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Inward FDI and demand for skills in manufacturing firms in Sweden

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Abstract We observe a substantial increase in foreign ownership in Sweden in the 1990s. Did that have any effect on relative demand for skilled labor? Has technology transfers—often associated with inward FDI—led to an increased demand for skills due to skilled-biased technical change? Are there any grounds for the concerns in the public Swedish debate that more skilled activities have been moved to other countries where the headquarters are located? Estimating relative labor demand at the firm level and using propensity score matching with difference-in-difference estimation, we obtain support for that relative demand for skilled labor tend to rise in non-multinationals (non-MNEs)—but not in multinationals (MNEs)—that become foreign-owned. Other interesting findings are that larger presence of foreign MNEs in an industry appears to have a positive impact on the relative demand for skills in Swedish MNEs within the same industry and that the elasticity of substitution between skilled and less-skilled labor seems to be lower in MNEs than in non-MNEs.

Keywords Foreign ownership · Skill upgrading · Wage differentials

JEL Classification F23 · J23 · J31

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1 Introduction

The employment share of skilled labor, i.e., employees with a post-secondary education, has grown continuously in Sweden over the last few decades. The increasing skill share in the 1990s might be explained by a larger supply of skilled labor owing to a heavy expansion of higher education in Sweden. Yet it seems that factors on the demand side have dominated since at the same time we observe rising relative wages of skilled labor.[1] In particular, two factors on the demand side have been emphasized in the literature, namely skilled-biased technological change and increased import competition from low-wage countries, and numerous studies on different countries have tried to quantify the importance of these factors.[2]

Another conceivable channel through which the increased internationalization may affect the relative demand for skills is foreign direct investment (FDI). Swedish headquartered multinational enterprises (MNEs) have been significant employers in Swedish manufacturing for a long period of time. Hansson (2005) examines the impact of their localization behavior (outward FDI) on relative labor demand in their Swedish parents.[3] He finds increased employment in affiliates in low-wage countries to be positively related to skill upgrading in the Swedish parents. This indicates that within Swedish MNEs, less-skilled activities are transferred to low-wage countries. Changes in employment in affiliates in other high-wage countries are, on the other hand, unrelated to parent skill upgrading. However, increased inward FDI to Sweden is a characteristic feature of the 1990s, resulting in rapidly growing foreign ownership.[4] Does more inward FDI explain the increased relative demand for skilled labor in Sweden in the 1990s?

The theory of MNEs assumes that MNEs possess firm-specific assets, such as technological assets, that give them an advantage relative to indigenous firms. This is necessary to compensate for the disadvantages they face in foreign countries and thus, to be able to establish themselves abroad (Dunning 1977). It is often believed that MNEs are important conveyers of technology internationally since one motive for FDI is to profit from utilizing firm-specific technology intensive assets in many countries. By transferring technology abroad, MNEs will affect technological change in their host countries. Consequently, if inward FDI has an impact on technological change, and if it is skill-biased, increased foreign ownership might have a positive influence on host country relative demand for skilled labor. Parallel trends in Sweden in the 1990s between rising shares of skilled labor, a growing wage differential between skilled and less-skilled labor, and increased inward FDI suggest that the larger presence of foreign affiliates is possibly an explanation for skill upgrading and rising inequality.

Another motive for FDI is technology sourcing. Technological capabilities of indigenous firms give rise to country-specific advantages, which attract foreign firms. If technology sourcing causes FDI, a reasonable assumption is that the

[1] Section 2 discusses this more in depth.

[2] Machin and Van Reenen (1998), Anderton and Brenton (1998), Hansson (2000) etc.

[3] Similar studies on US and Japanese multinationals are found in Slaughter (2000) and Head and Ries (2002).

[4] See Fig. 1 in Sect. 2 below.

acquired domestic firms keep the same skill mix after takeover, which means that the relative demand for skills is unaffected by inward FDI.

The increased foreign ownership has aroused some anxiety in the Swedish public debate. Jonung (2002) asserts that acquisitions of Swedish MNEs by foreign firms, where the headquarters move abroad, entail less employment of skilled labor in Sweden. He argues that when the headquarters leave, other functions using qualified employees will also disappear. Activities such as research and development (R&D) and advanced production will gradually be removed from Sweden. Increased inward FDI is then negatively related to skill upgrading.

Lower relative demand for skilled labor in the presence of more foreign-owned firms is also consistent with the recent MNE models where foreign affiliates are less skill-intensive than their parents. The reason is that skill-intensive activities, such as headquarter service and R&D, are assumed to be located in the parent country. However, in these models, the implications of greater MNE activities on skill upgrading and wage inequality are ambiguous (Markusen and Venables 1997).

Evidently, it may be argued that inward FDI has various, and sometimes opposite, effects on relative demand for skilled labor, which highlight the need for empirical work. The purpose of the paper is to examine the impact of growing inward FDI and rising foreign-affiliate presence on skill upgrading and increased wage inequality in Swedish manufacturing from 1993 to 2002.

The paper is related to, Feenstra and Hanson (1997), Blonigen and Slaughter (2001) and Taylor and Driffield (2005) and we contrast our findings to theirs.[5] Likewise, as in all these studies, we follow the approach by Berman et al. (1994) and estimate a relative labor demand function controlling for technological change. Unlike these studies, we have access to firm-level data, which is advantageous, since the channels discussed above, through which inward FDI may affect relative demand for skills, should mainly appear at the firm level. Feenstra and Hanson (1997) and Blonigen and Slaughter (2001) are studies at the industry level that capture such direct effects at the firm level, as well as indirect effects through technology and wage spillovers from foreign-owned firms to indigenous firms within the same industry. Moreover, Taylor and Driffield (2005) provide an industry-level analysis, but they entirely focus on the indirect effects of the presence of foreign-owned firms on domestic firms.

An improvement as compared to the previous literature estimating changes in relative demand for skilled labor is that we are able to more appropriately take changes in relative wages between skilled and less-skilled labor into account. Access to a new, large data set on individual wages makes it possible to generate relative wages at the industry level over the period studied.

[5] Feenstra and Hanson (1997) use regional data at the industry level in Mexican manufacturing 1975–1988. Blonigen and Slaughter (2001) and Taylor and Driffield (2005) are studies on developed countries, the former on US manufacturing industries 1977–1994 and the latter on UK manufacturing 1983–1992. A slightly different study on the same topic is Figini and Görg (1999). Based on a model by Aghion and Howitt (1998), they argue that there should be an inverted-U shape relationship between wage inequality and the presence of foreign-owned firms; something for which they also find empirical support using Irish data.

