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Do Foreign Mergers and Acquisitions Boost Firm Productivity?

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Abstract: This paper examines the causal relationship between foreign mergers and acquisitions and firm productivity in the UK over the period 1999-2007. Our results raise questions about the existence of aggregate effects of foreign ownership on TFP in the longer-run. However, we find significant heterogeneity in the TFP effects of foreign M&A at the industry level. Overall, we uncover a systematic pattern of post-acquisition TFP effects that is consistent with the most recent theoretical models of firm heterogeneity and cross-border mergers and acquisitions as mode of foreign entry. Furthermore, we find positive aggregate effects on labor productivity due to capital deepening but not due to changes in TFP.

Keywords: Cross-border mergers and acquisitions; Productivity; Firm heterogeneity

JEL classification: F23, D24, O33

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1 Introduction

Over the past decade there has been a surge in cross-border mergers and acquisitions (M&A) in both manufacturing and services. Economists and policy makers tend to assume that foreign-owned firms have an advantage over domestic firms due to large endowments of intangible assets which compensate for a lack of local information and experience. There is indeed a large empirical evidence showing that foreign-owned firms are more productive than domestic firms (Doms and Jensen, 1998 for the US; Driffield, 1997; Girma and Görg, 2007; Griffith and Simpson, 2001; for the UK; De Backer and Sleuwaegen, 2002, in the case of Belgium; Pfaffermayer and Bellak, 2002, in the case of Austria; Ruane and Ugur (2004), for Ireland). More recent studies have shown that a large part of this productivity differential is between multinational firms and non-multinationals (Griffith, 1999; Oulton, 2000; Temouri, Driffield and Higon, 2008). Hence, separating the effects of foreign ownership from other firm-specific factors appears to be difficult. Moreover, most of these studies do not distinguish between foreign greenfield investment and mergers and acquisitions.

Foreign M&A implying a change from domestic to foreign owners provide an appropriate framework to isolate effects of foreign ownership. However, existing empirical evidence on the causal link between foreign M&A and firm productivity is inconclusive. To the extent that foreign investors acquire the best performing firms, the productivity advantage might not be associated with foreign ownership *per se*. Harris and Robinson (2003) provide empirical evidence showing that foreign investors tend to acquire firms with higher productivity in comparison with other manufacturing firms in the UK. Furthermore, the higher productivity of foreign-owned multinationals observed at the economy-wide level might simply reflect the fact that they are concentrated in high productivity sectors (Griffith et al., 2004).

While a number of studies have found positive effects of foreign M&A on firm productivity (Lichtenberg and Siegel, 1987 for the US; Conyon et al, 2002 for the UK; Arnold and Javorcik, 2005, for Indonesia; Bertrand and Zitouna, 2008, in the case of France) other research has found

that acquired firms do not reap any benefit from foreign ownership (Harris and Robinson, 2003, for the UK), has rejected a causal link (Barba Navaretti et al, 2004) or has found a positive effect only in the case of US multinationals (Benfratello and Sembenelli, 2002). Girma and Görg (2002) examine the effect in two specific industries in the UK. They find that foreign acquisitions had positive effects on firm productivity in the food sector but negative in electronics.

This paper examines the causal relationship between foreign mergers and acquisitions and firm productivity in the United Kingdom (UK) in the short and the longer run. Since the existing empirical evidence is inconclusive, we also address the following additional research questions to shed more light on the source of the ambiguity in the results: what is the profile of firms which are acquired by or merged with foreign-owned firms? To what extent do the effects on firm productivity vary by the country of origin of the acquiring/merging firm? How do the effects vary at industry level? Do the answers depend on the particular measure of firm productivity?

We focus on the UK where the number of M&A deals has been especially large. Over the period 1999-2007 we identify over 10,000 mergers and acquisitions in the UK of which foreign takeovers account for a quarter of all deals. Griffith et al. (2004) show that foreign takeovers of non-multinational domestic-owned firms exceed foreign greenfield investments as the most frequent mode of entry by foreign firms in the UK over the period 1999-2001 in both manufacturing and services.

The question of whether foreign acquisitions lead to higher productivity is interesting and relevant for both research and policy. To the extent that foreign investment is perceived as a source of knowledge spillovers and productivity growth in the host economies, governments in some countries (including the UK) have designed and implemented policies aiming at attracting foreign investment. On the other hand, some governments (e.g. in France and Italy) have tended to discourage foreign take-overs and instead encouraged the emergence of 'national champions'.

Measuring the effect of foreign acquisition on firm productivity raises two major econometric issues. First, foreign investors may acquire better performing firms (selection bias). To address this selection bias we analyze the causal effect of foreign acquisition on UK firm productivity by using propensity score matching following Rosenbaum and Rubin (1983) combined

with difference-in-difference estimators (Heckman et al. 1997). Second, the derivation of firm productivity (total factor productivity) involves several measurement issues. Therefore, we determine total factor productivity (TFP) by means of production function estimations at the three-digit industry level. We follow the approach of Olley and Pakes (1996) which generates unbiased industry level input elasticities by controlling for the correlation between unobserved productivity shocks and firm inputs. In addition, we use three alternative firm productivity measures as a robustness check: and a multilateral TFP index based on Caves et al. (1982), TFP based on conventional OLS production function estimations, and labor productivity.

Our contribution to the literature is threefold. First, in comparison with existing studies, we use a richer micro data set which effectively covers all firms in the UK including over 2,000 foreign M&A over the period 1999-2007. Second, we use improved econometric techniques to account for selection biases and derive several alternative firm productivity measures to check for the robustness of our main result. Third, we explore the theoretical suggestion of Nocke and Yeaple (2007) that attributes the heterogenous effects of foreign acquisitions on firm productivity to industry-specific characteristics of the acquiring firm.

Our results lead us to question the existence of longer-run effects of foreign ownership on firm TFP in the UK at the aggregate level. However, we do find significant heterogeneity in the effect of foreign M&A on target firm productivity at the industry level. This heterogeneity across industries potentially explains the absence of positive TFP effects at the aggregate level. Moreover, following Nocke and Yeaple (2007) we classify acquiring firms as R&D- and marketing-intensive. Overall, we uncover a systematic pattern of post-acquisition TFP effects that is consistent with the most recent theoretical models of firm heterogeneity and cross-border mergers and acquisitions as mode of foreign entry. Finally, at the aggregate level we find that foreign acquisitions had positive effects on labor productivity due to capital deepening. This points to the potentially misleading results from using labor productivity instead of TFP to measure the causal impact of foreign M&A through technology or organizational spillovers on target firm performance in the UK.

The remainder of this paper is organized as follows. Section 2 reviews the relevant theoretical literature. The next section discusses the empirical methodology we use to explore the causal

relationship between foreign acquisitions and firm productivity. Section 4 specifies the data and our different approaches to measure firm productivity. Section 5 discusses our empirical results. Finally Section 6 concludes.

2 Theoretical background

The early theoretical literature on foreign direct investment known as the Ownership-Location-Internalization (OLI) framework (Vernon, 1966; Caves, 1974; Dunning, 1977) has focused on three characteristics of multinational firms that are likely to explain their better performance in comparison to domestic-owned firms. These characteristics are: (i) large endowments of intangible assets that compensate for the lack of local knowledge (of markets, consumer preferences and business practices), hence allowing successful competition with domestic firms; (ii) location advantages that arise from being located in a foreign country rather than exporting to it; and (iii) advantages from internalizing technology rather than licensing it to foreign producers. These elements have been formalized in seminal papers by Markusen (1984, 1995, 2002), Helpman (1984, 1985), and Markusen and Venables (1997, 1998). More recently, Helpman et al. (2004) show that in the presence of fixed costs to exporting and to undertaking foreign direct investment, in equilibrium, heterogeneous firms can be ordered in terms of productivity, as follows: the least productive exit, the more productive firms serve only the domestic market, the next more productive serve the domestic market and export, and the most productive firms serve the domestic market and undertake foreign direct investment. Accordingly, it follows that in their country of origin multinationals are the most productive firms.

