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## QUANTIFYING PRODUCTIVITY GAINS FROM FOREIGN INVESTMENT

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## ABSTRACT

### Quantifying Productivity Gains from Foreign Investment\*

We revisit the relationship between foreign investment and productivity of acquired firms. First, we construct a panel firm-level dataset for eight advanced European countries covering domestic and foreign acquisitions together with detailed balance sheet information for the years 1999-2012. Second, we address the challenge of identifying a causal relation. To that end, we compare foreign to domestic acquisitions in addition to accounting for the impact of majority versus minority acquisitions after controlling for country and sector trends. The productivity of foreign acquired affiliates increases modestly after four years, but only when majority stakes are acquired by foreigners. Our results are driven by foreign acquisitions and not by foreign divestment.

JEL Classification: E32, F15, F36 and O16

Keywords: Multinationals, Selection, Majority Ownership, Advanced Countries.

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# Quantifying Productivity Gains from Foreign Investment<sup>\*</sup>

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## Abstract

We revisit the relationship between foreign investment and productivity of acquired firms. First, we construct a panel firm-level dataset for eight advanced European countries covering domestic and foreign acquisitions together with detailed balance sheet information for the years 1999–2012. Second, we address the challenge of identifying a causal relation. To that end, we compare foreign to domestic acquisitions in addition to accounting for the impact of majority versus minority acquisitions after controlling for country and sector trends. The productivity of foreign acquired affiliates increases modestly after four years, but only when majority stakes are acquired by foreigners. Our results are driven by foreign acquisitions and not by foreign divestment.

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# 1 Introduction

The stock of foreign direct investment (FDI) inward positions in the OECD was a staggering 21.7 trillion dollars in 2017—a magnitude that makes the policy relevance of any potential impact self-evident.<sup>1</sup> FDI typically takes the form of take-overs of existing firms (Barba-Navaretti and Venables (2004)) and FDI is likely to increase the productivity of acquired firms because foreign owners may bring superior technical, marketing, and/or management skills to the acquired firm. Firms are heterogeneous and multinational firms that invest abroad are more productive than purely domestic firms (see Blonigen, Fontagne, Sly, and Toubal (2014)).<sup>2</sup> It is therefore likely that a domestic firm which is acquired by a foreign (likely high-productivity) firm will see an increase in productivity since technological knowledge (Aitken and Harrison (1999)) or good management practices (Bloom, Sadun, and Van Reenen (2012)) can be transferred to subsidiaries. Guadalupe, Kuzmina, and Thomas (2012), for example, show that foreign majority investors in Spain employ new equipment and production processes leading to higher productivity of acquired firms.

We revisit the question of whether investment by foreign firms leads to higher productivity growth of acquired firms in *advanced economies*. The existing results from the literature on the magnitude of productivity gains from FDI vary widely from nil to a high of 16% across studies conducted for different developed countries. Considering the wide range of estimates for single countries, there is a need for a cross-country study to provide estimates of the typical effect in advanced economies. We measure productivity as revenue total factor productivity, which we refer to simply as “productivity,” although, at places, we also consider labor productivity, which we will refer to as such.

We make several contributions. Our first contribution is the construction of a large-scale multi-country firm-level panel dataset using the Orbis database, available

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<sup>1</sup> *OECD International Direct Investment Statistics 2018*.

<sup>2</sup> Even in the advanced economy of the United States, foreign owned firms are more productive than domestic firms as shown by Doms and Jensen (1998) and Helpman, Melitz, and Yeaple (2004). These authors argue that the fixed cost of setting up foreign operations explains why only the most productive firms in an economy engage in foreign investment.

from Bureau van Dijk (BvD)-Moody's. Orbis is the only harmonized multi-country dataset that has accounting data and ownership information, needed for studying FDI, with near-universal coverage of registered firms of all sizes, with the distribution of firms by size and industry resembling the official data.<sup>3</sup> In order to obtain a dataset which allows for estimation without survivorship bias, we put together a longitudinal firm-level dataset from annual vintages of Orbis data, an endeavor which is in itself a non-trivial research undertaking. In Section 2, we highlight the strengths and weaknesses of this unique dataset for empirical research.

Our second contribution lies in the matching of foreign acquisitions to acquisitions by purely domestic firms in the same country as the FDI target: the large size of our dataset allows us to study the effects of FDI in a sample where firms acquired by foreign firms are matched to similar firms acquired by domestic investors, thereby isolating the “foreign” component of acquisitions from the acquisition itself, as previously done by [Chen \(2011\)](#) and [Wang and Wang \(2015\)](#) for the United States and China, respectively. By matching foreign acquisition to domestic acquisitions of similar domestic firms and further showing that productivity effects materialize only after four years and only when foreign owners take majority positions, we provide evidence for a causal effect of foreign investment on productivity. The four-year lag is consistent with new foreign owners reorganizing production, which takes time. If our estimates were plagued by reverse causality and/or selection bias, where foreign owners were superior at identifying firms with future growth potential, it is unlikely that this effect would show up only after four years. We further show that foreign investment increases productivity while foreign divestment has no significant effect.

We show that our results are robust to changes in the definition of productivity, to the choice of inputs in the production function, to the inclusion of a novel rich set of fixed effects, and to variation in the sample of countries and periods. Specifically, the results hold whether we: (1) measure productivity as labor productivity or total factor productivity, (2) estimate productivity using Cobb-Douglas or translog production

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<sup>3</sup>The work to validate and compare this data to the official sources continues as described in [Kalemli-Ozcan, Sørensen, Villegas-Sanchez, Volosovych, and Yesiltas \(2015\)](#), who provide detailed evidence supporting the validity of the Orbis data.

functions, (3) measure labor input as employment or wage bill, or (4) measure capital stock as tangible assets or the sum of tangible and intangible fixed assets. In addition, the results are robust to using alternative methods for estimating productivity (the one-step GMM estimation method of [Wooldridge \(2009\)](#) and the two-step control function approach of [Akerberg, Caves, and Frazer \(2015\)](#)).

Furthermore, the results hold for subsets of countries (for example, dropping Germany for which Orbis has less good coverage at the beginning of the sample, dropping Norway and France for which only aggregate manufacturing producer price index deflators are available, or dropping Spain for which the tangible fixed asset series has a break in 2008). The results also hold for the years before or after the Great Recession and they are robust to using Generalized Least Squares (GLS) or Ordinary Least Squares (OLS), to the inclusion of country-, sector-, or country-sector fixed effects, and to some further permutations described in the empirical section and in the online appendix.

For causal identification, we use propensity score methods (PSM) to match foreign acquisitions with domestic acquisitions as similar as possible in observable characteristics prior to the acquisition. We estimate the impact of foreign acquisitions using reduced-form linear regressions following the vast majority of papers in this literature. The literature mostly matches foreign acquisitions with domestic firms not acquired by foreign entities and interprets the estimates as the causal effect of FDI on productivity. Target firms are not randomly selected by foreign investors, but PSM is designed to account for selection patterns that may lead to bias; in particular, the tendency for foreign investors to acquire firms that are already highly productive. As matching is based on variables that are observable to researchers, such as current productivity, it cannot be ruled out that investors select firms that are likely to become more productive in the future. If foreign investors screen potential targets more strongly and have a better sense of future growth potential, then PSM that matches acquired firms to non acquired firms may not be causal. A PSM that matches firms acquired by foreign investors to firms acquired by domestic investors, on the other hand, is less likely to suffer from this issue unless foreign investors are somewhat



“smarter” than domestic investors in seeing the future growth potential. To further guard against this low probability outcome, we do our PSM with considerable lags and leads. We find that FDI affects productivity only after four years. These delayed productivity effects strengthen the likelihood that the effects are casual as it is highly unlikely that foreign investors forecast four-year ahead productivity-growth better than domestic investors at the time of acquisition.

The FDI literature performs regressions in levels or in growth-rates (first-differences). Firms with high productivity are more likely targets of FDI and in order to isolate the causal impact of FDI, researchers using levels-regressions typically include firm-specific constants (“firm fixed effects”) in order to identify results from “within variation;” that is, the relation between firm-level changes in FDI and productivity over the sample period. Many authors ([Aitken and Harrison, 1999](#); [Javorcik, 2004](#); [Liu, 2008](#)) find that the estimated effect of foreign acquisition on productivity is zero when firm fixed effects are included in levels-regressions. An alternative to levels-regressions with firm fixed effects is to estimate relations in first-differences or growth rates, where firm-specific constants difference out. We find this preferable as the error terms are closer to white noise, therefore improving inference. Further, growth rates of FDI at different lags are much less correlated than levels of FDI at different lags, and for this reason, using growth-rate regressions it is possible to properly identify coefficients to different FDI lags, thereby pinning down potential time delays in the impact of FDI on productivity.

In order to control for potential effects coming from technology shocks taking place at country and sector levels which may correlate with FDI, we include country-sector fixed effects.<sup>4</sup> We also include lagged firm productivity, which controls for the omitted variable bias that otherwise would occur due to the fact that firm productivity is mean-reverting. This is important and different from capturing unobserved heterogeneity in current observed productivity with PSM and firm fixed effects. If foreigners invest in current high-productivity firms, any productivity decline due to

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<sup>4</sup>[Damijan, Kostevc, and Rojec \(2015\)](#), who use firm-level data from seven recent Eastern European EU members to study pre- and post-acquisition performance of acquired firms, also use country- and sector fixed effects.

mean-reversion in productivity will create an omitted variable bias if initial firm-level productivity is not controlled for, therefore leading to a downward bias in the estimated effect of foreign acquisitions on productivity.

Our work is related to extensive previous research. In terms of econometric specification, recent papers match foreign acquisitions to non-acquisitions (domestic firms) or to domestic acquisitions and estimate productivity using methods similar to the ones we use. They consider the impact on the growth rate or the log of productivity consistent with our specification. All the studies we are aware of focus on the extensive margin by using dummy variables for foreign ownership. Some authors allow for minority versus majority ownership (e.g., [Chen \(2011\)](#)) and some authors (e.g., [Wang and Wang \(2015\)](#)) experiment with cut-offs in terms of foreign ownership share when defining acquisition, but still use dummy variables for foreign ownership. We estimate productivity regressions using either dummies for majority and minority foreign ownership (the extensive margin) or continuous changes in foreign ownership (the intensive margin) in order to examine which margin is more important and, in particular, whether majority ownership—which imparts control—is crucial.

In terms of the data, we significantly depart from the existing literature by using Orbis in a multi-country setting, covering a large representative set of domestic and foreign firms with full financial information. Most existing research papers in this field use survey data or more narrow datasets that only cover acquisitions, and hence their control group of domestic firms are much smaller than our near-universe firms coverage. For example, [Javorcik and Poelhekke \(2017\)](#) study disinvestment by foreign companies in Indonesia using survey data. Other papers with survey data are [Guadalupe, Kuzmina, and Thomas \(2012\)](#) for Spain and [Arnold and Javorcik \(2009\)](#) for Indonesia. These papers, and most others we are aware of, have much smaller samples than we have, with the exception of [Wang and Wang \(2015\)](#) who use a large survey with about 125,000 firm-level observations per year for China. Papers using acquisitions data in general focus on large firms for which financial information is available. For example, [Chen \(2011\)](#) uses Compustat financial information and SDC-Thompson data on acquisitions and limits herself to very large (listed) U.S. firms

for which financial information is available in the Compustat database. In our data, listed firms comprise less than 1% of the sample.