To preview our result, there seem to be no grounds for the concerns that foreign-owned firms move out skill-intensive activities from Sweden. If anything, the relative demand for skilled labor appears to increase in non-MNEs that become foreign-owned. In addition, we find that the larger presence of foreign MNEs in an industry has a positive effect on the relative demand for skilled labor in Swedish MNEs within the same industry, while it has no effect on non-MNEs. Moreover, the elasticity of substitution between skilled and less-skilled labor is lower in MNEs than in non-MNEs.

Domestic firms taken over by foreign firms are not randomly acquired, rather their characteristics differ systematically from non-acquired firms. If these characteristics also influence post-acquisition relative demand and are not controlled for, biased estimates of the effects of foreign ownership on relative demand for skills will arise. One method for dealing with likely endogenity problems is to combine propensity score matching with difference-in-difference estimation.[6] Therefore, as a complement to our standard labor demand analysis we also apply such an approach, and when it comes to the post-acquisition relative labor demand effects we arrive at similar results.

Recently, two studies have been published that use panel data at the disaggregated level to examine the impact of foreign ownership on the relative employment of skilled labor. Almeida (2007) carries out an analysis on Portuguese firms during the 1990s and she finds no significant changes in the average education in the workforce following foreign acquisitions. Huttunen (2007) investigates Finnish manufacturing establishments 1988–2001 and her results are mixed. While a regression model using the whole data shows that foreign acquisitions have no effect on the share of highly educated workers in the plant's employment, matching and regression analysis on the matched sample indicates that there is a small decrease in the share of highly educated workers after acquisitions.

The outline of the paper is the following. In Sect. 2.1, we present our data and how foreign ownership and skill intensities in MNEs (Swedish and foreign-owned) and non-MNEs have developed over the period studied. Among Swedish social scientists there have been discussions about whether the growing employment of skilled labor is due to factors on the supply or the demand side. In Sect. 2.2, we contribute to that debate by showing some new estimates on the trend in relative wages between skilled and less-skilled labor in Swedish manufacturing from 1993 to 2002, which we then plot against the employment share of skilled labor. From this analysis we conclude that factors on the demand side dominate, and in Sect. 3, we examine the effects of increased foreign ownership on relative demand for skills in Swedish manufacturing. In Sect. 3.1 we set out a framework for studying relative labor demand. Section 3.2 presents some empirical results from analyzing the impact of foreign ownership on relative demand for skilled labor. Section 3.3 contains a brief overview of propensity score matching and difference-in-difference estimation, and in Sect. 3.4, we report difference-in-difference matching results on post-acquisition effects on the relative demand for skills. Section 4 summarizes and concludes.

[6] See, e.g., Blundell and Costas Dias (2000).

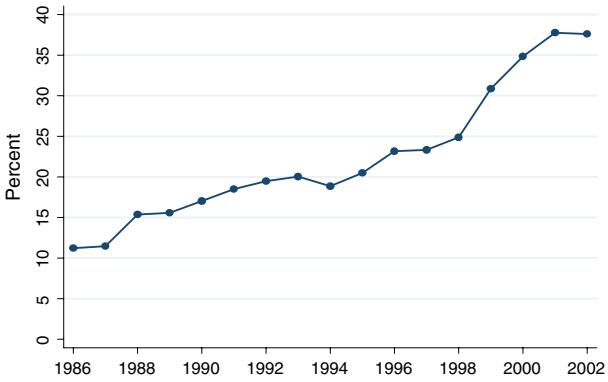

Fig. 1 Share of employment in foreign-owned firms in Swedish manufacturing 1986–2002 (percent). *Note*: Manufacturing firms with 20 employees or more. Firms are foreign-owned if foreigners have more than 50% of the voting rights

2 Data and description

2.1 Foreign ownership and skill intensities in MNEs and non-MNEs

The data in our microeconomic database come from Statistics Sweden (SCB) and the Swedish Institute for Growth Policy Studies (ITPS). The database enables us to link information on the financial accounts of enterprises, register-based labor statistics (i.e., education levels and incomes) and individual wage statistics. Moreover, from 1993 and onwards, it is possible to divide firms into foreign-owned firms, Swedish MNEs and other Swedish firms (non-MNEs). Here, we use a panel of firms including all manufacturing firms with 50 employees or more.

Ever since the mid-1980s, there has been a steady increase in foreign ownership in Swedish manufacturing (and in the business sector as a whole). Foreign-owned firms are firms where foreigners possess more than 50% of the voting rights. Figure 1 shows that in 1986, 12% of the manufacturing employment is in foreign-owned firms, while this share has risen to 37% in 2002. Above all, after 1994, in connection with the Swedish membership in the European Union (EU), foreign ownership in Swedish manufacturing really seems to have taken off. Between 1994 and 2002, the share of employment in foreign-owned firms increased by more than 15 percentage points.

To a large extent, the limited foreign ownership until the mid-1980s can be explained by legal impediments to foreigners owning Swedish firms and propriety. The reason for these obstacles were in many cases purely protectionist.[7] At the end of the 1980s and at the beginning of the 1990s, a considerable amount of the obstacles to foreigners acquiring Swedish firms were abolished. This, together with a general trend of more international mergers and acquisitions in most industrial

[7] A quotation from an official report (SOU 1986, p. 143) gives an indication of the sentiments at that time: "kontrollen över svenska företag bevaras åt svenska intressen" (the control over Swedish firms should be preserved to safeguard Swedish interests). See also Henrekson and Jakobsson (2002, p. 41).