This literature explores the effect of foreign ownership on firm productivity not distinguishing formally whether it refers to greenfield investment or foreign M&A. However, the paper by Nocke and Yeaple (2007) focuses explicitly on the relationship between cross-border M&A as a mode of entry into foreign markets and efficiency of firms. The authors show that either the most or the least productive firms acquire foreign targets. In particular, their model predicts that foreign acquirers operating in R&D-intensive industries represent the most productive firms in the corresponding industries in their home country while foreign acquirers operating in

marketing-intensive industries represent the least productive firms.[1] The predictions of Nocke and Yeaple (2007) contrast with the predictions of the earlier studies which did not distinguish between foreign M&A and greenfield investment. That is, instead of a linear productivity ordering, Nocke and Yeaple (2007) predict that both the most and the least productive firms will acquire foreign targets. Their finding limits the scope for positive aggregate effects of foreign acquisition on firm productivity and instead highlights the importance of industry-specific effects.

While the heterogenous trade and investment literature suggests that at least some multinational firms are more productive than domestic-owned firms, it does not imply that foreign ownership *per se* leads to higher productivity. Foreign multinationals may also affect the market structure and the degree of competition in the host economy. The industrial organization (I-O) literature offers further complex insights on the effects of M&A on firm productivity in the longer-run. On the one hand, incentives to concentrate market power involve a decline in competition which potentially entails lower long-run productivity growth in that industry. On the other hand, efficiency gains due to the diffusion of technological or organizational knowledge, economies of scale, or the reduction of managerial slack result in long-run productivity gains. In the short-run, however, the impact of a take-over on firm productivity is expected to be negative due to the high short-run costs of reorganization. The latter effect is expected to be larger after cross-border deals due to higher adaptation costs. Similarly, long-run productivity effects after foreign M&A are potentially more pronounced due to the larger scope for knowledge spillovers and adverse competition effects.

3 Empirical strategy

The key empirical objective of this paper is to evaluate the causal effect of foreign acquisition on firm productivity. The main challenge is that we do not observe the productivity of acquired firms had they not been acquired. We address this missing data problem by using propensity

[1] The authors consider R&D and advertising as relatively internationally mobile and immobile factors, respectively.

score matching (PSM) following Rosenbaum and Rubin (1983). The central idea is to compare the productivity of foreign-acquired firms with the firm performance of a control group that includes non-acquired firms with similar observable characteristics. While matching methods account for the bias due to observable firm characteristics, selection bias might also stem from time-invariant unobserved firm characteristics. To eliminate this latter bias, we combine the propensity score matching with the difference-in-difference estimator suggested by Heckman et al. (1997).

In the first stage, the propensity-score matching estimator summarizes the vector of pre-treatment characteristics, X, into a single-index variable, the propensity score $p(X)$. The propensity score measures the conditional probability of a firm to be acquired by a foreign owner given data on firm characteristics and past firm performance.[2]

In the second stage, we estimate the average effect of foreign acquisition on target firm productivity in the post-acquisition period. To do this, we use the productivity of the non-acquired domestic firms with a similar propensity score to generate counterfactual observations. To control for the possible bias that is due to selection on unobservables, we compute the effect using the difference-in-difference matching estimator (Heckman et al, 1997). Hence, we compare the evolution of productivity of foreign-acquired firms and domestic firms that exhibit an equivalent *ex ante* probability of being taken over given firm characteristics, performance indicators, and time-invariant unobservables. The average effect of acquisition on the acquired firms for the difference-in-differences matching estimator can be written as

$$\widehat{ATT} = \sum_{i \in A} (\Delta y_i - \sum_{c \in C} \omega(p_i, p_c) \Delta y_i) \tag{1}$$

where Δy is the difference between the average productivity before and after the acquisition, p_i denotes the predicted probability of being acquired for firm i in the group of acquired firms A, p_c the predicted probability of being acquired for firm c in the control group C, and $\omega(.)$ is

[2]It is determined in a probit regression, i.e., the binary dependent variable defines the firm's acquisition status in year t. It is equal to 1 in the year of a foreign takeover and 0 if the firm is domestically owned and has not been acquired during the sample period.

a function assigning the weights to the counterfactual firms c.[3]

4 Data and methodology

4.1 Data

Our analysis is based on firm-level data from the UK over the period from 1999 until 2007. We employ M&A data from the Bureau van Dijk's Zephyr database which has information on over 2,000 foreign M&A of UK firms between 1999 and 2007. This information is combined with the data from the Amadeus database which provides detailed balance sheet data for all UK firms. The combination of both data sets allows us to compare the effects of cross-border M&A on the performance of acquired firms in different industries and to distinguish short-run from longer-run effects.

We model the probability (propensity score) of foreign acquisition as a function of the following firm characteristics observed in the pre-acquisition period: the return on capital (firm profitability), the ratio of interest expenses to total assets (a proxy of perceived trustworthiness by financial institutions), a firm's age, size[4], and characteristic variables to capture ownership and solvency. Two dummy variables capture the ownership status of a firm: `state` is equal to 1 if its legal form is not private and 0 if it is, while `quoted` takes the value 1 if a firm is publicly quoted and 0 if not. The firm's solvencu status dummy variable `exit` is equal to 1 if the firm is insolvent and 0 otherwise. Finally, we account for year fixed effects and for industry-specific fixed effects, distinguishing sectors by means of three-digit NACE codes in the propensity score estimation.

The computation of TFP, which is described in the following section, requires information on output, physical capital, labor, and the corresponding input elasticities. We measure output as real[5] value added. Capital and labor are measured as real fixed tangible assets and the

[3] We use the propensity score matching procedure as described in Leuven and Sianesi (2003).

[4] We employ a firm's number of employees as a measure of its size.

[5] Real variables are obtained by using output price deflators at the two-digit industry level and aggregate input price deflators both stemming from Eurostat.

number of employees, respectively. We also include gross investment, measured by the change in the capital stock plus depreciation, which is included as an instrument for the unobservable technology shock in the estimation procedure of Olley and Pakes (1996).

4.2 Measuring productivity

The difference-in-difference matching estimator provides an appropriate framework to analyze the causal effect of foreign M&A on UK firm productivity. However, it would produce misleading results if the underlying productivity measure does not allow for a meaningful cross-firm comparison. Thus, the quality of the results hinges crucially on the construction of a detailed and unbiased productivity measure. Therefore, and in contrast to most previous studies, we use several different productivity measures to check for the robustness of our main results.[6]

Our main productivity measure is TFP since changes in TFP directly reflect the efficiency gains following foreign acquisitions due to the diffusion of technological or organizational knowledge and economies of scale. We derive TFP of firm j in sector s at time t as a residual from a production function in logs:

$$y_{jst} = \theta_s^k k_{jst} + \theta_s^l l_{jst} + \eta_s + \mu_t + \varepsilon_{jst} \tag{2}$$

where y_{jst} denotes a firm's value added, k_{jst} and l_{jst} the physical capital and labor inputs, η_s is a vector of industry specific effects, μ_t a vector of year specific effects, $\theta = (\theta^k, \theta^l)$ a vector of average input elasticities, and ε_{jsi} an error term.

We estimate (2) to obtain empirical measures of the average input elasticities θ_s^k and θ_s^l from firm level data. We account for heterogenous input elasticities across three-digit (NACE) industry levels in that we estimate the marginal input effects separately for each of the three-digit industries.[7] The estimation of (2) involves a well-known endogeneity problem, viz, a firm's demand for labor is expected to depend on its contemporaneous productivity level which

[6] We illustrate below that the use of TFP instead of labor productivity is crucial identifying the effect of foreign acquisitions on subsequent technological capabilities of UK target firms.

[7] We also employ three-digit output price deflators to deflate the output, capital, and investment series with industry specific deflators.

is captured in the error term. Appropriate instruments for labor services that are uncorrelated with productivity are typically not available. However, Olley and Pakes (1996) develop a semi-parametric estimator to extract consistent estimates of the input elasticities in production function estimations. The method supposes that a firm's investment decision is a function of its capital stock, age, and its unobserved productivity. Hence, the unobserved productivity parameter can be modeled as some (inverse) function of investments, capital, and age given the assumption of a monotonic relationship between investment and productivity. We apply this methodology to derive consistent estimates of the average input elasticities in our sample. A detailed description of the Olley and Pakes (1996) procedure is given in Appendix A.1.

We derive three additional productivity measures to examine the robustness of our main results. First, we follow Caves et al. (1982) to develop a relative TFP index using the industry-level geometric average as a reference point. This methodology employs firm level factor shares, instead of a production function estimation, to compute the corresponding input elasticities.[8] Second, we estimate (2) using a conventional least squares estimator and compute the corresponding TFP levels accordingly. Third, we use labor productivity, which is measured as a ratio of a firm's value added to its number of employees, a measure often used in the existing literature (e.g. Conyon et al, 2002). Note, however, that labor productivity is a broader measure than TFP since it reflects the joint influence of changes in TFP and the capital-labor ratio, i.e. in the case of a Cobb-Douglas production function, we have: $ln(Y/L) = ln(TFP) + \alpha ln(K/L)$.