Some studies use total factor productivity as the dependent variable while others use labor productivity. The results of studies using total factor productivity for advanced countries vary between finding no effect of a foreign acquisition (e.g., [Harris and Robinson \(2003\)](#) and [Criscuolo and Martin \(2009\)](#) for the UK, and [Balsvik and Haller \(2010\)](#) for Norway) and finding a small effect in the 4% range (e.g., [Karpaty \(2007\)](#) for Sweden and [Fukao, Ito, Kwon, and Takizawa \(2008\)](#) for Japan).

The literature for advanced countries using labor productivity tends to obtain a large effect of foreign acquisitions: [Guadalupe, Kuzmina, and Thomas \(2012\)](#) find an increase of 16% in Spain for majority foreign acquisitions, [Chen \(2011\)](#) finds an increase of 13% for the United States (compared to a domestic acquisitions), and [Conyon, Girma, Thompson, and Wright \(2002\)](#) document an increase of 13% for the UK. An exception is [Hanley and Zervos \(2007\)](#), who find a decline of 9% after a foreign acquisition for the UK. It may not be surprising that the impact is larger on labor productivity as foreign owners may increase or improve the capital stock; indeed [Balsvik and Haller \(2010\)](#) find an increase in labor productivity of 10% for Norway even as they found no effect on total factor productivity. Overall, the literature for advanced countries points to moderate effects on total factor productivity and larger effects on labor productivity.

The effect of a foreign acquisition is likely to be different in developing countries and is likely also dependent on local institutions. [Arnold and Javorcik \(2009\)](#) find a large 15% productivity increase (after three years) for Indonesia, while [Stiebale and Vencappa \(2018\)](#) find no effect for India and [Wang and Wang \(2015\)](#) find no effect for China (compared to a domestic acquisitions). [Damijan, Kostevc, and Rojec \(2015\)](#) find, for Eastern European countries, a large effect on labor productivity for targets with previously low productivity—an issue that we do not explore.

The studies that allow for dynamics, as we do, tend to find a delayed effect: in [Blonigen, Fontagne, Sly, and Toubal \(2012\)](#) productivity at first declines and then recovers while [Guadalupe, Kuzmina, and Thomas \(2012\)](#) and [Arnold and Javorcik](#)

(2009) find positive effects that grow larger with time.

The rest of the paper is structured as follows. Section 2 reviews the data, discusses the benefits and drawbacks of the Orbis data, and describes the construction of the variables. Section 3 discusses our empirical methodology. Section 4 introduces the empirical specification. Section 5 presents the results and Section 6 concludes.

## 2 Data and Construction of Variables

We use the Orbis database assembled by Bureau van Dijk (BvD) (a Moody's company). Orbis allows us to perform a multi-country study on a dataset that is harmonized across countries. BvD collects data from various sources, in particular, national business registries, and harmonizes the data into an internationally comparable format. The Orbis database covers more than 200 countries and over 200 million firms (private and publicly listed), with the longitudinal dimension and representativeness of the firms varying from country to country depending on whether the smallest firms are required to file information with business registries. The Orbis database is not a census, as it is based on firms' filings of accounts and the requirements for filing varies by country as listed in the online appendix. We believe that the productivity effects from foreign acquisitions that we document based on the Orbis data are very informative and provide a value supplement to existing work, but because the data construction is an independent contribution of this paper, we outline the strengths and weaknesses of our dataset in more detail.

### 2.1 Strengths of the dataset

Most previous studies using cross-country datasets are based on listed companies (often the Worldscope database, which is now a part of ThomsonONE product by Thomson Reuters). One advantage of Orbis is that it includes private firms and, importantly, small firms which are key if we are to derive implications for the aggregate economy. Another advantage of Orbis is that it provides (foreign and domestic) information about the owners of both listed and private firms, including name, country

of residence, and type (e.g., bank, industrial company, private equity, individual) allowing us to identify changes in ownership that, with some effort, can be compiled into time-series of ownership over time. Exploiting time-varying information on the percentage stakes of foreign entities allows us to evaluate, among other things, whether intensive margin changes have different effects than extensive margin changes. In the current paper, we document that our results are mainly driven by transitions to foreign *majority* ownership. Besides detailed time series of ownership information, the Orbis dataset has detailed financial information which, among other things, is important for matching purposes. No other dataset has both types of information for private firms in a large set of countries.

Further, no other representative dataset has information on the percentage of capital stock owned, nationality of the owner, type of owner, and financial information of the owner and the target, over time. For example, the Thompson SDC Platinum database (also merged into ThomsonONE) gives the information on the ownership stakes and financial information based on M&A deals and, therefore, is limited to these transactions only. Orbis feeds in the M&A data from Zephyr, a source similar to Thompson SDC, and fills in missing information on the full ownership structure of the companies involved in M&A deals from alternative sources. In addition, Orbis provides ownership information for firms that were not directly involved in an M&A transaction (greenfield investments both by foreign and domestic owners).<sup>5</sup> For each firm, we have full balance sheet information over time and sector codes at the four-digit NACE level. Firms are linked to their domestic and foreign parents through unique ID numbers, which allows us to construct precise firm-level measures of changes in foreign investment in firms over time based on changes in ownership stakes by foreigners.

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<sup>5</sup>To assess the coverage of the foreign ownership information, we compare the turnover reported by Orbis firms in our sample to the turnover reported by MNCs in the OECD AMNE database (Activity of Multinational Enterprises). Table A.3 in the online appendix shows high correlation between the two datasets and levels are also close, though in most cases our data captures a higher level of foreign output.

## 2.2 Weaknesses of the dataset

Orbis provides ownership information as a snapshot of the year for which data are purchased and time series information on foreign ownership can only be achieved by using separate vintages and merging these into time series. This is a labor intensive process as explained in detail in [Kalemli-Ozcan, Sørensen, Villegas-Sanchez, Volosovych, and Yesiltas \(2015\)](#), but it is necessary to go back to historical vintages in order to avoid the survivorship bias that would results because more productive and/or foreign-owned firms are more likely to survive. In that paper, we discuss several practical issues when merging information across vintages (e.g, changes in the sector classification over time, differences in currencies, differences in units, etc.).<sup>6</sup>

Coverage varies across countries because of different filing requirements which we list in online appendix Table [A.1](#) for the countries in our sample. The choice of countries included in this paper is made aiming at mitigating concerns about low coverage. In online appendix Table [A.2](#), we show how coverage varies by country with more details available in [Kalemli-Ozcan, Sørensen, Villegas-Sanchez, Volosovych, and Yesiltas \(2015\)](#). We focus on Western European countries for which our data covers at least 30% of the manufacturing output once we have imposed the condition of non-missing sales, capital stock, wage bill, and material expenditure—variables that are necessary for computing total factor productivity. Austria and Portugal are not included despite fulfilling these conditions because their coverage is unstable over our time frame.

Coverage improves over time and more very small firms are added in later vintages; however, very small firms are not often targets of foreign acquisition and therefore the matched regression sample is hardly affected by this. We display extensive sets of robustness regressions which show that our main results are unlikely to be affected by uneven coverage. To further alleviate concerns about uneven and time-varying country coverage, we focus on a sample of firms with more than ten employees. This choice also allows us to better benchmark our results to the existing literature, which

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<sup>6</sup>A new dataset, called “Historical Product,” launched by BvD in 2017 is intended to alleviate these problems.

is mainly based on manufacturing censuses of firms with more than ten (or even twenty) employees (see [Arnold and Javorcik \(2009\)](#) for Indonesia, [Javorcik \(2004\)](#) for Lithuania, or [Haskel, Pereira, and Slaughter \(2007\)](#) for the UK).

Orbis is unsuited for studying entry and exit decisions and we refrain from studying those in this analysis. In general, entry can be better measured because the date of company incorporation is available for most firms; however, it is not possible to accurately distinguish between exit from the sample and exit from production. We show that our results are similar if we perform our analysis on a sample of firms present during the whole sample period, so it is unlikely that the results of this paper are biased due to exit and entry. We choose to start our sample in 1999 when coverage for European countries was improved due to Financial Sector Action Plan (FSAP) rules that were launched together with the Euro.

We next describe the main firm-level variables used in the analysis. More details on the cleaning process and firm-level statistics are provided in the online appendix.

### 2.3 Firm-Level Productivity

Our main dependent variable is total factor productivity at the firm-level. We assume that firm  $i$ 's output is determined by a Cobb-Douglas production function (CD),

$$Y_{it} = TFP_{it} L_{it}^{\beta_\ell} K_{it}^{\beta_k}, \quad (1)$$

where firm value added,  $Y_{it}$ , is a function of productivity ( $TFP_{it}$ ) and firm inputs ( $L_{it}, K_{it}$ ).  $L_{it}$  is labor input,  $K_{it}$  is capital input,  $\beta_k$  is the output elasticity of capital, and  $\beta_\ell$  is the output elasticity of labor. We measure nominal value added,  $P_{it}Y_{it}$ , where  $P_{it}$  stands for the price of output of firm  $i$ , as the difference between gross output (operating revenue) and expenditure on materials. As is the case for almost all relevant datasets, prices are not available at the firm level, and we calculate “real” output,  $Y_{it}$ , by dividing nominal value added with Eurostat two-digit industry price deflators. This is still a revenue based measure because firm level prices are not

available to deflate revenue.<sup>7</sup> Labor input,  $L_{it}$ , is measured as the firm’s wage bill (deflated by the same two-digit industry price deflator).<sup>8</sup> Finally, we measure the capital stock,  $K_{it}$ , as the book value of tangible fixed assets, deflated by the price of investment goods.<sup>9</sup>

We obtain firm-level revenue total factor productivity estimates as a residual:

$$\log(TFP_{it}) = \log(Y_{it}) - \hat{\beta}_\ell \log(L_{it}) - \hat{\beta}_k \log(K_{it}), \quad (2)$$

where the output/revenue elasticity measures,  $\hat{\beta}_\ell$  and  $\hat{\beta}_k$  are primarily estimated following the GMM approach suggested in [Wooldridge \(2009\)](#).

There is a broad literature on various methodologies for estimating production functions (see [Akerberg, Caves, and Frazer \(2015\)](#) for a review) and we apply the two most recent methods: the one-step GMM estimation method of [Wooldridge \(2009\)](#) and the two-step control function approach of [Akerberg, Caves, and Frazer \(2015\)](#). This literature was pioneered by [Olley and Pakes \(1996\)](#) and [Levinsohn and Petrin \(2003\)](#). The estimation methods rely on an observable—the “proxy”—being a function of the unobserved productivity level. The early contributions to the literature on estimating production functions differed mainly by the choice of proxy, investment in the case of OP and materials in the case of LP. [Wooldridge’s](#) approach uses materials as a proxy. [Wooldridge’s](#) method uses a system estimation rather than a two-step estimation but it takes into account the [Akerberg, Caves, and Frazer \(2015\)](#) critique, that if labor is partly hired before productivity is known, the coefficient on labor input

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<sup>7</sup>Norway and France do not have industry price deflators at the two-digit level, and we use the total manufacturing industry price deflator for these two countries. In [Table 4](#), we show that our results are robust to excluding France and Norway from the analysis. Our baseline estimates of total factor productivity include time-year dummies and therefore control for changes in aggregate prices.

<sup>8</sup>Using the wage bill, rather than the head count, helps adjust for differences in the quality of workers across firms because more skilled workers normally are paid more. However, as noted by [Hsieh and Klenow \(2009\)](#), wages could be impacted by rent sharing within the firm, leading to biased measures of revenue productivity. We re-estimated total factor productivity using employment as a measure of labor input and show in the online appendix [Table A.10](#) that our results are robust.

