of potential selection bias due to observable differences between acquired and non-acquired firms, but it also eliminates bias due to time-invariant unobservable differences between the two.

Our results are based on two different matching algorithms: single nearest neighbour matching and kernel matching based on the Epanechnikov kernel (in both cases we match with replacement). In single nearest neighbour matching, each acquired firm is matched to the most similar comparison firm in terms of the propensity score. This approach generally trades reduced bias for increased variance. However, if the closest neighbour is far away, single nearest neighbour matching might still generate bad matches. Using the Epanechnikov kernel, each acquired firm is matched to a weighted average of non-acquired firms within a specific distance or bandwidth from the acquired firm. Heavier weight is put on more comparable firms, and in the case where there are no non-acquired firms within the chosen bandwidth the acquired firm is dropped from the calculations due to a lack of comparability.[26]

Table 4.2 presents matching estimates of the effects of foreign acquisitions on R&D intensity for the sample of firms with 50 employees or more. The reported results are based on the Epanechnikov kernel using a bandwidth of 0.001. Estimates for alternative bandwidths and single nearest neighbour matching are reported in Table A1 in the Appendix. Contrary to Bertrand (2009) and Bandick et al. (2014), we find no significant effect of foreign acquisition on R&D intensity in the targeted firms. This holds for firms in the entire Swedish business sector as well as for firms in the manufacturing industry. The lack of significant effects is robust across the different matching estimators and regardless of whether R&D is expressed in intensity terms or in absolute levels.[27]

[26] For both single nearest neighbour and the Epanechnikov kernel, we match on the so-called common support, i.e. we drop all firms whose propensity score is smaller than the minimum and larger than the maximum in the opposite group.
[27] Note that the effects of foreign acquisitions on the absolute levels of R&D are not presented in any table.

**Table 4.2.** Matching estimates of the effects of foreign acquisitions on R&D intensity by sector.

| | All sectors | | Manufacturing | |
|---|---|---|---|---|
| | Estimate | % | Estimate | % |
| *t*+1 | -0.0002 | -3.8 | 0.0012 | 14.8 |
| | (0.0027) | | (0.0075) | |
| *t*+3 | -0.0024 | -45.1 | -0.0016 | -19.7 |
| | (0.0019) | | (0.0034) | |
| *t*+5 | -0.0016 | -30.1 | -0.0005 | -6.1 |
| | (0.0023) | | (0.0049) | |
| Untreated | 8,312 | | 3,386 | |
| Treated | 255 | | 109 | |

*Notes:* The estimates are based on conditional difference-in-differences matching using an Epanechnikov kernel with a bandwidth of 0.001. For details on the specification of the propensity scores, see Section 4.1. Approximate standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Percentage effects are calculated as estimate divided by average R&D intensity in acquired firms in year *t*-1.

Because we match firms based on the propensity score instead of the underlying covariates, we need to assess how successful the matching has been in terms of balancing differences in the included covariates between acquired and matched non-acquired firms. Table A2 in the Appendix presents some basic indicators of the quality of the matching for the Epanechnikov kernel with a bandwidth of 0.001. This is the matching estimator that performs best in terms of balancing the covariates and which we use throughout the analysis.

One commonly used indicator of matching quality is the standardized bias of a covariate, which is defined as the difference of the sample means in the acquired and non-acquired group as a percentage of the square root of the average of the sample variance in the two groups (see Rosenbaum and Rubin, 1985). A value above 20 for this statistic is generally considered to be problematic. However, as can be seen from the table the standardized bias for any covariate is well below this figure. The table also reports *t*-values and accompanying *p*-values from a test of differences in covariate means between the two groups. As can be seen, there are no significant differences in the means for any of the covariates. Finally, the table reports pseudo $R^2$ values before and after matching. This statistic indicates how well the covariates in the propensity score explain the probability of acquisition. After matching, the value should be fairly low because there should be no systematic differences in the distribution of covariates between acquired and matched non-acquired firms. As can be seen, the value drops to virtually zero after matching. Overall, the different balancing indicators suggest that the quality of the matching is fairly good.