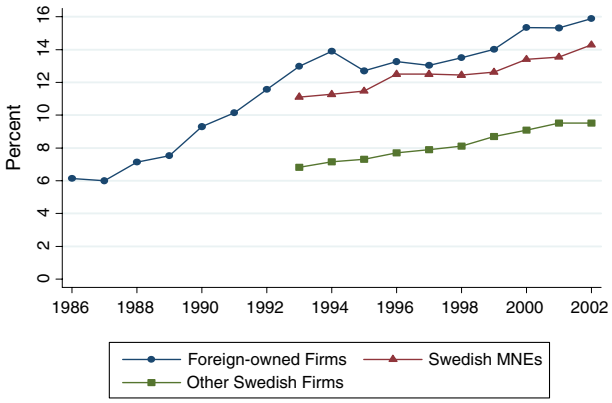

Fig. 2 Share of skilled labor in foreign-owned firms, 1986–2002, in Swedish MNEs and non-MNEs, 1993–2002, median (percent)

countries, constitute the main explanations for the increased foreign ownership in Swedish business sector.[8]

Foreign-owned firms differ from domestically owned firms in many respects. Yet, the crucial differences appear to exist between MNEs (foreign-owned firms and Swedish MNEs), on the one hand, and non-MNEs, on the other. Bandick (2008) shows that MNEs in Swedish manufacturing pay higher wages, are larger, more capital and skill intensive, and have higher productivity than non-MNEs. By now it is well documented that the gaps between MNEs and non-MNEs (even after controlling for firm and industry characteristics) are more pronounced than those between foreign-owned and domestically owned firms.[9] The multinationality of firms is thus more important than foreign ownership per se. Access to superior technology and being part in an international network are factors that may give rise to these performance gaps.

Since our main interest is associated with skill upgrading when firms become foreign-owned, we begin by taking a closer look at the development of skill intensities (shares of the employees with a post-secondary education) in our three types of firms: foreign-owned firms, Swedish MNEs and non-MNEs. Swedish MNEs are Swedish owned firms that have at least one affiliate abroad or are part of an enterprise group with affiliates abroad. Non-MNEs are firms that are neither Swedish MNEs nor foreign-owned firms.

From Fig. 2, it is clear that the share of skilled labor has been growing continuously in foreign-owned firms ever since 1986. From 1993 onwards, we are able to separate the domestically owned firms into Swedish MNEs and non-MNEs. The skill intensity levels are higher in MNEs than in non-MNEs; in 2002 the median

[8] Other explanations put forward are that: (i) the Swedish tax system has favored foreign ownership at the expense of private Swedish ownership, (ii) the depreciation of the Swedish krona at the beginning of the 1990s entailed that Swedish firms were particularly cheap to acquire, (iii) the Swedish "business climate" improved in the 1990s as compared to the 1980s, and (iv) due to the Swedish membership in the EU it has become more inviting to acquire Swedish firms. Jonung (2002) emphasizes the importance of the tax system, while the other explanations are discussed in, e.g., Malmberg and Sölvell (1998).

[9] See, e.g., Doms and Jensen (1998).

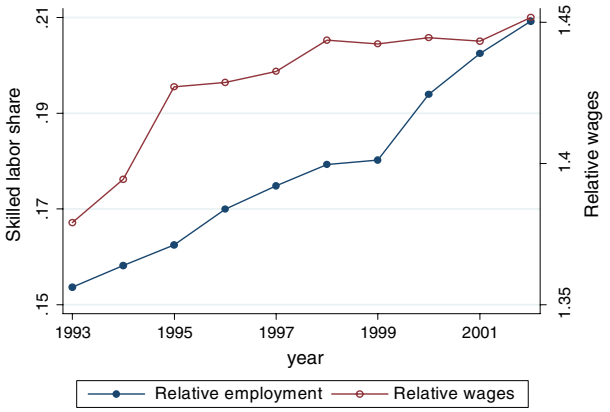

Fig. 3 Relative wages and skill share in Swedish manufacturing 1993–2002. *Note*: The relative wages between skilled and less-skilled labor are calculated from estimated wage equations (see Table 4 in Appendix 1). Skilled labor is individuals with 3 years of university education and less-skilled labor has 3 years of upper secondary school. The relative employment of skilled labor is the share with post-secondary education in total manufacturing employment

in foreign-owned firms and Swedish MNEs is around 15%, while it is just below 10% in non-MNEs. This suggests that the relative labor demand pattern differs between MNEs and non-MNEs. Yet we observe similar trends in skill shares in all types of firms, which means that there has been an overall increase in the share of skilled labor in Swedish manufacturing. Is this development due to the expansion of higher education in the 1990s or is it a result of high relative demand for skilled labor?

2.2 Growing skill shares—larger supply of skilled labor or increased demand for skills?

A simple model, where factors on the demand and supply side interact, has often been used to explain trends in relative employment and relative wages of skilled labor. While much of the international literature emphasizes factors on the demand side—skilled-biased technical change and increased competition from low-wage countries—some Swedish social scientists stress explanations on the supply side. Edin and Holmlund (1995) examine the relative wages of skilled labor (university wage premiums) from the late 1960s until the beginning of the 1990s and their finding is that the development is consistent with changes in the relative supply of skilled labor (individuals with a university education). Le Grand et al. (2001) a group of sociologists that has studied the Swedish labor market in the 1990s in an official report, conclude that the supply of skilled labor has grown faster than employers' demand.

In Fig. 3, we plot the share of skilled labor together with the relative wages between skilled and less-skilled labor over the period 1993–2002. This gives a hint as to whether changes on the demand or the supply side are most influential in explaining the development of the skill share in manufacturing. Factors on the demand side appear to be more important if the growing skill share in manufacturing is accompanied by increased relative wages. The university wage premium for individuals in manufacturing is used as a measure of relative wages.

We get the university wage premium from estimating a standard Mincerian wage equation on a new, large data set on individual wages (see Appendix 1). We compare individuals with at least 3 years of university education to those with 3 years of upper secondary school.[10] The skill share is the share of employed in manufacturing with some post-secondary education.

Figure 3 shows some interesting patterns. First, we observe a significant increase in the relative wages of skilled labor (the university wage premium) in manufacturing over the period studied 1993–2002. In 1993, skilled labor wages in manufacturing are 38% higher than less-skilled labor wages, whereas in 2002 skilled labor wages are 45% higher, i.e., between 1993 and 2002 the relative wages of skilled labor have increased by 7 percentage points. Our result deviates from that of Le Grand et al. (2001) who only found small changes in the relative wages of skilled labor, yet it is in line with Gustavsson (2004).[11]

Second, we can see that in Fig. 3, relative employment and relative wages of skilled labor move in the same direction. This indicates that although the supply of skilled labor has increased, factors on the demand side appear to dominate in explaining the growing skill share in manufacturing. Given the relative importance of factors on the demand side, it seems reasonable to base the analysis of how foreign ownership affects advanced production in Sweden on a framework that aims at explaining relative demand for skilled labor, where the effects of foreign ownership are then taken into account.