4.3 Sample properties

Our sample comprises an unbalanced panel. Moreover, we do not observe the amount of value added and fixed tangible assets for all of the firms.[9] This reduces the effective number of foreign

[8] In particular, the factor shares of labor and intermediate inputs are measured by the mean of firm- and industry-level (three-digit) factor shares. The factor share of the capital stock is derived by assuming constant returns to scale. The output and input measures are all computed relative to an industry-level median. Note that this procedure implicitly assumes perfectly competitive factor markets and constant returns to scale.

[9] In addition, we restrict the sample to cover non-negative observations for value added, fixed tangible assets, and number of employees. Note that we do not impose further corrections for outliers among non-target domestic firms since the matching estimator does not take observations into account which can not be matched properly.

M&A that can be included in the propensity-score estimation. In the end, we are left with 606 foreign M&A with available data to compute a TFP measure for the UK foreign acquired firms. The second stage of the difference-in-difference matching estimator, however, requires that a firm's TFP measure is available for at least two consecutive years after a foreign takeover which further reduces the effective number of matched foreign M&A to 392. Finally, since we do not observe the debt-asset ratio and profitability for all of these firms, the effective number of foreign M&A in the difference-in-difference estimation is reduced to 318.[10] Since the control group of domestic firms that have not been the target of a (foreign or domestic) takeover numbers over 14,000 firms, it is possible to match target and control firms very closely.[11]

Table 1 displays the descriptive statistics for the foreign-acquired firms and all other firms for each of the variables. The average log TFP levels and labor productivity of foreign-acquired firms are lower than the corresponding productivity indicators of all other firms. Moreover, foreign-acquired firms have, on average, a higher return to capital, are smaller, younger, more likely to be quoted or publicly-owned, and less likely to be insolvent. The higher average return to capital, which measures a firm's profitability, indicate that foreign acquirers "cherry pick" on the basis of firm profitability. The propensity score estimations, which are outlined in Table 2 below, generally confirm this conjecture. The data also reveal considerable heterogeneity among foreign-acquired firms, since the standard deviations among these firms generally exceed the ones among all other firms. Table 1 also shows the descriptive statistics for the manufacturing and services sectors separately. Accordingly, the TFP measures based on Olley-Pakes or OLS display higher levels for foreign-acquired firms in the manufacturing sector while all

[10] Note that we obtain the same qualitative results if we base our effective sample on the 392 foreign M&A by excluding the debt-asset ratio and our measure of profitability from the propensity score estimation. However, the balancing tests (see Section 4.5) indicates that both variables improve the test results in some specifications.

[11] Moreover, 75% of the 318 foreign M&A represent vertical takeovers. We label a takeover "horizontal" if (a subsidiary of) the acquirer operates in the same industry, defined by four-digit NACE codes, as the target firm. Otherwise, the M&A is labeled "vertical". Note that vertical foreign investments are generally considered to involve a larger scope for spillovers between foreign and domestic firms (e.g. Javorcik, 2004). However, we do not find significant differences between the effects of vertical and horizontal M&A (see Table A2 in the Appendix).

four productivity proxies indicate a lower average level for foreign-acquired firms in the service industries. In contrast, the returns to capital are higher for foreign-acquired firms in both sectors.

The reduction in the effective number of foreign M&A in our sample due to the data requirements of the estimation procedure raises the question of whether the remaining deals are still representative of the underlying population of more than 2,000 cross-border deals from 1999-2007. Therefore, the last three columns of Table A3 in the Appendix explicitly report the descriptive statistics for the foreign-acquired firms that can not be accounted for in the second stage of the difference-in-difference matching estimation. It appears that the TFP levels based on Olley-Pakes or OLS are very similar among the foreign-acquired firms that are included in the sample and the ones that have to be excluded. Thus, the main outcome variable in our sample, TFP based on Olley-Pakes, appears to be representative of the population of foreign-acquired UK firms. However, labor productivity and TFP based on Caves et al. (1982) are relatively higher among the latter group while the returns to capital and age are relatively lower.[12] Table A4 in the Appendix lists the total number of deals in the population and our effective sample across two-digit NACE industries. The fifth and the sixth columns display the shares of the number of foreign deals in an industry relative to the total number of deals in the two groups, respectively. The last columns indicate that the distribution of foreign M&A across industries in the effective sample and in the total population is very similar. There are only some notable differences in the construction sector as well as two service industries: computer & related activities and R&D & other business. Therefore, we calculate sample weights for the changes in TFP in the second stage of the difference-in-difference matching estimator.[13] Table A5 in the Appendix and Table 4 report the results for the weighted and unweighted TFP estimations, respectively; they reveal that the results in post-acquisition periods are qualitatively the same. Finally, a Hausman test, which is given in the last column of Table A5 in the Appendix, does

[12]The level of labor productivity in our effective sample relative to the population seems to be, if anything, biased downwards. Still, we find a significant increase in labor productivity in post-acquisition periods (see Section 5) which therefore seems to even understate the effect for the whole population.

[13]The weights are calculated for each three-digit industry sub-group by dividing the number of foreign M&A in the population by the number of foreign M&A in the sample.

Table 1: Descriptive statistics

	Target firms			All other firms		
	firms	mean	sd	firms	mean	sd
lntfp-op	318	0.70	0.52	14330	0.71	0.60
Y/L	400	256.81	931.71	12884	552.88	2375.10
lntfp-ols	318	0.76	0.53	14330	0.80	0.60
lntfp-Caves	316	-1.12	2.54	14330	-0.19	31.01
return-cap	318	31.40	93.33	14330	28.69	70.89
debt-asset	318	0.02	0.02	14330	0.02	0.02
size	318	1.22	5.66	14330	5.79	4.86
age	318	27.68	24.72	14330	28.74	21.78
state	318	0.14	0.35	14330	0.09	0.29
quoted	318	0.06	0.24	14330	0.03	0.17
exit	318	0.02	0.14	14330	0.03	0.17
Manufacturing (NACE 15-37):						
lntfp-op	127	0.55	0.36	51382	0.51	0.43
Y/L	161	129.81	378.26	45523	346.69	979.32
lntfp-ols	127	0.58	0.32	51382	0.56	0.40
lntfp-Caves	126	-1.04	2.06	51382	-0.09	3.45
return-cap	127	26.55	90.05	51382	20.52	51.73
debt-asset	127	0.02	0.02	51382	0.02	0.02
size	127	0.95	4.01	51382	0.65	4.92
age	127	31.50	29.48	51382	34.61	25.19
state	127	0.08	0.27	51382	0.08	0.27
quoted	127	0.02	0.12	51382	0.04	0.19
exit	127	0.02	0.12	51382	0.03	0.17
Services (NACE 50-74):						
lntfp-op	166	0.79	0.61	100600	0.83	0.64
Y/L	215	351.47	1194.75	92858	668.94	2779.61
lntfp-ols	166	0.86	0.62	100600	0.89	0.66
lntfp-Caves	165	-1.11	2.95	100600	-0.25	40.46
return-cap	166	33.45	101.71	100600	31.78	78.47
debt-asset	166	0.01	0.02	100600	0.02	0.02
size	166	1.34	6.64	100600	0.55	4.84
age	166	24.33	20.45	100600	25.94	19.90
state	166	0.18	0.39	100600	0.10	0.30
quoted	166	0.09	0.29	100600	0.03	0.16
exit	166	0.02	0.15	100600	0.03	0.18

not reject the exogeneity of our sampling procedure.

4.4 Propensity score estimation

The first stage of the estimation strategy involves the estimation of the propensity scores. Table 2 reports the results of the corresponding probit estimation. Note that all explanatory variables are lagged by one year since we aim to account for pre-takeover firm characteristics.[14] The first column shows that there is a positive concave relationship between the size of a firm and the probability of a foreign takeover. Moreover, the probability of a foreign takeover is declining in the age of a firm and significantly influenced by industry- and year fixed effects. The coefficients of TFP and profitability are negative and positive, respectively, but not significant at conventional levels. The next columns provide the results of the probit estimations that correspond to our alternative estimation specifications. They reveal the determinants of domestic M&A, foreign takeovers by US and EU^+ firms[15], and M&A in the manufacturing and service sector, respectively. The last two columns display the findings for TFP based on Caves et al. (1982) and labor productivity. Most importantly, our evidence suggests that domestic takeovers tend to favor less productive firms. In addition, the results show that foreign firms from other EU^+ countries acquire, on average, more profitable UK firms. This suggests that "cherry-picking" for this type of M&A is based on profitability instead of productivity which is harder to observe.[16]

[14]The Zephyr database provides two different calendar dates for each takeover: the day when the deal has been announced and the date when it has been completed. In the following, we use the date of completion to identify the year of a takeover. We obtain, however, the same qualitative results if we alternatively use the year of announcement. The corresponding results are available from the authors upon request.