The public debate in Sweden has been particularly focused on how large Swedish MNEs are affected by foreign acquisition. Concerns have been raised about what happens to both the headquarters and the R&D activities of these domestic MNEs when they become foreign-owned. However, as is shown in Table 2.1 above, not many Swedish MNEs were acquired during the period we focus on. The empirical prerequisites for allowing different effects of foreign acquisitions depending on the status of the targeted firm are therefore rather limited. Despite this limitation, Table 4.3 reports the effect of foreign acquisition on R&D intensity depending on whether a Swedish MNE or a Swedish non-MNE is acquired. In neither case do we find any significant effects of foreign acquisition on R&D in targeted firms. Note that the results for Swedish MNEs are based on only 28 acquisitions.

**Table 4.3.** Matching estimates of the effects of foreign acquisitions on R&D intensity by firm type.

| | non-MNE | | Swedish MNE | |
|---|---|---|---|---|
| | Estimate | % | Estimate | % |
| *t*+1 | 0.0015 | 46.8 | 0.0037 | 18.8 |
| | (0.0012) | | (0.0086) | |
| *t*+3 | 0.0002 | 6.2 | -0.0094 | -47.7 |
| | (0.0014) | | (0.0095) | |
| *t*+5 | 0.0004 | 12.5 | 0.0043 | 21.8 |
| | (0.0011) | | (0.0116) | |
| Untreated | 5,218 | | 1,242 | |
| Treated | 214 | | 28 | |

*Notes:* The estimates are based on conditional difference-in-differences matching using an Epanechnikov kernel with a bandwidth of 0.001. For details on the specification of the propensity scores, see Section 4.1. Approximate standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Percentage effects are calculated as estimate divided by average R&D intensity in acquired firms in year *t*-1.

Neither our present study nor the earlier study by Bandick et al. (2014) have found a negative effect on R&D in Swedish firms targeted by foreign MNEs. These results run counter to many of the contentions that have been aired in the Swedish public debate on this issue. In Bandick et al. (2014), the impact was even positive and significant during a period when many large Swedish MNEs became foreign owned, whereas we detect no effect during a period when only a few Swedish MNEs were acquired by foreign MNEs. We have, however, no explanation as to why the results differ between the studies.

### 4.3 Effects of foreign acquisitions on skill intensity

A limitation of the analysis thus far is that it only pertains to firms with 50 employees or more. This is because R&D data in Sweden primarily have been collected for larger firms. However, we know from the descriptive statistics in Table 2.1 that foreign firms primarily target small domestic firms. During the period in question, seven out of ten acquired firms had fewer than 50 employees. Even though the majority of takeovers seem to concern smaller firms, the academic literature has paid relatively little attention to the consequences of foreign acquisitions of smaller firms. For this group of firms, we have no information on R&D activities, but there are alternative ways to study how foreign takeovers affect high-skilled activities in targeted firms. One such approach is to examine the effect on the share of high-skilled labour in targeted firms. An obvious advantage of using skill intensity as the outcome variable in the analysis is that this variable is available for the entire Swedish business sector on an annual basis and without restriction on firm size.

Table 4.4 presents matching estimates of the effects of foreign acquisitions on skill intensity by firm sector and size. Again, the reported results are based on the Epanechnikov kernel using a bandwidth of 0.001. Interestingly, for small firms in the entire business sector, we find a positive and significant effect of foreign acquisition on skill intensity in targeted firms. Expressed as percentages, the initial effect is about 5 percent and the effect increases slightly thereafter and stabilizes at around 9 percent in the third to fifth year after acquisition. For larger firms, we find no significant effects of foreign takeovers on skill intensity in acquired firms.