3 Relative labor demand and foreign ownership

3.1 Analytical framework

To study how foreign ownership affects relative demand for skilled labor, we follow the commonly applied approach of Berman et al. (1994).[12] The derivation of the econometric specification starts out from a translog cost function, where skilled and less-skilled labor are variable factors and physical capital is treated as a fixed factor. By assuming cost minimizing firms a firm's wage bill share of skilled labor P^W is a function of the relative wages of skilled labor (w_s/w_u), capital stock K, real output Y, and technological level T.[13] Relative labor demand can be estimated at the firm level using the following regression equation:

$$P_{jt}^{W} = \alpha + \beta_1 \ln(w_s/w_u)_{it} + \beta_2 \ln K_{jt} + \beta_3 \ln Y_{jt} + \beta_4 T_{jt} + \varepsilon_{jt}, \quad (1)$$

[10] Table 4 in Appendix 1 shows the results from the estimated wage equations in 1993 and 2002.

[11] Le Grand et al. (2001) base their estimate on LNU (Swedish Level-of-Living Survey), where the number of individuals is relatively low; less than 1,800 each year. Gustavsson (2004) uses LINDA (Longtudinal Individual Data for Sweden), where the number of individuals is much larger (16,117 in 1992 and 61,035 in 2000). The wage variable in Gustavsson (2004) is the same as ours, i.e., full time equivalent monthly wages in logs, and is from Statistics Sweden's wage statistics, whereas wage in Le Grand et al. (2001) is log hourly wage.

[12] The same method has been used by, e.g., Author et al. (1998) and Machin and Van Reenen (1998). Anderton et al. (2002) and Hansson (2000) and (2005) are applications on Swedish data.

[13] See, e.g., Berndt (1991, Sect. 9.) for a derivation.

where j indicates firms, i industry and t time and α is an intercept and ε is an error term.

An increase in the dependent variable P_{jt}^{W}—a level change in the skill-labor share of the total wage bill—indicates skill upgrading in firm j. As mentioned above our definition of skilled labor is based on educational attainment; skilled labor is employees with a post-secondary education, i.e., with more than 12 years of schooling.[14]

The relative wage regressor $\ln(w_s/w_u)_{it}$ accounts for changes in P^W due to substitution away from a more expensive factor. The coefficient β_1 is positive (negative), depending on whether the average elasticity of substitution is below (above) 1. Due to lack of good measures of the relative wage between skilled and less-skilled labor many researchers have omitted the relative wage variable. If there is perfect labor mobility, relative wages are the same in all industries and time fixed effects will capture relative wages. Other researchers have constructed skilled (less-skilled) labor wages $w_s(w_u)$ by dividing wage bills for skilled (less-skilled) labor with total employment of skilled (less-skilled) labor. One problem is that such wage measures consist of the same terms as the dependent variable, P^W, which might introduce bias into the estimates. Another problem is that the constructed wages do not take cross-industry variations in skill mix into account. An improvement on the previous studies is that we have access to a new, large data set on individual wages from which we calculate relative wages in 23 manufacturing industries for every year over the period studied.[15] In our estimated model we use this variable as a measure of exogenous relative wages that firms in the various industries face at each year t.

A positive coefficient on $\ln K_{jt}(\beta_2 > 0)$ indicates that skilled labor is complementary to physical capital in the production process. Whether real value added Y_{jt} is related to the skilled labor share of the total wage bill is shown by the estimate of β_3. As a proxy of the technology level T_{jt}, we employ the R&D intensity RD/Q, i.e., R&D expenditure as a share of sales. New technologies are continuously introduced at a high rate in R&D intensive firms and if technological change shifts labor demand in favor of better-educated workers, β_4 is positive.[16] To take into consideration that it takes time before R&D turn into new technologies, we lag R&D intensity 2 years.

[14] Most likely, such a division into skilled and less-skilled labor is more appropriate than the often used production/non-production classification (e.g., in Blonigen and Slaughter 2001) or a distinction between operatives and non-operatives (e.g., in Taylor and Driffield 2005). However, educational attainment also has its imperfections, for instance, it does not capture experience, it partially understates participation in further education and training, and there are variations in quality of schooling over time and between regions/countries.

[15] Appendix 1 gives a description of this data and how we obtain relative wages on industry level. Table 5 in Appendix 1 shows our calculated relative wages between skilled and less-skilled labor in the 23 manufacturing industries in year 2002 and annual average changes in relative wages 1993–2002.

[16] Taylor and Driffield (2005) construct R&D stocks and weigh them with value added to obtain an intensity measure at the industry level of technological change, whereas Blonigen and Slaughter (2001) employ the share of computer investment in total investment.

To analyze the effect of foreign ownership on relative demand for skills, we append to the wage bill share equation in Eq. 1 regressors that aim to capture such an impact. We have argued that there will be a direct effect at the firm level of foreign ownership and we add a dummy variable FO_{jt} that equals 1 if firm j is foreign-owned at time t.

Taylor and Driffield (2005) put forward additional arguments for why increased inward FDI may widen the wage gap between skilled and less-skilled labor and give rise to the use of more skilled labor. Technology spillovers from entering foreign firms through the acquisition of domestic firms may increase the relative demand for skilled labor also in non-acquired domestic firms within the same industry. A larger foreign presence in an industry may lead to increased competition among firms, especially for skilled labor which, in turn drives up the relative wages of skilled labor. We expect to capture such effects of larger foreign presence by including the share of employment in foreign-owned firms in industry i at time t $SFDI_{it}$.

Equation 2 shows the firm fixed effect model we eventually estimate[17]:

$$P_{jt}^{W} = \beta_1 (w_s/w_u)_{it} + \beta_2 \ln K_{jt} + \beta_3 \ln Y_{jt} + \beta_4 (RD/Q)_{jt-2} + \gamma_1 FO_{jt} + \gamma_2 SFDI_{it} + (TD)_t + f_j + \varepsilon_{jt} \quad (2)$$

Our key variables are FO_{jt} and $SFDI_{it}$. The sign on the γ coefficients indicates whether inward FDI has an impact on the relative demand for skills. The interpretation of significantly positive (negative) estimates of the gamma coefficients is that increased foreign ownership has contributed to shifts in demand towards skilled (less-skilled) workers. $(TD)_t$ is time dummies and f_j is time-invariant firm fixed effects.