<sup>9</sup>We use country-specific prices of investment from the World Development Indicators to deflate the book value of tangible fixed assets. Spain experienced a change in the accounting system in 2007 (leasing items that until 2007 had been part of intangible fixed assets were from 2008 included under tangible fixed assets). We show that our results are robust to using the sum of tangible and intangible fixed assets as our measure of capital stock in online appendix [Table A.10](#). In addition, [Table 4](#) shows that the results are robust to excluding Spain from the analysis.



will not be correctly identified in the first step of the estimation. We estimate the production function by country and two-digit sector and winsorize the resulting firm level productivity distribution at the 1st and 99th percentiles by country.

While our baseline results follow the [Wooldridge \(2009\)](#) estimation procedure, we show that the results are robust to alternative production function estimation methods, to alternative assumptions about common technology across countries, to the choice of functional form of the production function, and to the use of more simple productivity measures, such as labor productivity. We estimate production functions by country and two-digit industry; but we also show results from estimating a common production function by two-digit industry, assuming that the production function is sector-specific but common across countries. We also consider a more flexible translog production function (TL). Finally, we consider two measures of labor productivity, value added over number of employees and sales over number of employees; however, the correlation between the growth rates of these measures is very high as shown in online appendix Table [A.9](#).

## 2.4 Firm-Level Foreign Ownership

To construct our main independent variable, we calculate for each firm the share of foreign ownership using Orbis data. The database refers to each record of ownership as an “ownership link.” An ownership link indicating that an entity A owns a certain percentage of firm B’s equity (voting shares) is referred to as a “direct” ownership link. BvD records direct links between two entities even when the ownership percentages are very small (sometimes less than one percent). For listed companies, very small stockholders are typically unknown.<sup>10</sup> We compute “foreign ownership” of firm  $i$  at time  $t$ ,  $FO_{it}$ , as the sum of all percentages of *direct* ownership by foreigners in that year, and we repeat this calculation for every year.<sup>11</sup> We define a firm to be “domestic” if

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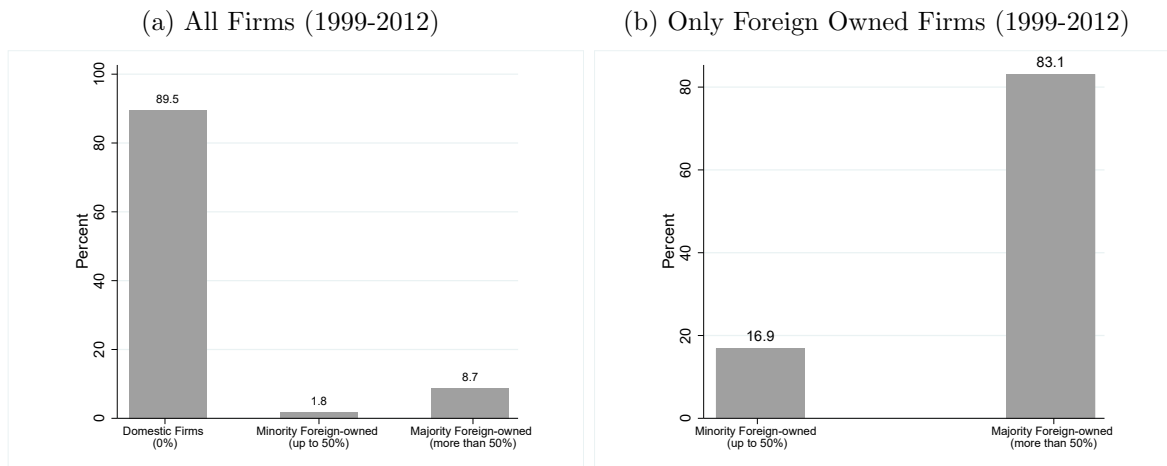
<sup>10</sup>Countries have different rules for when the identity of a minority owner needs to be disclosed for listed firms. France requires listed firms to disclose all owners with a stake larger than 5%, while Italy requires listed firms to disclose all owners with a stake larger than 2%.

<sup>11</sup>For example, if a company has three foreign owners with stakes of 10, 15, and 35%, the foreign ownership fraction for this company is 60%. The following year, the company may have a fourth foreign owner with a stake of 10%, in which case foreign ownership would become 70% and the

it did not have any foreign owner during the sample period.

Figure 1 displays the distribution of foreign ownership across firms. Panel (a) shows that close to 90% of firms in the sample are domestic firms (i.e., firms that never had a foreign owner during the period of analysis). Panel (b) shows that among foreign-owned firms (i.e., those that had at least one foreign owner during the sample period) more than 80% were majority-owned.

Figure 1: Distribution of Foreign Ownership.



*Notes:* Panel (a) shows the distribution of domestic, minority and majority-foreign owned firms, respectively, in the full sample. Panel (b) focuses on the sample of foreign-owned firms and shows the distribution of minority and majority owners.

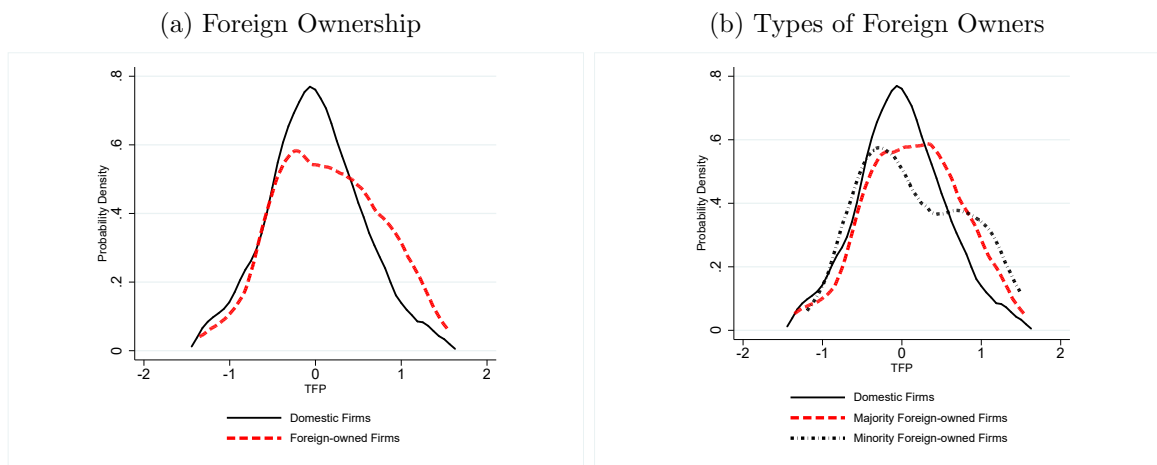
Because we are interested in the effect of changes in foreign ownership on the productivity of target firms after acquisition, we follow [Guadalupe, Kuzmina, and Thomas \(2012\)](#) and focus on the sample of firms that have no foreign ownership the first time they appear in the sample. We define a firm to be a majority-owned foreign firm if the foreign ownership is 50% or more after the acquisition. If ownership were very dispersed across owners (for example, if majority foreign-owned firms were owned by 50 different foreign owners, each holding a 1% ownership stake) our interpretation of 50% ownership as controlling ownership would be problematic. We therefore control for the number of owners, although most majority foreign-owned firms have only one owner. Specifically, 75% have a single owner, while the 95th percentile of the year-to-year change would be 10 percentage points.

distribution shows two foreign owners, and the 99th percentile corresponds to four foreign owners.

### 3 Endogenous Selection and Identification

In Figure 2, we plot the initial productivity of firms that are acquired versus those that are not. More precisely, the figure shows the density distribution of initial productivity (in terms of deviations from country and sector means) for the sample of domestic firms which are not acquired, and for the sample of firms which are initially domestic but have some foreign ownership four years later.

Figure 2: Distribution of Initial Productivity for Acquired and Non-Acquired Firms.



*Notes:* Initial productivity at the firm level is measured by total factor productivity (log TFP) in the first year the firm appears in the sample, demeaned by sector and country over the sample period. The solid line represents (log TFP) of domestic firms (firms that originally do not have any foreign ownership and remain non-acquired after four years ( $t+4$ )). In panel (a), the dashed line refers to foreign owned firms (those that are originally domestic but were acquired at some point during the next four years ( $t+4$ )). In panel (b), the dashed line refers to foreign majority-owned firms (those that are originally domestic but were majority owned by a foreign investor four years after ( $t+4$ )); the dotted-dashed line refers to minority owned foreign firms (those that are originally domestic but were minority owned by a foreign investor four years after ( $t+4$ )).

The distributions of the two groups of firms in panel (a) in Figure 2 are quite similar, but among the firms that are acquired, there is less mass at the overall average productivity level and more mass at the highest level of productivity. So while there is a large spread in the distribution of the initial productivity of acquired

firms, there is also a clear tendency for foreign acquisitions to be concentrated in firms with the highest level of productivity. It is evident that foreign investors do not select firms randomly.

In panel (b), we separate the sample of firms that are acquired by foreigners with total majority and minority foreign stake. The distribution of initial productivity of firms that are subsequently acquired and have foreign minority ownership have a higher variance than those acquired by foreign majority owners. Some foreign minority owners invest in a priori low-productivity domestic firms while other foreign minority owners invest in a priori high-productivity firms; that is why we see two humps in the distribution. However, both majority and minority foreign investors, *on average*, invest in firms with above-average productivity. In the next section, we explore the relationship between foreign ownership and productivity using regression analysis, controlling for country- and sector-level trends, and for mean-reversion in initial productivity, using propensity score matching techniques to control for possible non-random selection of firms by foreign investors.

### 3.1 Matching

Foreign-acquired firms tend to be different from non-foreign-acquired firms and a regression of an outcome on foreign acquisition without correcting for this, might interpret a positive coefficient as a causal effect of the foreign acquisition even if it may be reflection of other differences between foreign-acquired and other firms. It is therefore common to match the foreign-acquired firms to *similar* domestic firms (with not foreign ownership) in order to interpret the estimated coefficients causally. We match foreign-acquired firms to *similar* domestic-acquired firms. We define a *foreign acquisition* as the event that a foreign entity acquires any stake (no matter how small) in a company with no identified foreign owner before the event. A *domestic acquisition* is the event that a domestic investor acquires any stake (no matter how small) in a company where this investor was not previously a shareholder. To identify domestic acquisitions, we need to identify unique owners (as opposed to the nationality of the owner in the foreign case) and trace their changes over time. Our firm-owner-year

data allows us to achieve this goal.

We drop firms that remained foreign throughout the sample period and we drop firms that experienced multiple foreign acquisitions. We retain for our initial sample all domestic acquisitions except firms that experienced multiple domestic acquisitions. We use a combined set of these two sets of firms to construct the matched sample based on observable characteristics (“matching variables”). Matching is done by estimating a probability (logit) model of the probability of being acquired by a foreign firm and selecting a subset of foreign and domestic firms with similar probabilities.

Our choice of variables to include in the probability estimation is guided by existing papers on foreign acquisitions (such as [Arnold and Javorcik \(2009\)](#); [Javorcik and Poelhekke \(2017\)](#)) and we follow the general advise of [Roberts and Whited \(2013\)](#). Specifically, we use as explanatory variables the second lags of the following variables: the log of productivity, log employment, log wage bill, log tangible fixed assets to employment, log total assets, log company age, the squares of log assets and log age, the growth of assets; and the first and second lag of the growth rates of productivity (our outcome variable). Lagged values of the dependent variable are included in order to hedge against the regressions spuriously picking up pre-existing trends with the foreign acquisition variables. The estimated coefficients are reported in online appendix Table [A.5](#). The fitted probability value is known in this literature as the “propensity score.”