Looking at firms in the manufacturing industry, the results are less stable but tend to indicate positive effects in the short run for both smaller and larger targeted firms. The estimated effects for firms in the manufacturing industry also tend to be somewhat larger, generally around 10-15 percent, compared to the effects for firms in the entire business sector.

All of the above results are robust across the alternative matching estimators (see Table A3 in the Appendix), and the different balancing indicators also suggest that the quality of the matching is satisfactory (see table A4 in the Appendix).

**Table 4.4.** Matching estimates of the effects of foreign acquisitions on skill intensity by sector and size.

| | All sectors | | | | Manufacturing | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-49 | | 50+ | | 1-49 | | 50+ | |
| | Estimate | % | Estimate | % | Estimate | % | Estimate | % |
| *t* | 0.0089*** | 4.9 | 0.0015 | 1.2 | 0.0139* | 11.7 | 0.0050* | 7.4 |
| | (0.0030) | | (0.0021) | | (0.0075) | | (0.0026) | |
| *t*+1 | 0.0140*** | 7.7 | -0.0015 | -1.2 | 0.0112 | 9.5 | 0.0083** | 12.3 |
| | (0.0036) | | (0.0033) | | (0.0088) | | (0.0040) | |
| *t*+2 | 0.0172*** | 9.5 | -0.0010 | -0.8 | 0.0187* | 15.8 | 0.0122** | 18.1 |
| | (0.0042) | | (0.0038) | | (0.0108) | | (0.0048) | |
| *t*+3 | 0.0164*** | 9.0 | -0.0043 | -3.4 | 0.0106 | 9.0 | 0.0104* | 15.5 |
| | (0.0046) | | (0.0044) | | (0.0121) | | (0.0055) | |
| *t*+4 | 0.0154*** | 8.5 | -0.0029 | -2.3 | 0.0179 | 15.1 | 0.0047 | 7.0 |
| | (0.0047) | | (0.0047) | | (0.0129) | | (0.0055) | |
| *t*+5 | 0.0149*** | 8.2 | 0.0003 | 0.2 | 0.0147 | 12.4 | 0.0056 | 8.3 |
| | (0.0049) | | (0.0062) | | (0.0130) | | (0.0065) | |
| Untreated | 383,549 | | 7,922 | | 47,353 | | 3,156 | |
| Treated | 1,608 | | 250 | | 206 | | 104 | |

*Notes:* The estimates are based on conditional difference-in-differences matching using an Epanechnikov kernel with a bandwidth of 0.001. For details on the specification of the propensity scores, see Section 4.1. Approximate standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Percentage effects are calculated as estimate divided by average skill intensity in acquired firms in year *t*-1.

Table 4.5 presents the estimated effects on skill intensity depending on whether a Swedish MNE or a Swedish non-MNE is acquired by a foreign enterprise. Not surprisingly, we find effects for small non-MNE firms that are very similar to those above for small firms in the entire business sector. Almost all of the small firms belong to the non-MNE group. For larger non-MNE firms, we find no significant effects of foreign acquisition on skill intensity in targeted firms.

From the bottom row of Table 4.5 it is evident that the number of acquired (treated) Swedish MNEs is very limited. Bearing this in mind, the results do not indicate any significant effects of foreign takeovers on skill intensity in either smaller or larger targeted Swedish MNEs.

Our analysis provides no evidence that high-skilled activities are being relocated to the home countries of the acquiring firms. On the contrary, acquiring firms seem to be taking advantage of and developing the knowledge base in the acquired small firms. The fact that a positive effect appears in small firms might be a consequence of technology transfers from the acquiring foreign MNEs to targeted small Swedish firms, a transfer that in turn leads to increased demand for skilled labour.