[15]EU^+ represents the following European countries: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland.

[16]We do find cherry picking based on TFP in the manufacturing sector if we exclude the profitability measure and include the ratio of R&D over assets as an additional determinant for foreign M&A. However, we only observe R&D for 270 of the 318 deals in the effective sample. Therefore, we do not include this variable in the propensity score estimation. These results are available from the authors upon request.

Table 2: Propensity score estimation

	for M&A	dom M&A	US M&A	EU$^+$ M&A	man M&A	ser M&A	for M&A	for M&A
lntfp-op	-.0424	-.0624***	-.0359	-.0734*	-.0464	-.0688*		
	(-1.39)	(-2.69)	(-.74)	(-1.71)	(-.78)	(-1.73)		
lntfp-Caves							-.0001**	
							(-2.05)	
Y/L								-.0005
								(-1.24)
return-cap	.0003	.0001	.0003	.0005**	.0006	.0002	.0002	-.0002
	(1.41)	(.43)	(.99)	(2.04)	(1.14)	(.87)	(1.01)	(-.92)
debt-asset	.1569	-.2031	-1.24	.3038	2.50***	-2.50*	.1573	.5059***
	(.28)	(-.35)	(-.89)	(.48)	(3.59)	(-1.86)	(.28)	(2.60)
size	.0330***	.0291***	.0208**	.0512***	.0575***	.0287***	.0330***	.0230***
	(3.55)	(3.27)	(2.18)	(3.49)	(2.76)	(2.97)	(3.55)	(2.88)
size^2	-.0004*	-.0005**	-.0002*	-.0012**	-.0011**	-.0003*	-.0004*	-.0003*
	(-1.88)	(-2.20)	(-1.61)	(-2.40)	(-2.11)	(-1.63)	(-1.88)	(1.87)
age	-.0018**	-.0021***	-.0020	-.0019*	-.0020*	-.0012	-.0017*	-.0019**
	(-1.96)	(-2.79)	(-1.39)	(-1.65)	(-1.62)	(-.88)	(-1.93)	(-2.28)
state	.0513	-.0944*	-.1002	.2026***	.0624	.0302	.0524	.0117
	(.87)	(-1.76)	(-.95)	(3.03)	(.59)	(.40)	(.89)	(.21)
quoted	-.0329	-.1729*	.3500**	.0137	-.4844**	.1252	-.0316	.0646
	(-.32)	(-1.61)	(2.39)	(.11)	(-2.17)	(.98)	(-.30)	(.73)
exit	-.0106	.1907***	.0216	-.0242	.3472	-.1523	-.0089	.0389
	(-.12)	(3.00)	(.15)	(-.19)	(1.59)	(-1.06)	(-.10)	(.47)
year-FE	yes	yes	yes	yes	yes	yes	yes	yes
industry-FE	yes	yes	yes	yes	yes	yes	yes	yes
P-values of joint test:								
year-FE = 0	.000	.000	.000	.000	.000	.000	.000	.000
industry-FE = 0	.000	.000	.000	.000	.000	.000	.000	.000
Observation.	152608	161216	126912	128729	42678	92682	152608	138839
pseudo R2	.042	.044	.060	.051	.042	.045	.042	.045
ps-likelihood	-3080	-4845	-1204	-1665	-1146	-1662	-3081	-3263

Sample covers all U.K. firms with information on value added, employment, and investments between 1999-2007. M&A is a dummy variable that is equal to 1 in the year of a (foreign) takeover and 0 if the firm is domestic and has not been the target of a (domestic or foreign) takeover between 1999-2007. Explanatory variables lagged by one year. t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

4.5 Balancing test

The difference-in-difference matching method provides a robust method for estimating the foreign acquisition effect on firm productivity if, conditional on the propensity score, the potential outcomes before and after acquisition are independent of the acquisition. Under the assumption of independence conditional on observables, the pre-acquisition variables should be balanced between the acquired and matched groups. Lack of balance points to a possible mis-specification of the propensity score estimation. We handle the balancing hypothesis in two ways: (i) we test the significance of differences between acquired and matched firms for each variable entering the propensity score estimation; (ii) we test whether those differences can be taken as jointly insignificant using a likelihood ratio test.

Table 3 summarizes the results for the balancing tests based on the different matching estimates.[17] The standardized differences between the acquired and matched control firms are smaller than 15% for foreign and domestic M&A.[18] Moreover, the formal paired t-test between acquired and matched control firms indicates that the balancing hypothesis can not be rejected at conventional levels for most of the individual series. The balancing hypothesis is rejected at the 5% for the age of a firm in the case of domestic M&A and for the debt-to-asset ratio in the manufacturing sector, respectively. In addition, it is rejected for the dummy variables "quoted" and "state" at the 5% level for US and EU$^+$ M&A and in the service sector.

In addition to the t-test for the individual series, we use a likelihood-ratio test which tests for the joint insignificance of the standardized differences between the acquired and the matched control firms. The corresponding p-values of the likelihood ratio test are presented in the fifth and ninth column in each of the corresponding tables that report the results of the difference-in-difference matching estimator (Tables 4-8). Accordingly, the test results show that the balancing conditions are satisfied for each difference-in-difference matching estimation in each

[17] Table 3 outlines the test results based on the matching estimator for year 0. The test results for all other years can also not be rejected but are not reported here. The corresponding summaries are available from authors upon request.

[18] Even though there is no formal criterion as to how large a standardized bias should be at most, we follow Rosenbaum and Rubin (1983) in assuming that a value of 20% is large.

year.

5 Empirical results

5.1 Aggregate TFP effects

Table 4 reports the results of the difference-in-difference matching estimator. The first column shows the (cumulative) effect of foreign acquisition on firm productivity in the year of completion of a takeover (0) up to 5 years thereafter. We find that foreign-acquired firms have, on average, 5.1% lower TFP-growth in the takeover year than domestic firms that had a comparable pre-takeover probability of becoming a foreign M&A target.[19] The coefficient is statistically significant at a 5% level. The estimation is based on 318 foreign takeovers between 1999 and 2007. The cumulative growth difference is close to zero in the first year, increases to 4% two years afterwards, and levels off at about 2-3% in the third and fourth year after the takeover.[20] However, the positive cumulative growth differences in the first four years after the M&A are not statistically significant at conventional levels.[21]

The negative initial impact of M&A suggests the presence of restructuring costs that reduce the TFP-level in the year of completion of the M&A. In contrast, we do not find evidence for positive longer-run effects of foreign M&A on the productivity of acquired firms.

The limited evidence for positive productivity effects of foreign M&A in the first five years after the takeover might be explained by heterogenous TFP performances among foreign acquired firms. In particular, the existence or magnitude of productivity spillovers might depend

[19] We employ the Epanechikov kernel matching estimator. The results are, however, qualitatively equivalent if we use a Gaussian kernel estimator or the nearest neighborhood matching estimator. The results of the alternative estimations are available from the authors upon request.

[20] We use the $n+1$'s difference in log TFP-levels to compute the growth rate n years after the takeover. For example, if a foreign M&A takes place in t TFP-growth in the fourth year after the takeover is compute as $lnTFP_{t+4} - lnTFP_{t-1}$.

[21] Table A1 in the Appendix reports the effects of domestic M&A on target firm TFP as a consistency check. Accordingly, the TFP effects of domestic M&A follow a different pattern over time than those for foreign M&A. Still, the corresponding coefficients are not statistically significant at conventional levels.