We match firms based on this propensity score to domestic acquisitions in the same country, two-digit industry, and year. We drop foreign-acquired firms for which the propensity score is higher than the maximum or less than the minimum propensity score of the domestic-acquired firms. For each remaining foreign-acquired firm, we match with up to two domestic firms, but domestic firms can be chosen as a match more than once, resulting in a “many-to-many” matched sample.<sup>12</sup> We delete matches for which the probability of selection differs by more than twenty percentage points (“a 0.2 caliper of the propensity score”). As a test of validity, we verify that the average values of the observable firms’ characteristics do not statistically differ between the

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<sup>12</sup>We use Stata’s `psmatch2` command written by E. Leuven and B. Sianesi.

foreign- and domestic-acquired firms in the matched sample. The results from the balancing test are reported in online appendix Table A.6.<sup>13</sup>

## 4 Empirical Specification

We estimate the linear relation:

$$\begin{aligned} \Delta \log \text{TFP}_{i,t} &= \sum_{k=1}^4 \beta_k \Delta \log (1 + \text{FO}_{i,t-k}) + \kappa \log \text{TFP}_{i,t-1} \\ &+ \sum_{k=1}^4 \gamma_k \Delta \text{Nr\_For\_Owners}_{it} + \gamma_{c,s4} + \nu_t + \epsilon_{i,t}, \end{aligned} \quad (3)$$

where  $i$ ,  $s4$ ,  $c$  and  $t$  indices the firm, 4-digit sector of the firm, the country of the firm, and time (year), respectively.  $\text{TFP}_{i,t}$  is current productivity,  $\text{TFP}_{i,t-1}$  is lagged productivity,  $\text{FO}_{i,t}$  is the share of foreign ownership at time  $t$ ,  $\text{Nr\_For\_Owners}_{it}$  is the number of foreign owners,  $\nu_t$  is a year dummy (time fixed effect),  $\gamma_{c,s4}$  is a dummy for country  $c$ , four-digit sector  $s4$  (we also, for comparison to the literature, estimate a specification where the country-sector dummy is replaced with a country and a sector dummy  $\phi_{s4} + \delta_c$ ), and  $\epsilon_{i,t}$  is a mean zero error term. The lag length of four is chosen from pre-testing: as reported in online appendix Table A.11, we find no effect of foreign ownership with three lags and if we include five lags, the fifth lag is insignificant.<sup>14</sup>

We regress productivity growth on the logarithm of (1+percent foreign ownership share).<sup>15</sup> Productivity may depend on foreign ownership concentration, so we control

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<sup>13</sup>We conducted a thorough robustness analysis by estimating the regressions on alternative matched samples. We found that the results are robust to a number of changes in the matching procedure. In particular, we tried a) changing the domestic sample to include both domestic acquired and domestic non-acquired firm (this was reported in the first version of this paper); b) changing the foreign-acquired sample to include any foreign-owned firm and changing the definition of “acquisitions” to be any change in foreign ownership; c) using nearest-neighbor one-to-one matching rather than two-neighbor caliper matching; d) changing the set of matching variables, matching using various measures of productivity (productivity based on tangible K (the reported results), labor productivity rather than total factor productivity, and using measures of productivity calculated using tangible plus intangible K), and using different values for the caliper. The permutations all delivered similar results for impact of foreign acquisition on productivity.

<sup>14</sup>The finding of a four period lagged effects is very robust but, for brevity, we only report these lags for the alternative specification using dummies for foreign majority acquisition.

<sup>15</sup>We add the number 1 in order to allow for zero values of  $x$ .  $\log(1+x) \approx x$  when  $x$  is small, so

for the number of foreign owners—the number of foreign owners correlates with the share of foreign ownership, potentially leading to omitted-variable bias if that variable is omitted. Productivity may be mean-reverting and because foreign investors target high-productivity firms, changes in foreign ownership may mechanically correlate with changes in productivity. In this case, one would underestimate the productivity impact of foreign investment if one does not control for lagged productivity because the high-productivity firms are likely to be acquired by foreigners at the same time as they are likely to have productivity declining from a high level. We therefore include the previously existing productivity level in the regression.<sup>16</sup> We assume that the error term is orthogonal to the regressors and independent across firms, but the error variances may vary across firms, in which case feasible GLS is asymptotically efficient and our firm-clustered standard errors are consistent in the case of auto-correlation in the residuals.<sup>17</sup> We estimate our relations using feasible GLS, allowing for firm-specific weights but in robustness tables we display OLS results. The weights are the inverse of the square root of firm-level mean squared residuals from an initial OLS estimation.

## 5 Empirical Results

In Table 1, we display results using our full (non-matched) sample and various definitions of productivity. Our main variable of interest is total factor productivity; however, we also show robustness using labor productivity which is simply value added divided by the number of workers—while we are mainly interested in total factor productivity, it lends credence to our results if they are not solely the result of sophisticated and somewhat opaque calculations of productivity. We also show

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the regression coefficient on foreign ownership is best interpreted as a semi-elasticity.

<sup>16</sup>In a previous version of the paper, we used productivity in the first period the firm is observed in order to minimize correlation with the foreign ownership regressors, but here we simply use the first lag of the productivity level. This choice has little to no effect on the results of interest. In the previous version, we also used a presample lagged value as an instrument, following the logic of [Arellano and Bond \(1991\)](#), and this also had little effect on the results. .

<sup>17</sup>Using the residuals from the differenced regression, we find an AR(1) coefficient of  $-0.2$ . This is significantly different from 0, but close enough to zero that correcting for this autocorrelation in the regressions would matter little.

results using output (operating revenues) per worker as a rough measure of labor productivity. In addition, we address sensitivity to how total factor productivity is estimated—with parameters of the production function estimated by sector or by country-sector, by the method of [Wooldridge \(2009\)](#), or the method of [Akerberg, Caves, and Frazer \(2015\)](#) (ACF). We also explore if a translog production function delivers different results.

The regressions include the change in the number of foreign owners and lagged productivity, but we do not report the estimated coefficients in most tables. Lagged productivity is highly significant and the inclusion of this variable is important for our findings—indeed, omitted variable bias from its exclusion may explain why some studies in the literature has found not effect of foreign acquisition.<sup>18</sup>

Columns (1)–(5) display results for total factor productivity while columns (6)–(7) show results for labor productivity. The first two columns show results using total factor productivity estimated following Wooldridge while the next three columns show results using productivity estimated following ACF. Across all those specification, we find that an increase in foreign ownership increases productivity after four years, while the impact is not robustly statistically significant for previous years, with the exception of labor productivity for which we also find a significant impact after three years. The magnitude of the four-year impact is very robust although the “ACF estimates” at 1.4–1.7% are slightly (not significantly) smaller than the “Wooldridge estimates” of 2.7–2.9%.<sup>19</sup> The impact on foreign acquisition on labor productivity measured as value added over labor is larger (but not significantly so) than the “Wooldridge estimates,” while the impact on operating revenue per worker is at about the same size. Overall, the data supports a small but significant delayed productivity effect of an increase in foreign ownership.

“Post hoc ergo propter hoc” (after this, therefore resulting from it) has long been

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<sup>18</sup>The estimated coefficients for these variable are tabulated in the online appendix for one specification in [Table A.11](#).

<sup>19</sup>We do not tabulate p-values for test of similarity of coefficients because we are not testing any formal hypothesis. But if the difference between coefficients are not at least two times the largest standard error in absolute value, the coefficients are not significantly different from each other at the 5% level.



recognized as a potential fallacy, but a four-year delay in the productivity pick-up seems consistent with a causal effect of new owners reorganizing the firm. Causality would be broken if foreigners identified domestic firms which, regardless of actual changes in ownership, would become more productive in four years. The regressions in Table 1 compares changes in foreign ownership with firms that have no foreign owners; however, the results may confound effects of any changes in ownership with effects of FDI. In order to address this possibility we, in Table 2, compare foreign acquisitions to domestic acquisitions using a sample of firms with changes in foreign ownership matched to domestic firms with changes in ownership.<sup>20</sup> We show results using the Wooldridge productivity estimates but results are robust to alternative productivity estimates.

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<sup>20</sup>Matching-related tables are available in the appendix.

Table 1: Foreign Ownership and Productivity

DEPENDENT VARIABLE:  $\Delta \log$  FIRM PRODUCTIVITY

TFP ESTIMATION METHOD:	WLP			TFP			ACF			LABOR PRODUCTIVITY		
	COUNTRY-SECTOR	SECTOR	CD	COUNTRY-SECTOR	SECTOR	CD	COUNTRY-SECTOR	SECTOR	CD	TL	VA EMPL	OPRE EMPL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)					
$\Delta \log(\text{FO})_{t-4}$	0.027*** (0.006)	0.029*** (0.006)	0.017** (0.006)	0.016** (0.006)	0.014** (0.007)	0.034*** (0.008)	0.026** (0.008)					
$\Delta \log(\text{FO})_{t-3}$	0.013** (0.006)	0.011* (0.006)	0.000 (0.006)	-0.002 (0.006)	-0.004 (0.007)	0.025** (0.008)	0.020** (0.007)					
$\Delta \log(\text{FO})_{t-2}$	0.013** (0.005)	0.013** (0.005)	-0.001 (0.005)	0.001 (0.005)	-0.001 (0.006)	0.011 (0.007)	0.011* (0.007)					
$\Delta \log(\text{FO})_{t-1}$	0.009* (0.005)	0.010* (0.005)	0.002 (0.005)	0.002 (0.005)	-0.002 (0.006)	0.011 (0.007)	0.001 (0.007)					
Observations	276,259	277,102	277,048	277,102	277,102	212,674	224,686					
Year-FE	yes	yes	yes	yes	yes	yes	yes					
Entry $\times$ Sec4-FE	yes	yes	yes	yes	yes	yes	yes					

*Notes:* The dependent variable in columns (1) to (5) is the change in log revenue firm-level total factor productivity at time  $t$  ( $\Delta \log \text{TFP}_{i,t}$ ).  $\Delta$  indicates one-year changes. The dependent variable in columns (6) and (7) is the change in firm-level labor productivity (value added over number of employees and output over number of employees, respectively). In columns (1) and (3) the productivity elasticities are estimated by country and two-digit industry while in columns (2), (4) and (5) elasticities are estimated by two-digit industry. In columns (1) and (2) the productivity estimation method follows [Wooldridge \(2009\)](#) (WLP). In columns (3) to (5) the productivity estimation method follows [Akerberg, Caves, and Frazer \(2015\)](#) (ACF). Columns (1) to (4) estimate a Cobb-Douglas production function (CD) while column (5) estimates a translog production function (TL).  $\Delta \log(\text{FO})$  is the yearly change in the  $\log(\text{FO} + 1)$  where FO stands for percent foreign ownership.  $t - 1$ ,  $t - 2$ ,  $t - 3$  and  $t - 4$  refers to lags one, two, three, or four years, respectively. Standard errors are clustered at the firm level. Results are obtained by a weighted (GLS) regression. The regression weights are the square roots of each firm's mean squared predicted residuals from an initial OLS estimation. All specifications include the lag one, two, three and four change in number of owners and lag one of the corresponding log firm productivity. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

Table 2: Foreign Ownership and Productivity

DEPENDENT VARIABLE:  $\Delta \log$  FIRM REVENUE TFP

	(1)	(2)	(3)
$\Delta \log(\text{FO})_{t-4}$	0.019** (0.009)	0.020** (0.009)	0.021** (0.010)
$\Delta \log(\text{FO})_{t-3}$	0.002 (0.008)	-0.002 (0.009)	0.002 (0.009)
$\Delta \log(\text{FO})_{t-2}$	-0.008 (0.006)	-0.009 (0.006)	-0.009 (0.007)
$\Delta \log(\text{FO})_{t-1}$	-0.004 (0.007)	-0.005 (0.007)	-0.008 (0.007)
Observations	16,220	16,219	16,202
Firm-FE	no	no	no
Year-FE	yes	yes	yes
Sec4-FE	no	yes	n.a
Cntry-FE	no	yes	n.a
Cntry $\times$ Sec4-FE	no	no	yes

*Notes:* The dependent variable is the change in log revenue firm-level productivity at time  $t$  ( $\Delta \log \text{TFP}_{i,t}$ ).  $\Delta$  indicates one-year changes.  $\Delta \log(\text{FO})$  is the change in the  $\log(\text{FO} + 1)$  where FO stands for percent foreign ownership. Results are obtained by a weighted (GLS) regression where regression weights are the square roots of each firm's mean squared predicted residuals from an initial OLS estimation. All specifications include the lag one, two, three, and four change in number of owners and lag one log firm productivity. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

The estimated parameters (0.019–0.021%) for the impact of foreign investment after four years in Table 2 are slightly smaller than those found for the full sample. While the difference is only borderline significant (from a comparison of the difference with the standard errors), it is intuitive that the coefficient is slightly smaller contrasted with domestic acquisitions as some domestic investors improve the productivity of their targets. In this table, we highlight that the results are not sensitive to the inclusion of sector- and country-fixed effects or sector-country fixed effects and that the lag structure is exactly as it was for the previous sample. We will mainly show results using the large set of country-sector fixed effects going forward, but this choice does not impact our results.