3.2 Empirical results

We carry out our econometric analysis at the firm level and we include into the analysis all firms in manufacturing with 50 employees or more during the period 1993–2002.[18] Firms that switch between domestic and foreign ownership more than once over the period and firms that disappear from the sample 1 year and reappear in later years are excluded. Table 1 presents the results. Column (1) comprises all firms, whereas in columns (2) and (3) we have divided the domestic firms into

[17] We would have preferred to also include a variable measuring increased competition from (and offshoring to) low-wage countries, e.g., the share of consumption in an industry that is based on imports from low-wage countries. Unfortunately, owing to changes in the classification of origins of imports after Sweden's accession to the EU, there is a large drop in the time series (Hansson et al. 2007, Fig. 7.9). From 1995 and onwards, imports originating from outside the EU, but cleared through the customs in another EU country, are falsely registered as imports from the transit EU country. Apparently, this entails that the amount of imports from low-wage countries is underestimated.

[18] Data on expenditure on R&D are only available in firms with 50 employees or more. However, we have also estimated the model in Eq. 2 using all manufacturing firms with 20 employees or more and replaced the R&D intensity at the firm level with other technology indicators: the share of employees with post-secondary science or technical education and the industry level R&D intensity. This does not qualitatively affect our results, which can be sent upon request. The reason why our period of analysis begins in 1993 is that from 1993 onwards we are able to separate domestically owned firms into Swedish MNEs and non-MNEs. This is an important distinction for the outcome as will be clear from Table 1. Moreover, there is a new industry classification in 1993.

Table 1 Impact of foreign ownership (inward FDI) on skill upgrading in Swedish manufacturing, 1993–2002

Regressors	(1) All firms	(2) Non-MNE	(3) Swedish MNEs	(4) Swedish MNEs and non-MNEs
Relative wage $\ln(w_s/w_u)$	−0.021 (2.76)***	−0.024 (2.67)***	−0.004 (0.41)	−0.039 (3.31)***
$\ln(w_s/w_u) \times MNE$				0.039 (2.84)***
Capital stock ln *K*	0.002 (2.58)***	0.003 (2.72)***	0.004 (3.34)***	0.001 (1.49)
Output ln *Y*	−0.008 (7.24)***	−0.010 (7.14)***	−0.008 (5.33)***	−0.010 (7.66)***
R&D intensity (*RD*/*Q*)	0.090 (4.13)***	0.111 (3.80)***	0.081 (3.32)***	0.050 (2.07)***
Dummy variable: Foreign-owned = 1 *FO*	0.003 (1.62)	0.005 (1.96)**	0.002 (0.64)	0.001 (0.41)
Share of employees in foreign-owned firms *FDI*	0.001 (2.09)**	−0.000 (−0.04)	0.002 (2.20)**	0.001 (1.41)
Time dummies *TD*	Yes	Yes	Yes	Yes
R^2 within	0.221	0.212	0.214	0.242
R^2 between	0.004	0.004	0.014	0.006
R^2 overall	0.005	0.006	0.009	0.002
Number of observations	9,342	6,375	5,490	7,560

Firm fixed effect model. Dependent variable: Skilled labor wage-bill share P^W. Skilled labor is employees with a post-secondary education. Firms that switch from being foreign owned to becoming domestically owned are excluded in all specifications. *t*-statistics are within parentheses

***, **, * indicate significance at the 1, 5, and 10% level, respectively

Swedish MNEs and non-MNEs to see whether increased foreign ownership affects skill upgrading differently in different types of firms. In column (4) we include both Swedish MNEs and non-MNEs.[19]

From column (1) in Table 1 we infer that, in general, there is no direct effect on skill upgrading in firms that become foreign owned. The coefficient on the dummy variable *FO* is insignificant. On the other hand, there seems to be a positive indirect effect of increased foreign presence in an industry on the demand for skills in domestically owned firms within the same industry. The coefficient on *FDI* is positive and significant.[20]

Some interesting patterns appear when we separate the domestically owned firms into non-MNEs and Swedish MNEs in columns (2) and (3). Relative demand for skilled labor increases in non-MNEs acquired by foreigners, whereas there seems to be no such effect on relative labor demand in acquired Swedish MNEs. The coefficient on *FO* is positive and significant in column (2), but insignificant in

[19] More specifically, column (2) includes non-MNEs and foreign-owned firms and column (3) Swedish MNEs and foreign owned firms. In column (4), foreign owned firms as well as Swedish MNEs and non-MNEs are included. Unlike in column (1), we exclude in columns (2–4) firms that switch from being non-MNEs to becoming Swedish MNEs and vice versa.

[20] Taylor and Driffield (2005) find also positive impact of increased inward FDI in an industry on the relative demand for skills in UK manufacturing firms within the same industry.

column (3). An interpretation consistent with this result is that technology transfers leading to skilled-biased technical change play an important role in non-MNEs taken over by foreigners, while technology sourcing is the essential motive behind foreign acquisitions of Swedish MNEs.

The impact of larger foreign presence in an industry is positive on relative demand for skilled labor in Swedish MNEs within the same industry, while it has no effect on non-MNEs. The coefficient on *FDI* is positive and significant in column (3) but insignificant in column (2). One explanation might be that increased foreign ownership in an industry intensifies the competition for skilled labor, above all between foreign MNEs and Swedish MNEs, which drives up the wages of skilled labor in Swedish MNEs to a larger extent than in non-MNEs.

Interestingly, we also find that the elasticity of substitution between skilled and less-skilled labor appears to differ between Swedish MNEs and non-MNEs. The elasticity of substitution is significantly larger than one in non-MNEs (columns (2) and (4)), whereas we cannot reject the hypothesis of an elasticity of substitution equal to one in Swedish MNEs (column (3)). In fact, we observe in column (4), where we interact the relative wage ln (w_s/w_u) with a dummy variable $MNE_{jt} = 1$ if firm j is a Swedish MNE or a foreign-owned firm at time t, that the elasticity of substitution between skilled and less-skilled labor differs significantly in MNEs and in non-MNEs. One reason put forward for the often observed higher productivity in MNEs is that MNEs possess firm-specific assets and, presumably, it is skilled labor that has most knowledge about this asset. Accordingly, MNEs might be more concerned about worker turnover than non-MNEs, because this knowledge can leak out to competitors as employees change jobs. This might be a motive for why MNEs are paying a higher wage premium to skilled labor than to less-skilled labor.[21] It might also be an explanation for why the elasticity of substitution between skilled and less-skilled labor is significantly smaller in MNEs than in non-MNEs.