Table 3: Balancing test from kernel estimation

	Mean		% bias	t-test	Mean		% bias	t-test
	target	control			target	control		
	foreign M&A:				domestic M&A:			
lntfp-op	.6970	.7088	-2.2	-0.28	.6802	.7090	-5.5	-0.84
return-cap	31.40	29.47	2.4	0.30	31.87	29.33	3.6	0.56
debt-asset	.0179	.0168	5.4	0.68	.0163	.0169	-3.1	-0.47
size	1.22	.5500	13.0	1.65	.6700	.5800	2.4	0.37
$size^2$	34.00	21.00	2.0	0.25	10.00	12.00	-2.1	-0.32
age	27.68	29.18	-6.5	-0.82	26.27	29.09	-12.8	-1.97
state	.1447	.0971	14.6	1.84	.0764	.0970	-7.3	-1.12
quoted	.0629	.0323	14.4	1.82	.0191	.0312	-7.7	-1.19
exit	.0189	.0270	-5.4	-0.68	.0297	.0277	1.2	0.19
	US M&A:				EU M&A:			
lntfp-op	.7376	.7286	1.5	0.11	.6746	.7233	-8.9	-0.80
return-cap	29.05	30.17	-1.7	-0.12	36.81	30.15	7.7	0.69
debt-asset	.0161	.0169	-3.9	-0.29	.0186	.0165	10.4	0.93
size	1.37	.4735	14.8	1.10	1.19	.5590	14.7	1.32
$size^2$	62.13	13.44	8.9	0.66	18.78	19.97	.2	0.02
age	24.21	28.50	-20.2	-1.50	28.76	28.81	-0.2	-0.02
state	.1607	.0964	19.3	1.44	.2112	.1024	30.2	2.71
quoted	.1161	.0302	33.3	2.49	.0932	.0338	24.5	2.19
exit	.0179	.0265	-5.9	-0.44	.0186	.0261	-5.1	-0.45

Table 3 continued

	Mean		% bias	t-test	Mean		% bias	t-test
	target	control			target	control		
	manufacturing M&A:				services M&A:			
lntfp-op	.5454	.5331	3.2	0.26	.7927	.8056	-2.1	-0.19
return-cap	26.55	21.54	6.9	0.55	33.45	32.43	1.1	0.10
debt-asset	.0236	.0166	33.6	2.69	.0145	.0175	-16.4	-1.49
size	.9500	.7100	5.0	0.39	1.34	.4856	15.6	1.43
size^2	17.00	31.00	-1.9	-0.15	45.58	15.49	5.6	0.51
age	31.50	35.10	-13.1	-1.04	24.33	26.49	-10.8	-0.98
state	.0787	.0885	-3.5	-0.28	.1807	.1042	22.0	2.00
quoted	.0158	.0421	-15.8	-1.25	.0904	.0291	26.0	2.37
exit	.0158	.0248	-6.4	-0.51	0.0241	.0272	-1.9	-0.18
	foreign M&A:				foreign M&A:			
Y/L	17.32	71.47	-12.0	-1.50				
lntfp-Ca					-1.12	-.1382	-6.3	-0.79
return-cap	13.39	25.74	-12.0	-1.70	31.30	29.43	2.3	0.29
debt-asset	.0194	.0176	7.5	1.06	.0179	.0168	5.7	0.72
size	1.10	.6852	7.7	1.10	1.23	.5524	13.1	1.65
size^2	27.68	31.32	-.5	-0.07	33.67	21.23	2.0	0.25
age	27.72	28.85	-4.8	-0.68	27.64	29.19	-6.7	-0.84
state	.15	.1195	8.9	1.26	.1456	.0972	14.8	1.86
quoted	.07	.0410	12.7	1.79	.0633	.0323	14.5	1.82
exit	.0325	.0296	1.7	0.24	.0190	.0270	-5.3	-0.67

Balancing tests based on propensity score matching for year 0.

Table 4: The cumulative effect of foreign M&A on TFP

year	TFP-diff		deals/obs	LR-test
0	-.0511**	(-2.00)	318/124688	.219
1	.0130	(0.49)	239/102582	.198
2	.0402	(1.03)	176/84647	.178
3	.0315	(0.84)	133/68581	.160
4	.0203	(0.49)	92/54050	.186
5	-.0566	(-1.03)	72/40034	.103

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

LR-test of joint insignificance of all regressors after matching.

Table 5: The cumulative effect of US versus EU M&A on TFP

	US M&A				EU M&A			
year	TFP-diff		deals/obs	LR-test	TFP-diff		deals/obs	LR-test
0	-.0234	(-0.42)	112/103431	.373	-.0207	(-0.68)	161/104684	.123
1	.0558	(1.16)	83/84873	.237	-.0083	(-0.21)	126/85758	.240
2	.1478*	(1.66)	56/69859	.378	.0159	(0.39)	96/70524	.215
3	.0212	(0.35)	45/56464	.808	.0551	(0.92)	67/56993	.126
4	.0360	(0.42)	31/44373	.612	-.0187	(-0.35)	45/44789	.373

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

on the home country of the foreign acquirer. For example, Benfratello and Sembenelli (2002) uncover positive M&A effects only in the case of US multinationals. In Table 5, we distinguish between two different regions of origin of the foreign acquirer: the US and the EU^+. The evolution of the TFP performance of target firms of US multinationals is comparable to the overall effect of foreign takeovers in the first four post M&A periods: the coefficient is negative in the year of completion, positive thereafter, peaks in the second year after the M&A, and levels off afterwards.[22] However, the positive growth difference in the second year after the M&A is 3.5 times higher (it amounts to 14.8%) and statistically significant at the 10% level for US takeovers. Thus, we find some evidence in favor of positive TFP effects from foreign M&A if the acquiring firm is based in the US. In contrast, we do not observe significant impacts of M&A from EU^+ countries.

Table 6 distinguishes between the effects from foreign takeovers in manufacturing and service industries. The evolution of TFP for target firms in the manufacturing sector is again comparable to the overall effect of foreign takeovers in the first four post M&A periods: the coefficient, which amounts to 7.8%, is negative and significant at a 5% level in the year of the takeover and positive but not significant at conventional levels thereafter. In contrast, we are not able to detect a similar pattern in the service sector. The corresponding coefficients are very small and not significant.

Finally, Table 7 outlines the results for two alternative TFP measures which are based on an OLS production function estimation and the multilateral TFP index ($lntfp - Caves$) developed by Caves et al. (1982), respectively. The latter TFP indicator has been used in the literature, e.g., by Bertrand and Zitouna (2008).[23] Table 7 shows that we do not find a significant aggregate impact of foreign takeovers on target firm productivity in post-acquisition periods based on these two alternative TFP measures. This is consistent with the results based on Olley-Pakes TFP levels.[24]

[22] The pattern of TFP effects due to US (or foreign) takeovers can be described by an 'S-curve'.

[23] Note that, in contrast to our preferred TFP measure based on Olley and Pakes (1998), it implicitly assumes perfect competition in factor markets and constant returns to scale in order to compute input elasticities.

[24] We also convert the logged TFP levels based on Olley-Pakes into a TFP index relative to industry averages. The results, which are reported in Table A5 in the Appendix, do not differ qualitatively from the findings in

Table 6: The cumulative effect of foreign M&A on TFP in manufacturing versus services

	M&A in manufacturing				M&A in services			
year	TFP-diff		deals/obs	LR-test	TFP-diff		deals/obs	LR-test
0	-.0779**	(-2.39)	127/35677	.164	-.0374	(-0.90)	166/74656	.173
1	.0159	(0.41)	95/29894	.744	.0270	(0.68)	126/60775	.191
2	.0283	(0.53)	71/25127	.506	.0702	(1.19)	95/49622	.286
3	.0899	(1.32)	57/20691	.492	-.0096	(-.21)	67/39804	.321
4	.0602	(.99)	40/16589	.544	-.0002	(-0.00)	46/31071	.256

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

Table 7: The cumulative effect of foreign M&A on alternative TFP measures

	Caves et al.				OLS			
year	TFP-Ca-diff		deals/obs	LR-test	TFP-OLS-diff		deals/obs	LR-test
0	-.1782	(-1.13)	316/124251	.001	-.0523**	(-2.07)	318/124688	.164
1	-.1302	(-0.87)	239/102188	.004	.0122	(.47)	239/102582	.145
2	-.1558	(-1.08)	176/84320	.010	.0408	(1.08)	176/84471	.165
3	-.1071	(-0.61)	133/68319	.022	.0283	(.78)	133/68581	.176
4	-.1062	(-0.49)	91/53832	.066	.0141	(.34)	92/54050	.214
5	-.4134	(-1.18)	72/40873	.074	-.0614	(-1.07)	72/41034	.101

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

In sum, we do not find solid evidence in favor of a longer-run TFP gain in the post-acquisition period caused by foreign acquisition at the aggregate level.