From now on, we will only use the sample matched to domestic acquisitions and in the next table we explore the role played by the degree of firm control by including dummies for changes to and from minority- or majority-foreign ownership. The specification we estimates takes the form: We run the regression

$$\begin{aligned}
\Delta \log \text{TFPR}_{i,t} = & \sum_{k=1}^4 \beta_k^{\text{maj}^+} \text{DFO}^{\text{maj}^+}_{i,t-k} + \sum_{k=1}^4 \beta_k^{\text{maj}^-} \text{DFO}^{\text{maj}^-}_{i,t-k} \\
& + \sum_{k=1}^4 \beta_{k+4}^{\text{min}^+} \text{DFO}^{\text{min}^+}_{i,t-k} + \sum_{k=1}^4 \beta_{k+4}^{\text{min}^-} \text{DFO}^{\text{min}^-}_{i,t-k} \\
& + \sum_{k=1}^4 \beta_{k+8} \Delta \text{Nr.For.Owners}_{it} + \beta_{13} \log \text{TFPR}_{i,t-1} + \nu_t + \gamma_{c,s4} + \epsilon_{i,t},
\end{aligned} \tag{4}$$

where  $\text{DFO}^{\text{maj}^+}$  is a dummy variable that equals one if the firm went from being foreign minority owned or domestically owned to foreign majority owned (a share of 50% or more).  $\text{DFO}^{\text{maj}^-}$  is a dummy variable that equals one if the firm went from foreign majority ownership to minority or domestic ownership.  $\text{DFO}^{\text{min}^+}$  is a dummy variable that equals one if the firm went from being foreign majority owned or domestically owned to foreign minority owned and  $\text{DFO}^{\text{min}^-}$  is a dummy variable that equals one if the firm went from foreign minority ownership to foreign majority or domestic ownership.  $\nu_t$  is a year dummy and  $\gamma_{c,s4}$  is a dummy for country  $c$ , four-digit sector  $s4$ .

Table 3: Majority and Minority Changes in Foreign Ownership and TFP Growth

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DEPENDENT VARIABLE: $\Delta \log$ FIRM REVENUE TFP			
	(1)	(2)	(3)
$DFO^{maj+}_{t-4}$	0.019** (0.008)	0.017** (0.007)	0.012** (0.006)
$DFO^{maj-}_{t-4}$	0.004 (0.014)		
$DFO^{min+}_{t-4}$	0.018** (0.009)	0.015* (0.008)	
$DFO^{min-}_{t-4}$	-0.023* (0.013)		
$DFO^{maj+}_{t-3}$	0.005 (0.007)	0.003 (0.006)	0.003 (0.006)
$DFO^{maj-}_{t-3}$	0.009 (0.013)		
$DFO^{min+}_{t-3}$	-0.001 (0.008)	-0.002 (0.008)	
$DFO^{min-}_{t-3}$	-0.016 (0.011)		
$DFO^{maj+}_{t-2}$	-0.005 (0.005)	-0.004 (0.005)	-0.005 (0.005)
$DFO^{maj-}_{t-2}$	-0.005 (0.009)		
$DFO^{min+}_{t-2}$	0.003 (0.006)	0.003 (0.006)	
$DFO^{min-}_{t-2}$	-0.009 (0.009)		
$DFO^{maj+}_{t-1}$	-0.010** (0.004)	-0.008* (0.005)	-0.006 (0.005)
$DFO^{maj-}_{t-1}$	0.013 (0.009)		
$DFO^{min+}_{t-1}$	-0.009 (0.005)	-0.006 (0.006)	
$DFO^{min-}_{t-1}$	0.018** (0.008)		
Observations	16,202	16,202	16,202
Year-FE	yes	yes	yes
Cntry $\times$ Sec4-FE	yes	yes	yes

*Notes:* Dependent variable is  $\Delta \log$  revenue firm-level total factor productivity at time  $t$  ( $\Delta \log TFP_{i,t}$ ).  $DFO^{maj+}$  is a dummy variable that equals one if the firm went from being foreign minority owned or domestically owned to foreign majority owned.  $DFO^{maj-}$  is a dummy variable that equals one if the firm went from foreign majority ownership to minority or domestic ownership.  $DFO^{min+}$  is a dummy variable that equals one if the firm went from being foreign majority owned or domestically owned to foreign minority owned and  $DFO^{min-}$  is a dummy variable that equals one if the firm went from foreign minority ownership to foreign majority or domestic ownership. GLS regression with using as weights the square roots of each firm's mean squared residuals from an initial OLS estimation. All specifications include the lag one, two, three and four change in number of owners and lag one log firm productivity. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

The results in Table 3 include four types of variables: (i) change towards a foreign majority ownership; (ii) change away from a foreign majority ownership; (iii) change towards a foreign minority ownership; and (iv) change away from a foreign minority ownership. We introduce four lags for each of these variables, leading to a total of 16 estimated coefficients presented in the table. The table is heavily parameterized, in order to attempt to sort out the effect of foreign minority and majority acquisitions and “divestments,” so some coefficients are significant in some columns and not in others and we do not in general comment on those.<sup>21</sup> The estimated coefficient for the 4-year lagged change towards a foreign majority ownership is robustly estimated at around 0.012–0.019%.

A move out of foreign minority ownership after one year has a positive effect on productivity—if this is associated with a change towards a foreign majority ownership, the net effect in column (3) is 0.08 (0.018—0.010) which is clearly not significant. A change to domestic ownership would have a positive effect of 0.018, but the cumulative impact will be nil as the impact after four years is  $-0.023$  leading to a cumulative impact of  $-0.005$ . Javorcik and Poelhekke (2017) found a negative effect on divestment in Indonesia, but it is intuitive that divestment to domestic owners may have no effect in advanced economies. However, our focus is on the effect of foreign acquisitions and, in column (2), we drop dummies for changes away from foreign ownership. In this column, the effect of majority foreign acquisition after four years is 0.017. There is a negative effect of majority acquisition after one year, but this is only significant at the 10% level and not robust in column (3). The effect of foreign minority acquisition is significant at the 10% level after four years which may reflect that some minority owners take control and improve on productivity, but given the low level of significance, we drop the dummies for foreign minority acquisition in column (3). In this more parsimonious regression, there is a significant impact on productivity after four years of being acquired by a foreign firm with a majority stake, but not earlier. We will focus on the impact of a change to foreign majority ownership and turn to

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<sup>21</sup>We do not have enough degrees of freedom to include even more terms, so we do not have separate dummies for whether a foreign minority holding changes to a foreign majority holding or to a domestic holding, so the term “divestment” is used loosely.

robustness in Table 4.

Table 4: Foreign Ownership and Productivity - Robustness

DEPENDENT VARIABLE:  $\Delta \log$  FIRM PRODUCTIVITY

PRODUCTIVITY MEASURE:	WLP	WLP	WLP	WLP	WLP	WLP	WLP	LABOR PROD.	ACF	ACF
	BASELINE	OLS	EXCL:ES	EXCL:DE	EXCL:FR&NO	BALANCED	$\frac{VA}{EMPL}$	CD	TL	TL
ROBUSTNESS	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(9)
$DFO^{maj}_t \uparrow_{t-4}$	0.012** (0.006)	0.026** (0.013)	0.014** (0.006)	0.015** (0.007)	0.022** (0.008)	0.013* (0.008)	0.027** (0.010)	0.013* (0.007)	0.018** (0.008)	
$DFO^{maj}_t \uparrow_{t-3}$	0.003 (0.006)	0.001 (0.011)	0.003 (0.006)	0.007 (0.006)	0.004 (0.007)	-0.010 (0.008)	0.007 (0.009)	0.004 (0.006)	-0.001 (0.007)	
$DFO^{maj}_t \uparrow_{t-2}$	-0.005 (0.005)	-0.001 (0.009)	-0.004 (0.005)	-0.004 (0.005)	-0.007 (0.006)	-0.008 (0.007)	-0.007 (0.007)	-0.013** (0.005)	-0.008 (0.005)	
$DFO^{maj}_t \uparrow_{t-1}$	-0.006 (0.005)	-0.004 (0.009)	-0.008* (0.005)	-0.007 (0.005)	-0.001 (0.005)	-0.007 (0.007)	-0.006 (0.007)	-0.009* (0.005)	-0.005 (0.005)	
Observations.	16,202	16,202	14,990	15,577	10,783	9,909	14,882	16,202	16,202	
Year-FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cntry $\times$ Sec4-FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The dependent variable in columns (1) to (6), (8) and (9) is the change in log revenue firm-level total factor productivity at time  $t$  ( $\Delta \log TFP_{i,t}$ ). WLP stands for the Wooldridge (2009) estimation method and ACF stands for the Akerberg, Caves, and Frazer (2015) estimation method. The dependent variable in column (7) is the change in log firm-level labor productivity at time  $t$  measured as value added over employment ( $\Delta \log \frac{VA}{EMPL_{i,t}}$ ).  $\Delta$  indicates one-year changes.  $DFO^{maj}_t \uparrow$  is a dummy variable that equals one if the firm went from minority or domestically owned to majority owned (majority refers to more than 50% ownership). Results are obtained by a weighted (GLS) regression except in column (2). The regression weights are the square roots of each firm's mean squared predicted residuals from an initial OLS estimation. All specifications include the lag one, two, three and four change in number of owners and lag one log firm productivity. Column (1) reports our baseline specification; column (2) reports results from OLS estimation; columns (3) and (4) exclude Spain and Germany from the analysis, respectively and column (5) excludes France and Norway. Column (6) reports results from the balanced sample of firms. Column (7) uses labor productivity, measured as the ratio of value added to employment, as the measure of firm productivity. The number of observations is lower compared to our baseline regression because coverage is lower for employment. Columns (8) and (9) follow Akerberg, Caves, and Frazer (2008) productivity estimation method and use firm total factor productivity estimated from a Cobb-Douglas (CD) and a translog (TL) production function, respectively. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.