**Table 4.5.** Matching estimates of the effects of foreign acquisitions on skill intensity by firm type and size.

| | non-MNE | | | | Swedish MNE | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-49 | | 50+ | | 1-49 | | 50+ | |
| | Estimate | % | Estimate | % | Estimate | % | Estimate | % |
| *t* | 0.0088*** | 4.9 | 0.0006 | 0.5 | 0.0073 | 2.2 | -0.0006 | -0.4 |
| | (0.0030) | | (0.0024) | | (0.0379) | | (0.0073) | |
| *t*+1 | 0.0141*** | 7.9 | -0.0013 | -1.1 | 0.0122 | 3.6 | -0.0024 | -1.5 |
| | (0.0036) | | (0.0039) | | (0.0480) | | (0.0087) | |
| *t*+2 | 0.0179*** | 10.0 | -0.0005 | -0.4 | 0.0069 | 2.1 | -0.0114 | -6.9 |
| | (0.0042) | | (0.0043) | | (0.0500) | | (0.0107) | |
| *t*+3 | 0.0173*** | 9.7 | 0.0039 | 3.2 | 0.0038 | 1.1 | -0.0148 | -9.0 |
| | (0.0047) | | (0.0050) | | (0.0532) | | (0.0127) | |
| *t*+4 | 0.0163*** | 9.1 | -0.0029 | -2.4 | -0.0170 | -5.1 | 0.0080 | 4.9 |
| | (0.0048) | | (0.0051) | | (0.0514) | | (0.0171) | |
| *t*+5 | 0.0158*** | 8.8 | 0.0016 | 1.3 | 0.0019 | 0.6 | -0.0032 | -1.9 |
| | (0.0049) | | (0.0070) | | (0.0615) | | (0.0194) | |
| Untreated | 375,719 | | 4,992 | | 2,085 | | 1,170 | |
| Treated | 1,577 | | 205 | | 20 | | 26 | |

*Notes:* The estimates are based on conditional difference-in-differences matching using an Epanechnikov kernel with a bandwidth of 0.001. For details on the specification of the propensity scores, see Section 4.1. Approximate standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Percentage effects are calculated as estimate divided by average skill intensity in acquired firms in year *t*-1.

*Other studies on skill upgrading using Swedish data*

Nilsson Hakkala et al. (2014) is a recent study of foreign acquisitions on skill upgrading and on job tasks in targeted firms. In contrast to our study, they found no impact of foreign acquisitions on skill upgrading in targeted firms. Their period of study was 1996 to 2005, and they examined firms with 20 employees or more in the private sector. An analysis of job tasks requires occupational data, and as we pointed out in section 2.1 a complete register on individuals' occupations in Sweden is only available from 2001. This means that Nilsson Hakkala et al. (2014) were obliged to use a dataset, the Survey of wages and salaries from Statistics Sweden, where smaller firms are heavily underrepresented.[28]

In this survey of the private business sector, a stratified sample according to industry affiliation and firm size is drawn and larger firms have a higher probability of being sampled.

[28] An indication that this sample of firms is quite different from the total population of firms is that in Table 2 of Nilsson Hakkala et al. (2014) there is no difference between MNEs and non-MNEs in the shares of employees with higher education. This is in stark contrast to our data, where in Figure 2.5 the skill intensity is significantly higher in MNEs.

In Table A6 in the Appendix, we can see the difference between register data and the survey in the number of firms of different size classes. For instance, in the size class 20-49 employees, only 11 percent of the firms in the register are included in the survey.[29] Individual wages and occupational codes for all individuals in the selected firms in the survey are collected. The sample of individuals in the survey includes around 50 percent of the individuals in the private business sector, but apparently the share of the firms is much less, slightly more than 3 percent.

We believe that this underrepresentation of smaller firms in the sample analysed by Hakkala et al. (2014) contributes significantly to explaining the difference in the results between their study and ours, but a more definite answer can only be obtained if the complete registers on individuals' occupations and educational attainments from 2001 onwards are used. However, this is a question outside the scope of our present study.