5.2 Industry specific effects

Nocke and Yeaple (2007) highlight the importance of industry specific effects of the relationship between firm productivity and cross-border M&A. To explore this, we analyze the impact of foreign M&A separately for 34 different two-digit industries. Table 8 shows the results for the six industries where we identify a positive causal impact of foreign M&A on UK target firm TFP levels in post-acquisition periods. First, we detect a negative significant initial drop in TFP that is followed by insignificant effects thereafter relative to domestic firms in the food, beverages & tobacco industries. Second, we find pronounced positive TFP effects due to foreign M&A in three manufacturing industries: manufacture of electrical equipment & machinery, manufacture of communication equipment & apparatus, and printing & publishing. Foreign-acquired firms outperform their domestic counterparts by 20-100% in the second to the fourth year after the takeover in the first two manufacturing industries and two years after the M&A in printing and publishing. Third, we observe the opposite impacts in two different service industries. On the one hand, foreign-acquired firms experience lower TFP-growth than domestic counterparts in all post M&A periods in renting of machinery & equipment. On the other hand, they have higher TFP-growth until the second post-takeover year in computer and related activities. Thus, we find positive evidence in favor of technological or organizational spillovers from foreign acquirers to domestic target firms in the electronic manufacturing and service industries. In other words, the potential for positive productivity effects appears to be largest in UK electronic industries.[25] Overall, the industry level results highlight a significant heterogeneity in the effect of foreign acquisitions on target firm productivity across industries which is consistent with the Nocke and Yeaple (2007) theoretical predictions. This heterogeneity across industries potentially explains

our baseline specification.

[25]This finding differs from Girma and Görg (2002) who use, however, a different data set, methodology, and a different measure of TFP.

the absence of positive longer-run TFP effects at the aggregate level.[26]

Moreover, the theoretical model of Nocke and Yeaple (2007) implies that the scope for productivity spillovers from the acquiring to the target firm is most pronounced if the acquirer operates in an R&D-intensive industry while productivity spillovers might even be negative if it operates in a marketing-intensive industry. A direct test of this hypothesis requires, however, information on the R&D and marketing expenses of the acquiring firms, respectively. This information is not available in the Amadeus data set. However, we can draw on the work of Peneder (2002) who uses cluster analysis to classify US manufacturing industries as R&D and marketing-intensive at the four-digit level.[27] We follow his classification to test for positive or negative productivity effects in the two different sub-groups, respectively.[28] Table 9 reveals positive TFP coefficients in all post-acquisition periods if the acquirer operates in an R&D-intensive industry indicating that foreign ownership enhances the TFP levels of foreign-acquired firms in these industries.[29] The effect is, however, only significant on a 10% level in the fourth year after the acquisition. In contrast, we find negative TFP coefficients in all

[26]Moreover, (horizontal) foreign M&A may lead to a concentration in market power involving a decline in competition which potentially entails lower long-run productivity growth in that industry. This effect would counteract the positive productivity effects and might hence also explain the absence of positive longer-run TFP effects at the aggregate level.

[27]Peneder (2002) classifies the following manufacturing industries as R&D-intensive: pesticides and other agro-chemical products, pharmaceuticals, medicinal chemicals, botanical, and other chemical products, office machinery and computers, electricity distribution and control apparatus, electronic components, television and radio transmitters, apparatus for line telephony, television and radio receivers, sound or video recording or reproducing apparatus, medical, precision and optical instruments, motor vehicles, aircraft and spacecraft. Furthermore, he classifies the following as marketing-intensive: food products, beverages and tobacco, leather and leather products, publishing, printing and reproduction of recorded media, soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations, tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers, cutlery, tools and general hardware, watches and clocks, musical instruments, sports goods, games and toys, miscellaneous manufacturing n.e.c.

[28]We assume that R&D and marketing intensities are comparable across countries at the industry level.

[29]We also classify target firms in high or low technology industries, respectively, following the OECD classifications (see for example OECD, 2007, p. 220-221). However, we do not find significant effects of foreign M&A in these particular sub-groups. The results are available from the authors upon request.

Table 8: The cumulative effect of foreign M&A on TFP by two-digit NACE codes

year	TFP-diff		deals/obs	LR-test	TFP-diff		deals/obs	LR-test
	Food, beverages & tobacco:				Publishing & printing:			
0	-.1695**	(-2.13)	16/4197	.734	.1153	(1.17)	10/3937	.613
1	-.0704	(-0.82)	11/3558	.888	.0141	(0.22)	8/3294	.504
2	-.0473	(-0.36)	10/3006	.770	.2988*	(1.84)	6/2762	.650
3	-.0783	(-0.77)	8/2491	.781	.3201	(0.66)	3/2251	.608
4	-.1042	(-0.60)	5/2012	.817	.2503	(1.23)	2/1798	.726
	Manuf. of office & electrical mach.:				Manuf. of communication equ.:			
0	-.0818	(0.96)	9/2501	.377	-.3213*	(-1.65)	3/766	.688
1	.1979***	(3.27)	5/2081	.813	.1494	(0.26)	3/635	.785
2	.1431**	(2.08)	5/1754	.811	1.03***	(2.97)	3/523	.491
3	.1818***	(2.77)	3/1447	.643	1.45***	(2.93)	3/434	.501
4	.2795***	(3.95)	3/1160	.657				
	Renting of mach. & equ.:				Computer services & related act.:			
0	-.2324*	(-1.92)	4/1177	.826	-.0323	(-0.50)	22/3880	.921
1	-.1640**	(-2.08)	3/974	.688	-.1236	(-1.03)	13/3088	.674
2	-.1616**	(2.38)	3/807	.678	.1990***	(2.55)	7/2485	.905
3	-.0775***	(-4.47)	3/650	.706	-.0341	(-0.31)	5/1972	.957
4	-.0711***	(-2.82)	2/512	.705	.1177	(1.31)	3/1505	.437

The industry codes are NACE15-16, NACE22, NACE30-31, NACE32,

NACE71, NACE72, NACE72, respectively.

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

post-acquisition periods if the acquirer operates in a marketing-intensive industry indicating that foreign ownership leads to a decline in the TFP levels of foreign-acquired firms in these industries. Again, the effect is only significant at a 10% level in the second year after a foreign takeover. In sum, a classification of acquiring firms as R&D and marketing-intensive results in a systematic pattern of post-acquisition TFP effects that is consistent with the specific TFP ranking of acquiring firms in Nocke and Yeaple (2007).

5.3 Labor productivity

The findings in Section 5.1 call into question the evidence of longer-run TFP effects of foreign ownership on foreign-acquired firms in the UK at the aggregate level and highlight instead a substantial heterogeneity in the effects across industries. These findings are consistent with Harris and Robinson (2003) who do not find aggregate TFP effects due to foreign M&A in the UK. However, they conflict with the findings of Conyon et al. (2002) who detect that US subsidiaries in the UK outperform domestic firms in terms of labor productivity. Therefore, we address the following question: does the impact of foreign M&A depend on the measure of firm productivity?

Table 10 reports the results for the difference-in-difference matching estimator for the effects of foreign acquisition on firm labor productivity. Indeed, we find that the use of labor productivity as a performance measure results in significant productivity increases due to foreign takeovers in all of the first five post-acquisition periods.[30] This is consistent with the labor productivity based findings of Conyon et al. (2002). The last four columns of Table 10 repeat the aggregate TFP results form Table 4 to contrast the difference between the two productivity measures. Moreover, Table 11 distinguishes between labor productivity effects in the manufacturing and service sector and reveals that the increase in labor productivity is predominantly

[30]Note that the likelihood ratio test rejects the balancing conditions in the second and third year after the takeover. Thus, the matching procedure does not allow for a meaningful comparison between foreign-acquired firms and the counterfactual of domestic firms for these periods. However, Table 11 shows that the increase in labor productivity is mainly due to an increase in the manufacturing sector and the balancing condition is satisfied in this sector in all post-acquisition periods.