Table 4 displays the results of a number of robustness exercises. For easy reference, we repeat the last column of Table 3, which we refer to as our baseline specification. In all columns, the impact of foreign majority acquisition is significant while other coefficients are not, apart from one coefficient that is significant at the 10% level in column (3) only. Our comments about this table therefore are all about the impact of foreign majority acquisition after four years. Column (2) displays OLS estimates. Again, foreign majority acquisitions have a positive impact only after four years—the OLS-estimated coefficient is larger at 0.026 but it is not more significant than the GLS-estimated coefficient as the standard errors are larger for the less efficient OLS-estimator.

The following columns return to using GLS and columns (3)–(5) examine the sensitivity to certain countries. Column (3) drops Spain, for which there was a change in accounting rules in middle of our sample, and column (4) drops Germany, for which coverage is relatively low in early years, but the results in either case are similar to the baseline. Column (5) drops France and Norway for which we do not have sector specific deflators. The coefficient, at 0.022, is somewhat larger than the baseline coefficient, but the overall result remains, that there is a small impact on productivity only after four years.

Column (5) examines if our results are driven by foreign-acquired firms surviving longer than domestic-acquired firms. This could lead to bias if foreign-acquired firms with low productivity do not survive four years in which case they will not be in our regression sample. We therefore examine if the results remain when we use a balanced sample of acquired firms where there is no exit for neither foreign-acquired nor domestic-acquired firms. The estimated coefficients are very close to the baseline results, implying that the outcomes we find are not an artifact of relatively more exits of weakly performing foreign-acquired firms. Column (7) revisits the effect on labor productivity and finds a slightly larger coefficient than the baseline results, but with the same pattern of a small effect on productivity after four years. Columns (8) and (9) show that results are robust to following ACF estimation strategy. Column (9) shows results when productivity is calculated under a translog production function;

the fourth lag is still significant and of the same order of magnitude as the previous results.

We conclude that there is robust evidence for a small positive effect only after four years. In the online appendix, we further show that the results are similar when comparing the years before and after the Great Recession and robust to alternative ways of measuring of capital (include intangibles or not) and labor inputs (wage bill or number of workers).

## 6 Summary and conclusion

We construct a panel dataset for eight advanced European countries tracking foreign investment over time at the firm level. Our dataset is based on the Orbis database which provides data for both listed and unlisted firms. To generate consistent time series, we combine several vintages of the raw data, because each Orbis vintage only provides a snapshot of foreign investment in a given year. For identification, we use PSM and match foreign acquisitions to domestic acquisitions. We find that the productivity of firms acquired by foreign investors increases modestly after four years and only when they are acquired by foreign majority owners. This finding survives several permutations of the way we perform the productivity estimation and variations of sample used. The results suggest that the productivity benefits of foreign investment are realized only when foreigners acquire corporate control and affect production decisions. We believe our large multi-country dataset helps us pin down the average effect in developed countries and our finding of a small delayed effect may partly explain why some authors have concluded that no effect exists.

Our results have the following policy implications. First, if foreign investors acquire a majority ownership, this delivers positive productivity benefits; hence, hostility to large take-overs by foreign firms in Europe may be misguided. Second, the effect of foreign investment on acquired firms' productivity is gradual and quite small. This implies that explanations for the high macroeconomic correlations found between growth and foreign investment has to come from elsewhere. While this is a topic for

further research, we speculate that they may be due to either reverse causality where growth-enhancing structural reforms and improved policy attracts multinationals or due to knowledge spillover effects from acquired to non-acquired domestic firms.

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## Online Appendix

In this appendix, we provide more details about the data, showing coverage of financial information—aggregated firm level operating revenue compared to the corresponding series from Eurostat statistics—and give details by country about the firms’ filing requirements that underly the coverage of the dataset; and ownership coverage comparing to official OECD MNCs activity series as well as describe the number of acquisitions and compare to other sources like Thompson SDC and Zephyr. We give details about our matching procedure in terms of probability estimation and balancing test and we display tables that show robustness with respect to data construction, countries included in the sample, and specification issues such as number of lags to include. Finally, we give details about the estimation of total factor productivity.

### Further Data Details

Table [A.1](#) provides a detailed tabulation of filing requirements by country. In some countries, very small firms do not have to file accounts, but the details vary by country. Table [A.2](#) compares, by country, operating revenue aggregated over the firms in our sample with aggregate operating revenue as reported by Eurostat. We show numbers for our full sample as well as for the sample of firms for which we are able to calculate total factor productivity. We do not have data for the self-employed and firms that do not file accounts with official sources—these firms are typically very small as can be gleaned from Table [A.1](#), which reports filing requirements by country. Very small firms are unlikely to be acquired by foreigners, so this type of non-perfect coverage is unlikely to affect our estimates, which we confirm by a number of robustness exercises.

For brevity, we comment only on the sample of firms reporting operating revenue. Belgium: 75% coverage (relative to Eurostat) in 1999, stable over time. Finland: 30% coverage in 1999, increasing (monotonically) to 51% in 2012. France: 64% coverage in 1999, increasing to 95% in 2012. Germany: 21% coverage in 1999, increasing to



48% in 2012. Italy: 61% coverage in 1999, increasing to 86% in 2012. Norway: 66% coverage in 1999, increasing to 88% in 2012. Spain: 75% coverage in 1999, increasing to 83% in 2012. Sweden: 60% coverage in 1999, increasing to 78% in 2012. The average coverage varies across countries and so does the rate at which it increases. Because of this, we show that the results are robust to leaving out subsets of countries, in particular Germany, which has the lowest coverage in early years.

In Table A.3, we show, by country, the operating revenue of foreign owned firms in our Orbis sample (where we define a firm as “foreign owned” if the sum of foreign ownership shares is at least 10%) and the operating revenue of MNCs as identified by the OECD. In panel A, we report the sum of turnover by country and year while in panel B, we report the sum of turnover by country and year where the turnover of each firm is weighted by the foreign ownership share. The Orbis numbers are in general quite close to those of the OECD, although the numbers in Orbis are substantially higher for Norway and Finland in panel A. Using turnover weighted by the foreign ownership shares, the data are of the same order of magnitude between the OECD data and Orbis, although far from identical (for example, for Germany \$247 Bill. using OECD and \$147 Bill. using Orbis). The Orbis data are not constructed the same way as the OECD data and one should not expect a perfect match; however, the similar magnitudes are reassuring. The Orbis numbers are based on foreign shares of equity for each firm with foreign investment, while the OECD data are based on surveys of the investing MNCs (where the definition of MNC may vary by country). The very different approaches should give similar magnitudes but cannot be expected to give identical numbers. The time series correlations reported in each panel are positive for all countries but France (which we verify can be dropped without changing estimated coefficients significantly) and for most countries are around 0.70 in panel A and slightly lower in panel B.

Table A.4 documents how we arrive at our sample of 1,063 foreign acquired firms and 9,481 domestically acquired firm in the matched sample. In the overall sample, we have 23,200 foreign firms and 3,174 foreign-acquired firms. The table shows, among other things, how this number gets whittled down when we leave out financial com-

panies, require non-missing values for the variables needed to calculate productivity, and require at least four lags. A number of foreign-acquired firms are also left out by the matching algorithm because no good domestic-acquired match exists.

## Matching

We match the foreign-acquired firms to a sample of similar domestic-acquired firms. As explained in the text, we estimate a logit regression with the probability that any share of a firm is acquired by a foreign entity, owned as a function of observable characteristics, measured before the firm becomes acquired. As independent variables, we include, for the first year the firm appears in the sample, the levels and squares of employment, assets, age, the level of value added per employee, the logarithm of capital stock per employee, and wages per worker. [Roberts and Whited \(2013\)](#) recommend to match on growth rates of outcome variables to ensure similarity of pre-treatment trends. We include productivity growth in the first year the firm is in the sample, and productivity in each of the two years before the foreign firm was acquired. For firms which were not acquired, we use the level of productivity in the first year the firm is in the sample and the first two years for growth.

We pre-clean the sample entering the matching by dropping firms that remained foreign throughout the sample period and firms which experienced multiple foreign acquisitions. We retain all domestic acquisitions to be used as control events but drop firms which experienced multiple domestic acquisitions. We construct the matched sample based on observable characteristics, relying on the existing papers on foreign acquisitions (such as [Arnold and Javorcik \(2009\)](#); [Javorcik and Poelhekke \(2017\)](#)) and the survey by [Roberts and Whited \(2013\)](#). Specifically, we match on the second lags of the following variables: log of productivity, log of employment, log wage bill, log of tangible fixed assets to employment, log of total assets, log of company age, the squares of log-assets and log-age, the growth of assets; and the first and second lag of the growth rates of productivity (our outcome variable), which helps ensure similarity of pre-treatment trends.

Matching is done by estimating a probability (logit) model of the probability of being acquired by a foreign firm and selecting a subset of foreign and domestic firms with similar probabilities. The logit estimation results are tabulated in Table A.5. It is clear that firms that are large in terms of assets, have high employment, have high wage bill are significantly more likely to be acquired. Conditional on the other regressors, the coefficient to productivity two years prior to acquisition is negative as are the productivity growth rates in each of the two years before acquisition. However, the specification is intended to obtain the best fitted probability value (known as the “propensity score”) and, therefore, heavily parameterized, so individual coefficients should not be structurally interpreted.

Using this predicted probability of foreign acquisitions, we match within the same country, two-digit industry, and year.<sup>22</sup> We match with replacement and drop observations whose propensity score is higher than the maximum or less than the minimum propensity score of the controls. In the baseline implementation, for each treated company, we keep the two closest domestic acquisitions except we delete matches for which the probability of selection differs by more than twenty percentage points (“a 0.2 caliper of the propensity score”) and we drop foreign-acquired firms for which the propensity score is higher than the maximum or less than the minimum propensity score of the domestic-acquired firms. For each remaining foreign-acquired firm, we match with up to two domestic firms, but domestic firms can be chosen as a match more than once, resulting in a “many-to-many” matched sample consisting of 1,141 foreign-acquired firms and 1,539 domestic-acquired firms, as reported in the appendix Table A.4.

In Table A.6, we test if the selected domestic-acquired firms are similar to the foreign-acquired firms in our sample—“balancing” tests. The main takeaway is that in all cases the differences between the means of includes variables for the foreign-acquired and the domestic-acquired firms are statistically insignificant. We further examine if variances are similar between the foreign-acquired and domestic-acquired firms. For most variables, the range is in range normally considered acceptable while

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<sup>22</sup>We use the popular Stata `psmatch2` command written by E. Leuven and B. Sianesi.

for lagged asset and unemployment, the variance is somewhat higher for the foreign-acquired firms; however, the ratios between 1.35 and 1.53 are not extreme.<sup>23</sup>—

**Summary Statistics** Table A.7 shows mean, median, standard deviations, maximum, and minimum values for the full sample, while Table A.8 shows the same statistics for the matched samples. The growth in the productivity measures is slightly negative on average (except for labor productivity) but there is large variation across firms as witnessed by the standard deviations. In the full sample, only about a tenth of a percent of firms experience changes in the foreign ownership dummies while 1-2% of firms see changes in these in the matched sample. Transitions into the foreign ownership categories are much larger than transitions out of them. In the match sample, the average foreign ownership share is 13.7% while it is only 1.5% in the full sample.

Table A.9 shows the correlations between the growth rates of different productivity measures in the full and matched samples. The measures of (the growth rate of) total factor productivity have correlations of 0.892 and higher in both samples while the correlation with labor productivity (value added per worker) is lower in the 60-70% range. The correlations of total factor productivity with operating revenue are positive but as low 41.2%; however, operating revenue per worker has a quite different interpretation than the other measures.