Another study of the effects of foreign acquisitions on skill upgrading in acquired firms is Bandick and Hansson (2009). They examined manufacturing firms with 50 employees or more between 1993 and 2002, and they found some support for a relative increase in the demand for skilled labour in non-MNEs, but not in MNEs, that become foreign-owned. The outcome variable in Bandick and Hansson (2009) was slightly different from ours.[30] Although there are differences in relation to our study, their results show some similarities because in Table 4.4 we saw that foreign acquisitions had positive effects on skill upgrading, at least in the short run, in targeted manufacturing firms with 50 employees or more.

[29] Interestingly, we notice in Table A6 in Appendix that, while the share of firms in the survey is decreasing the smaller the firms in a size class are, the corresponding shares in our cohort are more or less constant over the different size classes, around 70 percent.

[30] They use the wage bill share of employees with some post-secondary education (ISCED 4-8), while our outcome variable is the employment share of employees with three years or more of post-secondary education (ISCED 6-8).

# 5. Concluding remarks

The impact of foreign acquisitions on R&D and other high-skilled activities in MNEs and larger firms has been the subject of several studies, but the effect on skill upgrading in smaller, non-MNE firms has been less explored. By using register data on educational attainment and variables from the firms' balance sheets and income statements, we can include all Swedish firms with one employee or more. In the group of firms with fewer than 50 employees, there are quite a few foreign acquisitions in our study period and we find that foreign takeovers of such firms appear to have had a clearly positive effect on the share of high-skilled labour. An explanation for this might be that international technology transfers from foreign MNEs to small non-MNEs, on the condition that the resulting technical change in the targeted firms is skill-biased, will increase the demand for skills and skill upgrading will occur in the acquired firms. On the other hand, we find no impact on the share of high-skilled labour in MNEs and in firms with 50 employees or more, possibly because in these firms the potential for technology transfer is less. In other words, foreign acquisitions seem to primarily boost skill intensities, and probably the level of technology, in small, non-MNE targeted firms.

We also add to the literature on foreign acquisitions and R&D. In contrast to former studies on Swedish data, we examine a period with no spectacular increase in foreign ownership (the early 2000s), and we find no effect on R&D expenditures in firms acquired by foreign MNEs. Taken together with the results in Bandick et al. (2014), which analysed a more turbulent period regarding foreign acquisitions in Sweden (the late 1990s) and obtained a positive effect on R&D expenditures in targeted firms, we conclude that there seem to be no grounds to worry about the impact of foreign acquisitions on R&D (and other high-skilled activities). Hence, there is no need for policymakers to consider restrictions on foreign ownership because advanced activities might move abroad; if anything, there are reasons to welcome foreign acquisitions.

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# Appendix

**Table A1.** Matching estimates of the effects of foreign acquisitions on R&D intensity by sector. Alternative matching algorithms.

| | All sectors | | | Manufacturing | | |
|---|---|---|---|---|---|---|
| | NN(1) | E(0.01) | E(0.005) | NN(1) | E(0.01) | E(0.005) |
| *t*+1 | 0.0002 | -0.0007 | -0.0009 | 0.0016 | -0.0002 | 0.0002 |
| | (0.0018) | (0.0022) | (0.0025) | (0.0023) | (0.0055) | (0.0058) |
| *t*+3 | 0.0005 | -0.0023 | -0.0025 | -0.0014 | -0.0013 | -0.0016 |
| | (0.0021) | (0.0017) | (0.0018) | (0.0037) | (0.0029) | (0.0030) |
| *t*+5 | 0.0015 | -0.0018 | -0.0015 | 0.0002 | -0.0003 | -0.0007 |
| | (0.0030) | (0.0020) | (0.0022) | (0.0055) | (0.0040) | (0.0042) |
| Untreated | 8,312 | 8,312 | 8,312 | 3,386 | 3,386 | 3,386 |
| Treated | 282 | 279 | 276 | 131 | 125 | 122 |

*Notes:* The estimates are based on conditional difference-in-differences matching using single nearest neighbour matching, NN(1), and Epanechnikov kernel matching, E, with bandwidths 0.01 and 0.005. For details on the specification of the propensity scores, see Section 4.1. Approximate standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Percentage effects are calculated as estimate divided by average R&D intensity in acquired firms in year *t*-1.