In all specifications in Table 1, the output coefficient ln Y is negative, which indicates that firms that reduce their production lower their demand for less-skilled labor more than for skilled labor. The coefficient on capital ln K is positive in all specifications, except in column (4), which means that there is evidence of capital-skill complementarities. Finally, we observe that, as in most other similar studies, the coefficient on R&D intensity (RD/Y) is positive, which has been interpreted as technological change being an important driving force for the growing demand for skills.

3.3 Propensity score matching and difference-in-difference

Matching has recently become a quite popular method for investigating ex post performance of foreign ownership.[22] The matching approach means that for each domestically owned firm that becomes foreign-owned (treated units) the

[21] The estimated MNE wage premium for skilled workers in Swedish manufacturing during the period studied is 5.2% as compared to an MNE wage premium for less-skilled workers of 3.4–2.2% (Bandick 2008). Lipsey (2004) surveys the literature on the wage premium associated with foreign ownership.

[22] See, e.g., Girma and Görg (2007) and Huttunen (2007).

investigator attempts to find other similar firms that continue to be domestically owned (non-treated units). In other words, the idea is to try to construct a sample of non-acquired twin firms to acquired firms to approximate for the non-observed counterfactual event, i.e., what would have happened to relative labor demand of skilled labor in acquired firms, on average, had they not been acquired by a foreign-owned firm.

Matching involves pairing acquired with non-acquired firms with similar pre-acquisition characteristics, X, e.g., productivity, age, size etc. The method we adapt is propensity score matching due to Rosenbaum and Rubin (1983). This technique has the advantage of summarizing all observables X into a single index variable. To implement propensity score matching we begin by estimating the probability (or propensity score) of being acquired by a foreign firm using a probit model

$$p(AF_{it} = 1) = F(X_{it-1}, D_j, D_t), \tag{3}$$

where $AF_{it} = 1$ if a domestically owned firm in year $t - 1$ becomes foreign-owned in year t. X_{it-1} is a vector of relevant firm-specific characteristics in year $t - 1$, which may affect the firm's probability of being acquired in year t. D_j and D_t control for industry and time fixed effects. Once the propensity scores are calculated, we can (by using the "calliper" matching method) select the nearest control firms in which the propensity score falls within a pre-specified radius as a match for an acquired firm.[23]

After having identified the control group of firms, we proceed and estimate the impact of foreign acquisition on the relative labor demand of skilled labor using a difference-in-difference estimator. This estimator compares the difference in skilled labor wage bill shares of the acquired (treated) firms A before $t - 1$ and after $t + s$ $s \geq 0$ with our control group of non-acquired firms C. Formally, the parameter we want to estimate is $\varphi_{t+s} = (P^{WA}_{t+s} - P^{WA}_{t-1}) - (P^{WC}_{t+s} - P^{WC}_{t-1})$ and it can be obtained by regressing data pooled across the treated firms and the firms in the control group[24]

$$P^{W}_{it-1,t+s} = \beta_0 + \beta_1 AF_i + \beta_2 After_{t+s} + \beta_3 AF_i \times After_{t+s} + \varepsilon, \tag{4}$$

where $P^{W}_{it-1,t+s}$ is our outcome variable (skilled labor wage bill share) in periods $t - 1$ to $t + s$. AF_i is a dummy variable taking the value of 1 for acquired (treated) firms A and 0 for non-acquired firms C. It controls for constant differences in skilled labor wage bill shares between target firms and firms in the control group before the acquisition. We define the dummy variable $After_{t+s}$ as taking the value of 1 in post-acquisition years $t + s$ and 0 before acquisition $t - 1$. This dummy variable captures aggregate period effects that are common between the two groups T and C. Finally, the term $AF_i \times After_{t+s}$ is an interaction term between AF_i and $After_{t+s}$. Its coefficient β_3 represents the difference-in-difference (DiD) estimator of the effect of acquisition on the acquired (treated) firms A, i.e., $\beta_3 = \varphi_{t+s}$. An advantage of the

[23] The procedure we utilize to match treated (acquired) firms with control (non-acquired) firms is the PSMATCH2 routine in Stata version 9 described in Leuven and Sianesi (2003). In our analysis the pre-specified radius is set to 0.01.

[24] See Woolridge (2002).

Table 2 Difference-in-difference estimator

	Before acquisition	After acquisition	Difference
Acquired Swedish MNEs	$\beta_0 + \beta_1$	$\beta_0 + \beta_1 + \beta_3 + \beta_4$	$\beta_3 + \beta_4$
Acquired non-MNEs	$\beta_0 + \beta_2$	$\beta_0 + \beta_2 + \beta_3 + \beta_5$	$\beta_3 + \beta_5$
Non-acquired firms	β_0	$\beta_0 + \beta_3$	β_3
Difference between acquired Swedish MNEs and non-acquired firms	β_1	$\beta_1 + \beta_4$	β_4
Difference between acquired non-MNEs and non-acquired firms	β_2	$\beta_2 + \beta_5$	β_5

DiD estimator is that it eliminates unobserved time-invariant differences in skilled labor wage bill shares between acquired and non-acquired firms.

To allow for different impacts of foreign acquisitions on relative demand for skilled labor depending on whether a Swedish MNE or a non-MNE is acquired we extend Eq. 4. We add in Eq. 5 below interaction variables between our key variable $AF_i \times After_{t+s}$ (and the treatment dummy AF_i) and dummies showing the status of the acquired firm—Swedish MNE or non-MNE—before takeover; i.e., $MNES_i = 1$ if firm i was a Swedish MNE and $NMNE_i = 1$ if it was a non-MNE.

$$P^W_{it-1,t+s} = \beta_0 + \beta_1 MNES_i \times AF_i + \beta_2 NMNE_i \times AF_i + \beta_3 After_{t+s} + \beta_4 MNES \times AF_i \times After_{t+s} + \beta_5 NMNE \times AF_i \times After_{t+s} + \varepsilon. \quad (5)$$

Table 2 summarizes the interpretation of the coefficients in the regression model in Eq. 5. Moreover, in our empirical analysis below, we also include a vector of firm characteristics to control for differences in observable attributes between firms.