**Robustness** We show further robustness of our results.

Table A.10 explores if the results are sensitive to how we measure “labor” and “capital” in the productivity estimations, with the alternatives being employment/wage bill and tangible/(tangible+intangible) fixed capital. We show results for the full sample with a continuous FDI variable and for the matched sample using the indicator for change to foreign majority ownership. More observations are missing for employment

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<sup>23</sup>More precisely, the reported variances are of the residuals from regressing each variable on a linearized version of the propensity score, in order to isolate the components not used in the matching. This adjustment is recommended by Rubin (2001).

than for wage bill, so columns (3) and (4) show results for the sample where employment is available. The table delivers a consistent picture: the results are very robust to the choice of labor or capital measures and to whether employment is missing in the sample. For the full sample, the impact of an increase in foreign ownership is significant for lags two, three, and four, which reflects that foreign acquisition in the larger sample is compared to (in the main) no acquisition. For the matched sample which is our main focus, the effect of transition of foreign majority ownership is robustly significant after four years, but not earlier.

Table A.11 examines robustness with respect to lag-length and examines if the inclusion of the lagged level of productivity is important. In this table, we report the coefficients to the lagged level of productivity and the number of foreign owners. We estimate the relation using the change in foreign ownership allowing for three- or five-year lags, using the matched sample.

Column (1) repeats our baseline regression (column (3) of Table 3) while column (2) drops the lagged productivity level which potentially results in omitted variable bias. Indeed, we find an insignificant estimate for the effect foreign acquisition after four years while the first- and second-year impacts are negative and significant at the 10% level. The lagged level of productivity is robustly estimated with a coefficient of  $-0.095$  with sky-high levels of statistical significance. The level of initial productivity is not typically included in existing studies, but it is well known that foreign investors target high productivity firms and combined with mean reversion in productivity, it is intuitive why there may be omitted variable bias affecting the coefficients to foreign acquisition. The absence of this control may partly explain why some previous studies found no effect of foreign acquisition.

In the specification with three lags in column (3), there is no significant effect of foreign ownership and, in the specification with five lags in column (4), only the lag-four coefficient is significant. The coefficients to the change in the number of foreign owners is significant for the first and second lags at the 5% level with values around 0.005. We do not posit hypotheses for the impact of the number of foreign owners, but with a standard deviation of 0.25-0.35 for the number of foreign owners

(see Table A.8) the impact is not of much economic importance.

Table A.12 shows results for a “levels regression” with a sample split pre- and post-the Great Recession. Using four lags, it is not attractive to use our preferred differenced specification when we split the sample, because either the lags of the second period resides in the first period or alternatively, we lose the first four years after the Great Recession, leaving us with too small a sample. In the first column, we show results for the full sample. We include initial productivity times a time-trend, which upon differencing will become initial productivity (the results are virtually unchanged whether we use initial or lagged productivity in the differenced regressions). We prefer initial productivity to lagged productivity in this regression, in order to minimize the endogeneity of this term (the results are similar if we instrument for it).<sup>24</sup> The county-sector fixed effects are also multiplied by a trend in this regression. Firm fixed effects are included and are important in order to control for selection of more productive firms (firm fixed effects washes out in differences). The estimated coefficient for foreign ownership is almost identical to the comparable difference specification Table 1 in the main text (0.026 here, versus 0.027 there). Splitting the sample into pre- and post-the-Great Recession reveals that the coefficients are very robust, 0.020 before the Great Recession and 0.017 after the Great Recession. From quick inspection of the standard errors these values are insignificantly different from each other and from the pooled values. (The sub-period estimates are both smaller than the pooled values but this can happen because the fitted fixed effects and trends change values by sub-period.) In conclusion, the small effect is very robust over time.

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<sup>24</sup>A previous version of this paper us initial productivity in the differenced regressions and obtained similar results.

## Online Appendix Tables

Table A.1: BVD COMPANY FILING REQUIREMENTS AND DATA PROVIDERS FOR SELECTED COUNTRIES FOR YEAR 2005)

COUNTRY CODE	WHICH COMPANIES HAVE TO FILE ACCOUNTS?	HOW MANY COMPANIES DOES THAT REPRESENT?	DATA PROVIDER
BE	<p>Depends on the legal form:</p> <ul style="list-style-type: none"> <li>• Companies that must file their accounts are: SA; SPRL; SCRL (Société coopérative à responsabilité limitée); SE (Société européenne); GEIE (Groupement européen d'intérêt économique); GIE (Groupement d'intérêt économique); Foreign companies located in Belgium.</li> <li>• Companies that have to file their accounts under certain conditions are: SCS (Société en commandite simple) if the company is large and one of the associates is an individual; SCRI (société coopérative à responsabilité illimitée) if the company is large and one of the associates is an individual; SNC (société en nom collectif) if the company is large and one of the associates is an individual; ASBL and Foundations if they are large or very large; Other (there are some other specific cases).</li> </ul>	420,000	National Bank of Belgium, Coface Services Belgium
FI	<p>All joint-stock companies and all co-operatives; Limited partnerships, partnerships and private firms, which meet two of the following three conditions:</p> <ul style="list-style-type: none"> <li>• turnover over 7.30 million EUR;</li> <li>• balance sheet total over 3.65 million EUR;</li> <li>• number of personnel over 50.</li> </ul>	The exact number is not known, but the estimate is approx. 120,000 companies	Suomen Asiakasti-eto Oy
FR	<p>All of the following:</p> <ul style="list-style-type: none"> <li>• les sociétés à responsabilité limitée (SARL et EURL) ;</li> <li>• les sociétés de personnes (sociétés en nom collectif et sociétés en commandite simple), sous certaines conditions : les sociétés en nom collectif (SNC) dont au moins l'un des associés est une personne physique ne sont pas dans l'obligation de déposer leurs comptes annuels (pour plus de précisions, se référer à l'article L. 232-21 du Code de Commerce) ;</li> <li>• les sociétés par actions (sociétés anonymes, sociétés par actions simplifiées et sociétés en commandite par actions) ;</li> <li>• les sociétés commerciales dont le siège est situé à l'étranger qui ont ouvert un ou plusieurs établissements en France ;</li> <li>• les sociétés d'exercice libéral (SELARL, SELAFA, SELCA, SELAS) ;</li> <li>• les sociétés coopératives et unions sous certaines conditions (pour plus de précisions, se référer à l'article R. 524-22-1 du Code Rural).</li> </ul>	1,400,000	Ellisphere

Notes: Filing requirements were taken from the Orbis Online Manual on February 3d, 2014.

Table A.1: (CONT.) FILING REQUIREMENTS AND DATA PROVIDERS

COUNTRY CODE	WHICH COMPANIES HAVE TO FILE ACCOUNTS?	HOW MANY COMPANIES DOES THAT REPRESENT?	DATA PROVIDER
DE	Corporate enterprises (AG, GmbH) and cooperatives (e.G).	Breakdown: <ul style="list-style-type: none"> <li>• <i>small cooperate enterprises</i>: approx. 980.000. Definition ( 267 HGB): staff: <math>\leq 50</math> individuals turnover: <math>\leq 9.680</math> TEUR total assets: <math>\leq 4.840</math> TEUR at least two criteria must apply They have to announce only the balance sheet information and the notes on the accounts.</li> <li>• <i>medium sized cooperate enterprises</i>: approx. 80.000. Definition ( 267 HGB): staff: between 50 and 250 individuals turnover: between 9.680 TEUR and 38.500 TEUR total assets: between 4.840 TEUR and 19.250 TEUR at least two criteria must apply They have to announce the balance sheet information as well as the statement of income and the notes on the accounts.</li> <li>• <i>big cooperate enterprises</i>: approx. 33.000. Definition ( 267 HGB): staff: more then 250 individuals turnover: more then 38.500 TEUR total assets: more then 19.250 TEUR at least two criteria must apply They have to announce the balance sheet information as well as the statement of income and the notes on the accounts.</li> <li>• <i>cooperatives</i>: approx. 7.500. They have to announce the balance sheet information as well as the statement of income and the notes on the accounts.</li> </ul>	Creditreform and Creditreform Rating AG
IT	Includes: <ul style="list-style-type: none"> <li>• S.p.A. (Società per Azioni),</li> <li>• S.r.l. (Società a responsabilità limitata),</li> <li>• Sapa (Società in accomandita per azioni),</li> <li>• Società Cooperative,</li> <li>• Società Consortili,</li> <li>• G.e.i.e, Società di persone (only consolidated accounts),</li> <li>• Consorzi con qualifica di Confidi.</li> <li>• Società a responsabilità a socio unico e società per azioni a socio unico.</li> </ul>	Approximately 900,000	
NO	Limited.	Approximately 120,000.	Creditreform
ES	S.A., S.L.	776,000	INFORMA
SE	Limited companies.	About 348,000.	UC AB





Table A.3: Comparing MNC turnover from BvD and OECD data: 1999–2012

	BE	DE	ES	FI	FR	IT	NO	SE
Panel A: MNC turnover (OECD) and Total turnover of foreign Orbis firms								
Avg OECD turnover (bln \$)	217	516	173	25	355	214	27	85
Avg BvD turnover (bln \$)	180	564	217	85	402	232	73	122
Corr(OECD, BvD)	0.880	0.799	0.665	0.720	-0.740	0.735	0.644	0.784
Panel B: MNC turnover (OECD) and foreign-share weighted Orbis firms								
Avg OECD turnover (bln \$)	217	516	173	25	355	214	27	85
Avg BvD turnover (bln \$)	142	392	203	39	258	203	31	62
Corr(OECD,BvD)	0.953	0.851	0.311	0.846	-0.593	0.544	0.765	0.861

*Notes:* The table reports average turnover of foreign affiliates in manufacturing in billions of constant U.S. dollars with 2010 base, as reported in the OECD’s AFA and AMNE database (under “Avg OECD turnover”) and Orbis database (under “Avg BvD turnover”). The average values are computed for 1999-2012, by country. In line “Corr(OECD, BvD),” we report the correlations of the annual turnover series, by country, for 1999-2012. Foreign multinational activity in the OECD data is the sum of the multinational turnover in manufacturing reported by the AFA and AMNE databases of the OECD. With the Orbis data, we follow the usual convention of FDI investment and compute the multinational activity from the turnover of firms with at least 10% foreign ownership. In panel A, we add-up the turnover of foreign-owned companies from Orbis, following our definition of foreign-owned companies; in panel B, we add-up only a fraction of the firm turnover according to the observed foreign ownership stakes reported by Orbis. The country abbreviations are Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Italy (IT), Norway (NO), and Sweden (SE).