**Table A2.** Balancing indicators for the R&D intensity matching estimates.

| | All sectors | | | | | Manufacturing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | | | *t*-test | | Mean | | | *t*-test | |
| | Treated | Matched control | Std. bias | $t$ | $p > \|t\|$ | Treated | Matched control | Std. bias | $t$ | $p > \|t\|$ |
| R&D intensity | 0.0057 | 0.0044 | 4.3 | 0.60 | 0.549 | 0.0083 | 0.0093 | -3.1 | -0.21 | 0.832 |
| Skill intensity | 0.1269 | 0.1321 | -3.2 | -0.34 | 0.737 | 0.0658 | 0.0624 | 4.1 | 0.32 | 0.752 |
| Labor productivity | 579.1 | 569.6 | 1.9 | 0.25 | 0.803 | 556.3 | 578.4 | -7.5 | -0.62 | 0.537 |
| Capital intensity | 348.1 | 335.2 | 0.5 | 0.12 | 0.907 | 373.7 | 399.7 | -5.6 | -0.41 | 0.680 |
| Size | 265.8 | 254.8 | 1.7 | 0.20 | 0.841 | 292.9 | 258.1 | 4.7 | 0.33 | 0.74 |
| Age | 11.79 | 11.45 | 5.8 | 0.61 | 0.541 | 13.61 | 13.06 | 9.7 | 0.69 | 0.494 |
| Swedish MNE | 0.1373 | 0.1575 | -4.9 | -0.64 | 0.521 | 0.1468 | 0.1817 | -8.2 | -0.69 | 0.489 |
| Foreign presence | 0.2711 | 0.2774 | -3.6 | -0.39 | 0.694 | 0.3397 | 0.3393 | 0.2 | 0.01 | 0.989 |
| Pseudo-$R^2$ before | 0.087 | p>chi$^2$ | 0.000 | | | 0.127 | p>chi$^2$ | 0.000 | | |
| Pseudo-$R^2$ after | 0.003 | p>chi$^2$ | 0.999 | | | 0.011 | p>chi$^2$ | 0.993 | | |

*Notes:* The specifications of the propensity score on which the matching is based also include squared labor productivity, capital intensity, size and age, 3-digit ISIC Rev. 3.1 industry dummies and dummies for the year of potential foreign acquisition. See Table 2.2 for additional definition of variables.

**Table A3.** Matching estimates of the effects of foreign acquisitions on skill intensity by sector and size. Alternative matching algorithms.