3.4 Matching results: post-acquisition effects on relative demand for skills

To construct our sample of non-acquired (non-treated) firms with similar pre-acquisition characteristics as the acquired (treated) firms, we estimate the propensity score, the conditional probability of being acquired by a foreign firm, by using the probit model in Eq. 3.[25] There is no consensus, neither in the theoretical nor in the empirical literature, on what causes foreign acquisitions. To evaluate different specifications, we use the balancing condition which controls that each independent variable does not differ significantly between treated and non-treated firms. This means that only treated and non-treated firms with the same propensity score and with the same distribution of their observable characteristics will be matched. A set of explanatory variables that fulfill the balancing condition criterion is: firm labor productivity, the firm's employment relative to industry mean firm employment, firm age, firm age squared and a dummy variable indicating whether the firm is a Swedish MNE or not.

[25] Table 6 in Appendix 2 shows the result from estimating the probit model.

Table 3 Effects of foreign acquisitions on post-acquisition skill upgrading

Variables	(1) DiD OLS	(2) DiD FE
$MNES_i \times AF_i \times After_{t+s}$	0.004 (0.54)	0.005 (1.55)
$NMNE_i \times AF_i \times After_{t+s}$	0.008 (0.93)	0.008 (2.37)**
$MNES_i \times AF_i$	0.031 (1.77)*	
$NMNE_i \times AF_i$	−0.015 (1.05)	
$After_{t+s}$	−0.001 (0.23)	−0.002 (1.07)
Relative wage	0.021 (0.54)	0.013 (0.84)
Capital stock	−0.001 (0.04)	0.008 (4.30)***
Output	0.017 (1.81)*	−0.008 (3.60)***
R&D intensity	1.123 (4.43)***	0.117 (3.29)***
Year dummies	Yes	Yes
Industry dummies	Yes	No
$\bar{R}^2$	0.631	
R^2 within		0.193
R^2 between		0.073
R^2 overall		0.046
Observations	2,227	2,227

Matched sample. Dependent variable: Skilled labor wage-bill share P^W. Square brackets ( ) give White's heteroskedasticity-consistent t-statistics

***, **, * indicate significance at the 1, 5, and 10% level, respectively

Another condition that must to be fulfilled in the matching procedure is the so-called common support condition. This criterion implies that at each point in time, a newly acquired (treated) firm is matched with non-target firms with propensity scores only slightly larger or less than the target firm. Some treated firms may be matched with more than one non-acquired firm, while acquired firms not matched with a non-treated firm are excluded. Furthermore, since our purpose is to study post-acquisition relative labor demand dynamics, we only include in the analysis firms for which information is reported at least 3 years after acquisition.[26] Eventually, we end up with a sample, henceforth denoted the matched sample, which consists of 140 treated and 237 non-treated firms.[27]

To examine whether foreign acquisitions of Swedish owned firms have had any effects on relative demand for skilled labor in post-acquisition years we estimate the regression model in Eq. 5. Our dependent variable is the wage bill share of skilled labor and the key estimates are the difference-in-difference (DiD) estimators β_4 and

[26] Moreover, firms that switch back and forth between different ownership status and greenfield operations are excluded.

[27] Firms taken over by foreigners differ from non-targeted firms in many respects. This is shown by Table 7 column (1) in Appendix 2. The aim of the matching procedure is to find a group of non-acquired firms that displays similar characteristics as the group of acquired firms. Apparently, as we can see in Table 7 column (2), the matching procedure seems to have been successful since the significant differences between the acquired (target) and the non-acquired (non-target) firms have disappeared in the matched sample.

β_5. Table 3 reports the effects of foreign take-overs on post-acquisition skilled labor wage bill shares. The sample consists of matched firms remaining at least 5 years in the panel.

In column (2), where we estimate a firm fixed effect (FE) model, the DiD estimator indicates that foreign acquisitions have a positive impact on the demand for skilled labor in acquired non-MNEs. The result is consistent with the previous outcome in Table 1, where we included all firms in the analysis. We also notice that the other firm variables, e.g., capital and output, have the same effect as in Table 1. However, these results do not hold if, as in column (1), we do not control for time-invariant firm-specific effects and estimate a standard OLS model.

4 Concluding remarks

Sharply increased foreign ownership at a time of widening wage inequality and a growing employment share of skilled labor at the aggregate level hint that there might be significant technology transfers from abroad, leading to skilled-biased technical change and increased relative demand for skilled labor. Our econometric analysis indicates that technology transfers are important when non-MNEs are acquired by foreign-owned firms. On the other hand, foreign acquisitions of Swedish MNEs seem to be explained by technology sourcing, since such acquisitions do not give rise to any effects on relative demand for skilled labor in the acquired firms. Furthermore, no evidence is found for the concerns put forward in the Swedish public debate that foreign-owned firms would move out skill-intensive activities from Sweden.

Intensified competition for skilled labor in an industry, in particular between foreign MNEs and Swedish MNEs, leading to higher wages of skilled labor might explain why increased foreign presence in an industry has a positive impact on relative demand for skilled labor in Swedish MNEs within the same industry, while it has no effect on non-MNEs.

Reasonably, skilled employees have larger knowledge about an MNE's firm-specific assets than less-skilled employees. Therefore, one would expect that MNEs are more concerned about skilled worker turnover than non-MNEs. This could explain why MNEs are paying higher wage premia to skilled labor. It could also explain the significantly lower elasticity of substitution between skilled and less-skilled labor in MNEs than in non-MNEs that we observe in Swedish manufacturing.