Table 9: The cumulative effect of foreign M&A on TFP if acquirer R&D or marketing-intensive

	Acquirer R&D-intensive				Acquirer marketing-intensive			
year	TFP-diff		deals/obs	LR-test	TFP-diff		deals/obs	LR-test
0	-.0726	(-1.03)	29/19172	.759	-.1193**	(-2.19)	13/7893	.444
1	.0525	(0.63)	20/15704	.686	-.1456	(-1.59)	8/6406	.785
2	.0217	(0.18)	16/12873	.695	-.2222*	(-1.79)	7/5172	.820
3	.2407	(1.34)	14/10306	.638	-.1373	(-1.03)	6/4027	.849
4	.1684*	(1.66)	11/7834	.843	-.2253	(-1.19)	4/2974	.839

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

Table 10: The cumulative effect of foreign M&A on labor productivity versus TFP

	labor productivity				TFP			
year	Y/L-diff		deals/obs	LR-test	TFP-diff		deals/obs	LR-test
0	-.0192	(-0.83)	400/118675	.047	-.0511**	(-2.00)	318/124688	.219
1	.1064***	(3.97)	319/98379	.245	.0130	(0.49)	239/102582	.198
2	.0700**	(2.01)	247/81177	.021	.0402	(1.03)	176/84647	.178
3	.1115***	(2.88)	189/65710	.002	.0315	(0.84)	133/68581	.160
4	.1446***	(2.70)	146/51648	.094	.0203	(0.49)	92/54050	.186
5	.2242***	(3.55)	105/38860	.149	-.0566	(-1.03)	72/40034	.103

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

driven by manufacturing industries. It follows that foreign-acquired firms outperform matched domestic firms in the manufacturing sector in terms of labor productivity but not TFP in post-acquisition periods.[31]

Against this background, it is important to recall the difference between the two measures. TFP reflects target firm efficiency gains due to the diffusion of technological or organizational knowledge and economies of scale. Therefore, it is a precise empirical counterpart to the theoretical literature on multinational firms which exactly emphasizes these transmission channels. Labor productivity, in contrast, is a broader measure that captures these TFP effects as well as changes in the target firm's capital-labor ratio. For example, one can derive the following log-linear relationship between labor productivity, TFP and the capital-labor ratio in the case of a Cobb-Douglas production function: $ln(Y/L) = ln(TFP) + \alpha ln(K/L)$. Hence, we support that the increase in labor productivity due to foreign ownership stems from an increase in the capital-labor ratio, i.e., capital deepening, instead of technological or organizational knowledge diffusion. Table 12 confirms this conjecture, revealing that foreign M&A leads to capital deepening in UK target manufacturing firms in post-acquisition periods. The order of magnitude of the increases in the capital-labor ratios is in line with the increases in labor productivity. Thus, foreign firms substantially restructure acquired firms in the UK reducing the number of employees relative to capital stocks.[32] This finding reconciles the difference between the results based on TFP and labor productivity.

It follows that the use of labor productivity instead of TFP to measure the impact of foreign acquisition on improvements in technological or organizational knowledge in the UK acquired firms is misleading. Instead, the increase in foreign acquired firm's labor productivity in post-acquisition periods is caused by capital deepening and not the theoretically suggested TFP effects. This confirms that TFP is the more appropriate measure to identify the causal impact of foreign acquisitions on firm performance as described in the theoretical literature on

[31] Table A1 in the Appendix reports the effects of domestic M&A on labor productivity. It does not indicate any positive effect of domestic M&A on labor productivity in post-acquisition periods, in contrast to the effects of foreign M&A.

[32] In fact, we find that the number of employees in foreign-acquired firms declines significantly in the manufacturing sector in post-acquisition periods. These results are available from the authors upon request.

Table 11: The cumulative effect of foreign M&A on labor productivity in manufacturing vs services

	manufacturing				services			
year	Y/L-diff		deals/obs	LR-test	Y/L-diff		deals/obs	LR-test
0	-.0558*	(-1.84)	161/33852	.040	.0025	(.07)	215/72423	.043
1	.1125***	(3.03)	126/28684	.231	.1050***	(2.60)	174/59364	.233
2	.1308***	(2.86)	103/24144	.456	.0001	(0.00)	131/48457	.112
3	.0974**	(2.56)	83/19927	.443	.0672	(0.99)	95/38779	.042
4	.1074***	(2.05)	64/15946	.642	.1121	(1.23)	76/30136	.216
5	.2323**	(2.55)	45/12224	.684	.1490*	(1.68)	55/22393	.485

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

Table 12: The cumulative effect of foreign M&A on capital-labor ratio in manufacturing vs services

	manufacturing				services			
year	K/L-diff		deals/obs	LR-test	K/L-diff		deals/obs	LR-test
0	-.0001	(-.00)	160/34518	.000	.0204	(.39)	207/73316	.018
1	.1289***	(2.83)	126/29492	.057	.0018	(.02)	171/60829	.093
2	.2000***	(3.43)	104/25076	.219	-.0443	(-.41)	130/50193	.125
3	.1580**	(2.11)	84/20878	.237	-.0853	(-.79)	94/40550	.044
4	.1517	(1.59)	64/16896	.573	-.1428	(-.87)	75/31714	.159
5	.0534	(.43)	44/13059	.639	-.2674*	(-1.68)	55/23776	.448

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

multinational firms.

6 Conclusion

This paper examines the causal relationship between foreign acquisitions and target firm productivity using a rich micro data set from the UK over the period 1999-2007. We use propensity score matching combined with a difference-in-difference estimator which allows us to distinguish between causality and correlation effects of foreign ownership.

Our results call into question the existence of longer-run effects of foreign ownership on TFP at the aggregate level. A supplementary analysis which distinguishes between different countries of origin of foreign acquirers does not challenge this main conclusion.

However, we find that the effects of foreign acquisitions vary across industries. It appears that foreign ownership led to higher productivity in ICT manufacturing industries but not in ICT service industries. These industry level results highlight a significant heterogeneity in the effect of foreign M&A on target firm productivity across industries which is consistent with the theoretical predictions of Nocke and Yeaple (2007). This heterogeneity across industries potentially explains the absence of positive longer-run TFP effects at the aggregate level. Moreover, when we follow the theoretical suggestions of Nocke and Yeaple (2007) by classifying acquiring firms as R&D and marketing-intensive, we broadly reveal a systematic pattern of post-acquisition TFP effects that is consistent with their theoretical predictions which generate a specific TFP ranking of acquiring firms.

Finally, we find positive aggregate effects on labor productivity but not TFP in the manufacturing sector, i.e., foreign M&A leads to capital deepening but not improvements in technological or organizational knowledge in the longer-run. Hence, the use of labor productivity instead of TFP generates misleading results with respect to the causal impact of foreign M&A on target firm performance in the UK as described in the theoretical literature on multinational firms.

A Appendix

A.1 Estimation of production functions under simultaneity

Using equation (2) we decompose the error term ε_{jt} into two elements, i.e., $\varepsilon_{jt} = \omega_{jt} + \epsilon_{jt}$, where ω_{jt} is the productivity shock and ϵ_{jt} is the true error term. Further, a_{jt} measures a the age of a firm. Hence, we can write

$$Y_{jt} = \alpha_0 + \alpha^k k_{jt} + \alpha^l l_{jt} + \omega_{jt} + \epsilon_{jt} \tag{3}$$

The simultaneity problem arises if ω_{jt} is correlated with at least one of the regressors. In such a case, estimates $\hat{\theta}^k$ and $\hat{\theta}^l$ would be biased. In the recent literature on the estimation of production functions, one generally assumes that the demand for labor is the only input which is potentially correlated with ω_{jt} as capital stocks are assumed to be predetermined. As a remedy, Olley and Pakes (1996) propose a two-stage procedure for a consistent estimation of (3) in which they advocate the use of a firm's log investment i_{jt} to identify the productivity shock. In doing so, they define the investment function ι such that $i_{jt} = \iota_t(\omega_{jt}, k_{jt}, a_{jt})$. If investments are monotonically increasing in the technology shock for a given value of capital and age, this allows them to express the unobservable technology variable as a function of contemporaneous investments, capital, and age. Hence, they define the inverse investment function by m_t so that $\omega_{jt} = m_t(i_{jt}, k_{jt})$. Thus, one can rewrite (3) as

$$Y_{jt} = \alpha_0 + \alpha^k k_{jt} + \alpha^l l_{jt} + m_t(i_{jt}, k_{jt}) + \epsilon_{jt}. \tag{4}$$

Further, we define

$$\phi_t(i_{jt}, k_{jt}) := \alpha_0 + \alpha^k k_{jt} + m_t(i_{jt}, k_{jt})$$

and approximate this term by a third order polynomial series in k and i.[33] Consequently, we

[33] In particular, we define

$$\phi_t(i, k, a) = \theta_0 + \sum_{p=1}^{3} (\theta_p^i i^p + \theta_p^k k^p + \theta_p^{ik} (ik)^p).$$

can write

$$Y_{jt} = \alpha^l l_{jt} + \phi_t(i_{jt}, k_{jt}) + \epsilon_{jt} \tag{5}$$

Since we control for contemporaneous movements in productivity by the inverse investment function, OLS estimation of (5) yields consistent estimates of α^l.