| | All sectors | | | | | | Manufacturing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-49 | | | 50+ | | | 1-49 | | | 50+ | | |
| | NN(1) | E(0.01) | E(0.005) | NN(1) | E(0.01) | E(0.005) | NN(1) | E(0.01) | E(0.005) | NN(1) | E(0.01) | E(0.005) |
| *t* | 0.0143*** | 0.0090*** | 0.0092*** | 0.0004 | 0.0015 | 0.0013 | 0.0131 | 0.0131* | 0.0150** | 0.0051** | 0.0050** | 0.0058** |
| | (0.0039) | (0.0030) | (0.0030) | (0.0027) | (0.0020) | (0.0020) | (0.0090) | (0.0074) | (0.0074) | (0.0026) | (0.0023) | (0.0024) |
| *t*+1 | 0.0167*** | 0.0141*** | 0.0143*** | -0.0016 | -0.0017 | -0.0018 | 0.0036 | 0.0103 | 0.0126* | 0.0099*** | 0.0062* | 0.0070** |
| | (0.0048) | (0.0036) | (0.0036) | (0.0037) | (0.0030) | (0.0031) | (0.0117) | (0.0088) | (0.0088) | (0.0033) | (0.0033) | (0.0035) |
| *t*+2 | 0.0215*** | 0.0176*** | 0.0177*** | 0.0001 | -0.0020 | -0.0025 | 0.0017 | 0.0184* | 0.0196* | 0.0072 | 0.0071* | 0.0072* |
| | (0.0054) | (0.0042) | (0.0042) | (0.0044) | (0.0036) | (0.0036) | (0.0129) | (0.0106) | (0.0106) | (0.0052) | (0.0042) | (0.0043) |
| *t*+3 | 0.0206*** | 0.0168*** | 0.0168*** | -0.0040 | -0.0043 | -0.0054 | -0.0016 | 0.0108 | 0.0120 | 0.0017 | 0.0030 | 0.0032 |
| | (0.0059) | (0.0046) | (0.0046) | (0.0055) | (0.0042) | (0.0042) | (0.0139) | (0.0119) | (0.0119) | (0.0067) | (0.0048) | (0.0050) |
| *t*+4 | 0.0207*** | 0.0159*** | 0.0159*** | 0.0023 | -0.0024 | -0.0033 | 0.0005 | 0.0170 | 0.0184 | -0.0015 | -0.0057 | -0.0050 |
| | (0.0062) | (0.0047) | (0.0047) | (0.0064) | (0.0051) | (0.0051) | (0.0152) | (0.0126) | (0.0127) | (0.0069) | (0.0049) | (0.0051) |
| *t*+5 | 0.0194*** | 0.0157*** | 0.0156*** | 0.0069 | -0.0007 | -0.0018 | -0.0031 | 0.0132 | 0.0143 | 0.0046 | -0.0046 | -0.0040 |
| | (0.0065) | (0.0049) | (0.0049) | (0.0078) | (0.0063) | (0.0064) | (0.0163) | (0.0126) | (0.0127) | (0.0073) | (0.0057) | (0.0060) |
| Untreated | 383,549 | 383,549 | 383,549 | 7,922 | 7,922 | 7,922 | 47,353 | 47,353 | 47,353 | 3,156 | 3,156 | 3,156 |
| Treated | 1,613 | 1,613 | 1,613 | 270 | 269 | 267 | 213 | 211 | 210 | 129 | 123 | 122 |

*Notes:* The estimates are based on conditional difference-in-differences matching using single nearest neighbor matching, NN(1), and Epanechnikov kernel matching, E, with bandwidths 0.01 and 0.005. For details on the specification of the propensity scores, see Section 4.1. Approximate standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. Percentage effects are calculated as estimate divided by average skill intensity in acquired firms in year *t*-1.

**Table A4.** Balancing indicators for the skill intensity matching estimates, all sectors.

| | 1-49 | | | | | 50+ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | | | *t*-test | | Mean | | | *t*-test | |
| | Treated | Matched control | Std. bias | $t$ | $p > \|t\|$ | Treated | Matched control | Std. bias | $t$ | $p > \|t\|$ |
| Skill intensity | 0.1729 | 0.1712 | 0.7 | 0.18 | 0.857 | 0.1209 | 0.1321 | -7.1 | -0.73 | 0.466 |
| Labor productivity | 725.8 | 670.4 | 3.2 | 0.81 | 0.416 | 563.8 | 571.2 | -1.6 | -0.23 | 0.815 |
| Capital intensity | 768.8 | 865.3 | -1.0 | -0.25 | 0.806 | 281.1 | 356.9 | -2.8 | -0.79 | 0.431 |
| Size | 10.68 | 11.04 | -4.0 | -0.96 | 0.337 | 274.5 | 259.2 | 2.3 | 0.28 | 0.779 |
| Age | 6.88 | 6.99 | -2.0 | -0.57 | 0.570 | 11.46 | 11.28 | 3.0 | 0.31 | 0.756 |
| Swedish MNE | 0.0199 | 0.0254 | -4.2 | -1.04 | 0.297 | 0.1400 | 0.1679 | -6.7 | -0.86 | 0.389 |
| Foreign presence | 0.2479 | 0.2479 | -0.0 | -0.00 | 0.997 | 0.2768 | 0.2846 | -4.4 | -0.47 | 0.641 |
| Pseudo-$R^2$ before | 0.115 | p>chi$^2$ | 0.000 | | | 0.085 | p>chi$^2$ | 0.000 | | |
| Pseudo-$R^2$ after | 0.001 | p>chi$^2$ | 0.986 | | | 0.011 | p>chi$^2$ | 0.793 | | |