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Table 4 Estimated wage equations 1993 and 2002 for manufacturing (dependent variable: log monthly wage)

Regressors	Manufacturing	
	1993	2002
Gymnasium $\leq$ 2 years (Upper secondary school)	0.101 (0.003)	0.042 (0.003)
Gymnasium = 3 years (Upper secondary school)	0.199 (0.006)	0.138 (0.006)
University < 3 years	0.249 (0.007)	0.255 (0.008)
University $\geq$ 3 years	0.521 (0.011)	0.511 (0.009)
Graduate studies	0.723 (0.017)	0.727 (0.015)
Experience	0.021 (0.001)	0.022 (0.001)
(Experience)^2/100	−0.032 (0.001)	−0.034 (0.002)
Female	−0.143 (0.004)	−0.124 (0.005)
Constant	9.054 (0.020)	9.318 (0.026)
R-square	0.436	0.446
Number of observations	215,413	376,893

White's heteroskedasticity-consistent standard errors within parentheses

Appendix 1: Definitions and sources of data

Individual wage data

The wage variable is full-time equivalent monthly wage and comes from Statistics Sweden's (SCB's) annual study of wages in Sweden. This survey samples 50% of the individuals in the private sector and includes all individuals in the public sector. The sampling frame for the private sector consists of firms that are stratified according to industry and firm size (number of employees). Random draws are made within each stratum. Each year a new sample is drawn and larger firms have a higher probability of being sampled. This means that small firms and individuals working in smaller firms are underrepresented. The data set can be used to compare the wage structure over time, but is unsuitable for panel analyses at the individual level.[28]

In addition to wages, we also have information about sex, age, and education. Furthermore, we know in which firm (and industry) an individual is working and thus, he/she can be linked to our firm data. We use the information to estimate Mincer equations for each year over the period studied 1993–2002 for individuals working in manufacturing (Fig. 3). To take into account that individuals working in smaller firms are underrepresented, we weigh the regressions with the inverse of the probabilities of different individuals being sampled. Table 4 presents the results for 1993 and 2002.

We also utilize the data from SCB's annual study on wages to calculate relative wages between skilled and less-skilled labor w_s/w_u in 23 manufacturing industries that we use in our analysis of relative labor demand in Sect. 3. The industries are the

[28] See Bandick (2008).

Table 5 Relative wages between skilled and less-skilled labor at the industry level

SNI92	Industry	Relative wage 2002	Annual average change 1993–2002
15 + 16	Food, beverages and tobacco	1.44	2.14
17 + 18 + 19	Textiles, apparel and leather	1.40	1.42
201	Sawmilling and planing of wood, impregnation of wood	1.39	0.92
20–201	Other wood products	1.31	0.29
211	Pulp, paper and paperboard	1.35	1.80
212	Articles of paper and paperboard	1.47	0.97
22	Printing and publishing	1.24	0.30
23	Manufacture of coke, refined petroleum products and nuclear fuel	1.30	1.98
241	Basic chemicals	1.39	0.83
244	Drugs and medicines	1.47	0.03
24–241–244	Other chemicals and chemical products	1.38	0.49
25	Rubber and plastics	1.47	0.96
26	Stone, clay and glass	1.38	0.27
27	Basic metals	1.39	0.30
28	Metal products	1.48	1.87
29	Machinery and equipment n.e.c.[a]	1.46	1.77
30	Office machinery and computers	1.64	2.47
31	Electrical machinery	1.48	2.36
32	Communication equipment	1.52	2.05
33	Professional goods	1.49	1.81
34	Motor vehicles	1.39	1.71
35	Other transport	1.45	2.47
36	Other manufacturing	1.34	0.97

We obtain the relative wage between skilled and less-skilled labor in the following way. In SCB's annual study on wages, each industry is stratified into firm size classes in which firms are drawn randomly. In an industry for each firm size class, we calculate the average wage for the observed skilled (less-skilled) individuals. By using the actual number of skilled (less-skilled) employees in each firm size class, which we get from RAMS, we then compute a weighted average wage of skilled (less-skilled) labor in each industry. Finally, to obtain the relative wage, we divide the weighted average wage for skilled labor with the corresponding wage for less-skilled labor

[a] n.e.c. is not elsewhere classified

same as in SCB's strata. Table 5 shows the industries, relative wages for 2002, and annual average changes in relative wages between 1993 and 2002.

Other data

A summary of definitions and sources of the other variables we employ in the analysis of labor demand in Sect. 3 is given below.

Wage incomes W: Total wage incomes of employees.

Source: Statistics Sweden (SCB), Register-based labor statistics (RAMS).

Wage incomes skilled labor W^S: Wage incomes of employees with post-secondary education.

Source: SCB, RAMS.

Skilled-labor wage bill share P^W: $P^W = W^S/W$.
Capital stock K: Book value of buildings and machinery, 1991 prices.

Source: SCB, Financial accounts.

Real output Y: Value added, 1991 prices.

Source: SCB, Financial accounts.

R&D intensity RD/Q: *RD*: Expenditure on research and development, current prices.

Source: SCB, R&D Statistics. *Q*: Production value, current prices.
Source: SCB, Financial accounts.

Share of employment in foreign-owned firms FDI. Foreign-owned firms are firms where foreigners possess more than 50% of the voting rights.

Source: SCB, Financial accounts.

Appendix 2: Estimating propensity score and comparing matched and unmatched samples

Tables 6 and 7.

Table 6 Probit model to estimate propensity score

Variables	Probability of foreign acquisition
Labor productivity	0.197 (3.39)***
Relative employment	0.006 (2.27)**
Age	−0.033 (2.24)**
$(Age)^2$	0.001 (2.15)**
Swedish MNE	0.257 (4.47)***
Year dummies	Yes
Pseudo R^2	0.033
LR $\chi^2(13)$	88.83
Observations	17,249

The dependent variable $AF_{it} = 1$, if a domestically owned firm in year $t - 1$ becomes foreign owned in year t. z-statistics is within parentheses. The explanatory variables are firm-specific characteristics in year $t - 1$. Relative employment is firm employment relative to mean firm employment at the industry level (three-digit). Labor productivity is value added per employee. Age is firm age and Swedish MNE is a dummy variable indicating whether the firm is a Swedish MNE firm or not

***, ** indicate significance on the 1 and 5% level, respectively

Table 7 Differences in means between foreign acquired firms and non-acquired firms, unmatched and matched firms, 1993–2002

Variable	Target vs. non-target firms	
	(1) Unmatched firms	(2) Matched firms
Skilled labor wage bill share	3.9 (4.72)***	0.4 (0.31)
Firm size	108 (2.08)**	−38 (0.29)
Value added	113 (2.54)**	25 (0.22)
Capital stock	107 (3.61)***	36 (0.44)
Value added per employee	0.36 (0.03)	−15.7 (0.78)
R&D intensity	−0.2 (0.05)	0.1 (0.30)
Number of: Target firms	294	140
Non-target firms	1,913	237

Skilled labor wage bill share and R&D intensities are in percentages. Value added and capital are in thousand SEK. The *t*-statistics test the null hypotheses of equality between target and non-target firms

***, ** indicate significance on the 1 and 5% level, respectively

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