The second stage is necessary to identify α^k. Therefore, we assume that productivity follows a first order Markov chain, i.e, $\omega_{jt} = E(\omega_{jt}|\omega^j_{t-1}) + \xi_{jt}$, where ξ_{jt} denotes the innovation in the productivity and is assumed to be uncorrelated with capital in period t. Defining v_t as output net of the contributions of labor and substituting $h_{t-1}(i^j_{t-1}, k^j_{t-1})$ into a function

$$g(\phi^j_{t-1} - \alpha^k k^j_{t-1}),$$

we can write[34]

$$v_{jt} = \alpha_0 + \alpha^k k_{jt} + g(\cdot) + \xi_{jt} + \epsilon_{jt} \tag{6}$$

Note that we restrict capital and lagged capital to have the same coefficient. Consequently, as the coefficient enters the regression equation twice we estimate it efficiently and consistently by applying to (6) a non-linear least squares procedure.

A.2 Additional robustness checks

Table A1 reports the effects of domestic M&A on target firm TFP and labor productivity. Accordingly, the TFP effects of domestic M&A follow a different pattern over time than those for the foreign M&A. However, they are not statistically significant at conventional levels (apart from a positive TFP effect in the fifth year after a domestic takeover which is significant at the 10 % level). Moreover, we do not detect a positive effect of domestic M&A on labor productivity in post-acquisition periods (apart from the third year after a domestic takeover which is significant at the 10 % level). Hence, in contrast to foreign M&A, domestic M&A do not lead to capital deepening in the target firm in post-acquisition periods.

[34] Note that we do not correct for sample attrition since we do not observe the exit of firms.

Table A1: The cumulative effect of domestic M&A

	TFP				labor productivity			
year	TFP-diff		deals/obs	LR-test	Y/L-diff		deals/obs	LR-test
0	-.0327	(-1.51)	471/131753	.183	-.0309	(-1.29)	547/123418	.011
1	-.0115	(-0.42)	321/108106	.135	.0068	(0.25)	428/102346	.004
2	-.0312	(-0.77)	212/89236	.307	.0507	(1.52)	311/84419	.033
3	.0124	(0.32)	155/72489	.221	.0707*	(1.64)	246/68329	.073
4	.0347	(0.81)	115/56958	.458	.0588	(1.33)	179/53696	.134
5	.0468*	(1.93)	82/43246	.870	.0494	(.98)	134/40377	.627

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

Table A2 reveals that we do not find significant differences between the effects of vertical and horizontal M&A.

Tables A3 shows the descriptive statistics for foreign-acquired firms that can not be accounted for in the second stage of the difference-in-difference matching estimation. Table A4 lists the total number of deals in the population and our effective sample across two-digit NACE industries. Finally, Table A5 reports the results for a TFP index relative to industry averages and the weighted TFP estimations based on Olley and Pakes (1996), respectively.

Table A2: The cumulative effect of foreign vertical vs horizontal M&A on TFP

	horizontal M&A				vertical M&A			
year	TFP-diff		deals/obs	LR-test	TFP-diff		deals/obs	LR-test
0	-.0703	(-1.59)	80/99986	.146	-.0453	(-1.48)	238/111931	.381
1	.0216	(0.49)	52/82136	.143	.0089	(0.28)	187/91880	.586
2	.0338	(0.54)	33/67717	.140	.0394	(0.86)	143/75697	.686
3	.0950	(.79)	21/54755	.173	.0169	(0.44)	112/61297	.451
4	.0750	(1.49)	18/43090	.326	.0028	(0.06)	74/48301	.433
5	.1601**	(2.41)	15/32631	.136	-.1180*	(-1.81)	57/36654	.334

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%.

Table A3: Descriptive statistics including all foreign M&A

	Target firms			All other firms			Missing foreign M&A		
	firms	mean	sd	firms	mean	sd	firms	mean	sd
lntfp-op	318	0.7	0.52	14330	0.71	0.6	288	0.68	0.62
Y/L	400	256.81	931.71	12884	552.88	2375.1	560	516.84	1380.57
lntfp-Caves	316	-1.12	2.54	14330	-0.19	31.01	282	-0.05	4.19
lntfp-ols	318	0.76	0.53	14330	0.8	0.6	288	0.79	0.63
return-cap	318	31.4	93.33	14330	28.69	70.89	275	2.46	135.83
debt-asset	318	0.02	0.02	14330	0.02	0.02	340	0.03	0.15
size	318	1.22	5.66	14330	5.79	4.86	642	2.86	1.33
age	318	27.68	24.72	14330	28.74	21.78	1953	18.80	18.77
state	318	0.14	0.35	14330	0.09	0.29	1953	0.11	0.31
quoted	318	0.06	0.24	14330	0.03	0.17	1953	0.05	0.22
exit	318	0.02	0.14	14330	0.03	0.17	1953	0.14	0.35

Table A4: Number of foreign M&A by industry

industry	NACE	M&A total	M&A sample	% M&A total	% M&A sample	% diff
mining and quarrying	10	51	5	2.25	1.57	-0.67
food, beverages, tobacco	15-16	65	16	2.86	5.03	2.17
textile products	17	13	3	0.57	0.94	0.37
wearing apparel, leather	18-19	11	2	0.48	0.63	0.14
wood products	20	6	0	0.26	0.00	-0.26
paper products	21	14	1	0.62	0.31	-0.30
publishing, printing	22	58	10	2.55	3.14	0.59
chemical products	23-24	81	18	3.57	5.66	2.09
rubber, plastic products	25	38	11	1.67	3.46	1.79
non-metallic mineral products	26	28	4	1.23	1.26	0.02
basic metals	27	12	2	0.53	0.63	0.10
fabricated metal products	28	72	16	3.17	5.03	1.86
machinery and equipment	29	60	12	2.64	3.77	1.13
office, electrical machinery	30-31	50	9	2.20	2.83	0.63
communication equipment	32	28	3	1.23	0.94	-0.29
optical instruments	33	42	4	1.85	1.26	-0.59
motor vehicles, trailers	34	15	2	0.66	0.63	-0.03
other transport equipment	35	15	2	0.66	0.63	-0.03
furniture and recycling	36-37	72	12	3.17	3.77	0.60
electricity, gas, water supply	40-41	27	0	1.19	0.00	-1.19
construction	45	68	20	2.99	6.29	3.30
sale, repair of motor vehicles	50	15	5	0.66	1.57	0.91
wholesale, commission trade	51	185	35	8.15	11.01	2.86
retail trade	52	55	13	2.42	4.09	1.67
land transport	60	13	2	0.57	0.63	0.06
water and air transport	61-62	24	8	1.06	2.52	1.46
auxiliary transport activities	63	38	5	1.67	1.57	-0.10
post and telecommunications	64	45	6	1.98	1.89	-0.09
financial intermediation	65	80	6	3.52	1.89	-1.64
auxiliary financial intermediation	67	34	3	1.50	0.94	-0.55
real estate activities	70	46	6	2.03	1.89	-0.14
renting machinery, equipment	71	13	4	0.57	1.26	0.69
computer and related activities	72	306	22	13.47	6.92	-6.56
R&D and other business	73-74	591	51	26.02	16.04	-9.99
Sum		2271	318	100	100	0

Table A5: The cumulative effect of foreign M&A on TFP as an index or weighted

	foreign M&A								Hausman
year	TFP-OP-index		deals/obs	LR-test	TFP-OP-weighted		deals/obs	LR-test	test (H)
0	-.1008	(-1.13)	318/124688	.204	-.3032	(-1.34)	318/124843	.201	1.12
1	-.0592	(-1.48)	239/102582	.226	.1079	(.48)	239/101876	.158	0.18
2	.3725	(0.89)	176/84647	.181	.4120	(1.40)	175/84071	.153	1.63
3	.0093	(0.11)	133/68581	.212	.2595	(.87)	131/68109	.162	0.59
4	-.0727	(-1.21)	92/54050	.214	.2393	(.84)	90/53676	.194	0.60

t-statistics in parenthesis. ***,**,* significant at 1%, 5%, 10%. The Hausman test indicates that the results from the weighted estimation and the unweighted in Table 4 are not significant at conventional levels.

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