*Notes:* The specifications of the propensity score on which the matching is based also include squared labor productivity, capital intensity, size and age, 3-digit ISIC Rev. 3.1 industry dummies and dummies for the year of potential foreign acquisition. See Table 2.2 for additional definition of variables.

**Table A5.** Balancing indicators for the skill intensity matching estimates, manufacturing.

| | 1-49 | | | | | 50+ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | | | *t*-test | | Mean | | | *t*-test | |
| | Treated | Matched control | Std. bias | $t$ | $p > \|t\|$ | Treated | Matched control | Std. bias | $t$ | $p > \|t\|$ |
| Skill intensity | 0.1070 | 0.1079 | -0.5 | -0.04 | 0.966 | 0.0694 | 0.0586 | 12.6 | 1.01 | 0.315 |
| Labor productivity | 535.2 | 648.7 | -5.1 | -0.64 | 0.526 | 565.9 | 574.0 | -2.6 | -0.22 | 0.823 |
| Capital intensity | 223.3 | 232.9 | -1.4 | -0.23 | 0.815 | 393.2 | 424.8 | -6.5 | -0.42 | 0.678 |
| Size | 15.73 | 15.88 | -1.4 | -0.12 | 0.903 | 298.6 | 241.2 | 7.6 | 0.56 | 0.574 |
| Age | 9.17 | 9.32 | -2.6 | -0.25 | 0.802 | 13.60 | 13.21 | 6.9 | 0.48 | 0.631 |
| Swedish MNE | 0.0146 | 0.0164 | -1.3 | -0.15 | 0.878 | 0.1731 | 0.1853 | -2.8 | -0.23 | 0.819 |
| Foreign presence | 0.2883 | 0.2889 | -0.3 | -0.03 | 0.977 | 0.3253 | 0.3349 | -5.0 | -0.36 | 0.716 |
| Pseudo-$R^2$ before | 0.106 | p>chi$^2$ | 0.000 | | | 0.125 | p>chi$^2$ | 0.000 | | |
| Pseudo-$R^2$ after | 0.003 | p>chi$^2$ | 0.999 | | | 0.013 | p>chi$^2$ | 0.987 | | |

*Notes:* The specifications of the propensity score on which the matching is based also include squared labor productivity, capital intensity, size and age, 3-digit ISIC Rev. 3.1 industry dummies and dummies for the year of potential foreign acquisition. See Table 2.2 for additional definition of variables.

**Table A6.** Comparison of the number of firms in different size classes in the private business sector in register data from the year 2000, in the year 2000 for our sample cohort 1999-2005, and in SCB's survey of wages and salaries 2000.

| Firm size | Register | Cohort | | Survey | |
|---|---|---|---|---|---|
| (employees) | Number | Number | Share | Number | Share |
| 1-19 | 196,625 | 139,281 | 0.71 | 4,055 | 0.02 |
| 20-49 | 8,968 | 6,178 | 0.69 | 973 | 0.11 |
| 50-99 | 2,606 | 1,880 | 0.72 | 893 | 0.34 |
| 100-199 | 1,305 | 912 | 0.70 | 489 | 0.37 |
| 200-499 | 739 | 532 | 0.72 | 484 | 0.65 |
| 500+ | 458 | 346 | 0.76 | 419 | 0.91 |
| Total | 210,701 | 149,129 | 0.70 | 7,313 | 0.03 |

*Note*: Share is the share in the cohort or in the survey of the firms in register data.