Table A.4: Counts of Acquisitions in Our Sample

Data / Cleaning step	Firms	Acquisitions
0. Largest data ownership + financials in 6 countries, Manufacturing	506,577	-
of these,		
with non-missing foreign ownership	505,371	-
foreign-owned	23,200	-
domestic-owned	483,377	-
foreign-acquired	3,590	4,008
(memo) foreign-divested	2,760	3,174
1. Largest sample after cleaning steps on financials, etc.	124,496	
of these,		
foreign-owned	3,755	-
domestic-owned	120,741	-
foreign-acquired	1,618	1,660
foreign-divested	652	672
domestic-acquired	22,436	29,971
2. Cleaning on M&A events		
drop foreign firms w/ multiple foreign M&A (up to 2)	42	-
drop remaining foreign firms w/o foreign M&A	2,019	-
drop remaining foreign firms w/ foreign divestment	610	-
drop domestic firms w/ multiple domestic M&A (up to 7)	5,646	-
drop domestic-acquired firms w/ unknown foreign M&A status	401	-
Sample of acquired firms after cleaning steps 1, 2 above (This is the sample used to implement PSM)	18,366	18,366
of these,		
remaining foreign-acquired firms	1,576	1,576
remaining domestic-acquired firms	16,389	16,389
Matched sample of domestic and foreign-acquired firms	2,680	2,680
of these,		
foreign-acquired firms (=treated), 13,062 obs	1,141	1,141
domestic-acquired firms (=controls), 17,940 obs.	1,539	1,539
Regression Matched sample of domestic and foreign-acquired firms (some data lost due to requirements of up to 4 lags of fin. data)	2,522	2,522
of these,		
foreign-acquired firms (=treated), 6,739 obs.	1,063	1,063
domestic-acquired firms (=controls), 9,481 obs	1,459	1,459

*Notes:* We define *foreign acquisition* as the event that a foreign entity acquires any stake in a company with no identified foreign owner before the event. Firms may experience multiple foreign acquisitions, for example, an acquisition, divestment to domestic firm, and then acquisition by foreigners again. The *domestic acquisition* is the event that a domestic investor acquires any stake in a company where this investor was not a shareholder of this company before.

Sample cleaning steps are as follows. The starting sample (Step 0) are manufacturing firms in our 6 countries with available financial data (pre-cleaning). In Step 1, we a) drop firms that change 4-digit sector over time; b) drop firms that in any year reported less than 10 employees; c) construct firm age and drop firms with negative values; d) drop firm-years with zero total assets; e) drop firms with missing output; f) clean firms that have extreme values for some important ratios (if cost of employees to tangible fixed capital (L/K) > 1000 (99 percentile); if tangible fixed capital to total assets > 1; if cost of employees to value added, tangible fixed capital to value added, and tangible fixed capital to cost of employees are greater than the 99th and less than the 1st percentile. In Step 2, the cleaning is based on M&A events.

Table A.5: Determinants of Foreign Acquisitions (Logit)

DEPENDENT VARIABLE: INDICATOR VARIABLE OF FOREIGN ACQUISITIONS

	(1)
$\log \text{TFP}_{t-2}$	-0.059* (0.031)
$\Delta \log \text{TFP}_{t-1}$	-0.448** (0.227)
$\Delta \log \text{TFP}_{t-2}$	-0.116 (0.221)
$\log L_{t-2}$	0.113* (0.066)
$\log \text{WAGEBILL}_{t-2}$	1.056*** (0.116)
$\log (K / L)_{t-2}$	-0.031 (0.039)
$\log \text{ASSETS}_{t-2}$	4.123*** (0.631)
$\log \text{ASSETS}_{t-2}^2$	-0.108*** (0.019)
$\Delta \log \text{ASSETS}_{t-2}$	-0.227 (0.197)
$\log \text{AGE}_{t-2}$	0.017 (0.177)
$\log \text{AGE}_{t-2}^2$	-0.040 (0.032)
Observations	86,150

*Notes:* The table reports the results of the first step in our matching procedure. The sample includes both domestic and foreign-owned acquisitions. The dependent variable is an indicator variable of whether the firm experienced an acquisition on that year.  $\log \text{TFP}_{t-2}$  is the log revenue productivity lagged two periods.  $\Delta \log \text{TFP}_{t-1}$  and  $\Delta \log \text{TFP}_{t-2}$  are the yearly changes in firm revenue productivity lagged one and two periods, respectively.  $\Delta$  indicates one-year changes.  $\log L_{t-2}$  and  $\log \text{WAGEBILL}_{t-2}$  represent the log of employment and the wage bill lagged two periods.  $\log (K / L)_{t-2}$  stands for the log of the ratio of tangible fixed assets to employment lagged two periods.  $\log \text{ASSETS}_{t-2}$  stands for the log of assets and  $\log \text{AGE}_{t-2}$  for the log of firm age. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

In the matching procedure, we first estimate this logit model of the treatment indicator (foreign acquisition) on the pre-treatment outcomes, predict the probability of acquisition (the propensity score), and re-define the propensity score to include transformations of acquisition year, country number, and the 2-digit sector number in order to force matching within the year-country-sector triplets. Finally, we match the firms using this new propensity score (using the `psmatch2` routine in Stata) with replacement and impose a common support. In the baseline implementation, for each treated company, we keep the two closest matched controls and use a 0.2 caliper of the propensity score.

Table A.6: Balancing Tests

	MEANS OF VARIABLES				STANDARDIZED % BIAS		t-TEST		VARIANCE	
	U: Unmatched M: Matched	Mean For Acq	Mean Non-treated Dom Acq		reduction abs(bias)	% bias	t-test t-stats	$p >  t $	$V_e(T)/$ $V_e(C)$	
$\log TFP_{t-2}$	U M	3.54 3.54	3.38 3.52		87.7	14.40 1.80	4.92 0.40	0.00 0.69	1.21 1.03	
$\Delta \log TFP_{t-1}$	U M	-0.0150 -0.0150	-0.0050 -0.0237		13.2	-6.60 5.70	-2.30 1.33	0.02 0.18	1.25 1.18	
$\Delta \log TFP_{t-2}$	U M	-0.0030 -0.0030	-0.0014 -0.0094		-318.2	-1.00 4.40	-0.35 1.02	0.73 0.31	1.07 1.11	
$\log L_{t-2}$	U M	4.49 4.49	3.88 4.43		89.8	63.40 6.50	21.66 1.48	0.00 0.14	1.35* 1.02	
$\log WAGEBILL_{t-2}$	U M	11.18 11.18	11.04 11.18		98.0	46.70 -0.90	15.30 -0.22	0.00 0.82	0.97 1.15	
$\log (K/L)_{t-2}$	U M	-0.21 -0.21	-0.40 -0.25		78.4	20.10 4.30	6.43 1.02	0.00 0.31	0.96 0.91	
$\log ASSETS_{t-2}$	U M	16.90 16.90	15.94 16.82		92.0	78.80 6.30	25.24 1.55	0.00 0.12	1.44* 1.05	
$\log ASSETS^2_{t-2}$	U M	286.95 286.95	255.61 284.27		91.5	78.00 6.70	25.51 1.60	0.00 0.11	1.53* 1.06	
$\Delta \log ASSETS_{t-2}$	U M	0.0273 0.0273	0.0267 0.0389		-1858.2	0.30 -6.50	0.11 -1.52	0.91 0.13	1.14 1.20	
$\log AGE_{t-2}$	U M	2.97 2.97	2.98 3.00		-122.2	-2.00 -4.40	-0.66 -1.01	0.51 0.31	1.09 1.01	
$\log AGE^2_{t-2}$	U M	9.45 9.45	9.49 9.65		-418.3	-0.80 -4.40	-0.28 -1.01	0.78 0.31	1.09 1.02	

Notes: The sample includes domestic and foreign acquisitions. “U” stands for “Unmatched” while “M” stands for “Matched”.  $\log TFP_{t-2}$  is the log revenue productivity lagged two periods.  $\Delta \log TFP_{t-1}$  and  $\Delta \log TFP_{t-2}$  are the yearly changes in firm revenue productivity lagged one and two periods, respectively.  $\Delta$  indicates one-year changes.  $\log L_{t-2}$  and  $\log WAGEBILL_{t-2}$  are the logarithms of employment and wage bill lagged two periods.  $\log (K/L)_{t-2}$  stands for the log of the ratio of tangible fixed assets to employment lagged two periods.  $\log ASSETS_{t-2}$  stands for the log of assets and  $\log AGE_{t-2}$  for the log of firm age. The standardized % bias is the % difference of the sample means in the treated and non-treated (full or matched) sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups.  $V_e(T)/V_e(C)$  is the ratio of the variance of the residuals orthogonal to the linear index of the propensity score in the treated group (foreign-acquired) over the non-treated group (domestic-acquired) for each covariate. This ratio should equal 1 if there is perfect balance. Following common usage, one asterisk (\*) is displayed for variables with ratios in the intervals [0.5, 0.8) or (1.25, 2].

Table A.7: Summary Statistics: Full Sample

	Mean	Median	SD	Min	Max	Observations
$\Delta \log_{TFP}^{WLP}$	-0.011	-0.006	0.159	-1.731	2.007	276,259
$\Delta \log_{TFP}^{ACF}$	-0.006	-0.004	0.157	-1.714	2.007	276,259
$\Delta \log_{TFP}^{ACFTL}$	-0.007	-0.003	0.174	-2.550	2.285	276,259
$\Delta \log_{LP}^{VA}$	-0.001	-0.001	0.223	-2.778	2.832	214,971
$\Delta \log_{LP}^Y$	0.001	0.002	0.228	-3.158	2.670	214,971
FO	0.015	0	0.103	0	1	276,259
$\log(FO)$	0.011	0	0.075	0	0.693	276,259
Nr_For_Owners	0.049	0	0.366	0	52	276,259
DFO <sup>maj+</sup>	0.003	0	0.051	0	1	276,259
DFO <sup>maj-</sup>	0.001	0	0.026	0	1	276,259
DFO <sup>min+</sup>	0.002	0	0.040	0	1	276,259
DFO <sup>min-</sup>	0.001	0	0.037	0	1	276,259
$\Delta \log(FO)_{t-4}$	0.001	0	0.028	-0.693	0.693	276,259
$\Delta \log(FO)_{t-3}$	0.001	0	0.031	-0.693	0.693	276,259
$\Delta \log(FO)_{t-2}$	0.001	0	0.035	-0.693	0.693	276,259
$\Delta \log(FO)_{t-1}$	0.001	0	0.036	-0.693	0.693	276,259
$\Delta \text{Nr\_For\_Owners}_{t-4}$	0.001	0	0.133	-6	31	276,259
$\Delta \text{Nr\_For\_Owners}_{t-3}$	0.001	0	0.149	-31	31	276,259
$\Delta \text{Nr\_For\_Owners}_{t-2}$	0.001	0	0.169	-31	32	276,259
$\Delta \text{Nr\_For\_Owners}_{t-1}$	0.002	0	0.168	-31	32	276,259
DFO <sup>maj+</sup> <sub>t-4</sub>	0.002	0	0.041	0	1	276,259
DFO <sup>maj-</sup> <sub>t-4</sub>	0.000	0	0.016	0	1	276,259
DFO <sup>min+</sup> <sub>t-4</sub>	0.001	0	0.031	0	1	276,259
DFO <sup>min-</sup> <sub>t-4</sub>	0.001	0	0.033	0	1	276,259
DFO <sup>maj+</sup> <sub>t-3</sub>	0.002	0	0.045	0	1	276,259
DFO <sup>maj-</sup> <sub>t-3</sub>	0.000	0	0.018	0	1	276,259
DFO <sup>min+</sup> <sub>t-3</sub>	0.001	0	0.033	0	1	276,259
DFO <sup>min-</sup> <sub>t-3</sub>	0.001	0	0.034	0	1	276,259
DFO <sup>maj+</sup> <sub>t-2</sub>	0.002	0	0.049	0	1	276,259
DFO <sup>maj-</sup> <sub>t-2</sub>	0.001	0	0.024	0	1	276,259
DFO <sup>min+</sup> <sub>t-2</sub>	0.002	0	0.039	0	1	276,259
DFO <sup>min-</sup> <sub>t-2</sub>	0.001	0	0.037	0	1	276,259
DFO <sup>maj+</sup> <sub>t-1</sub>	0.003	0	0.051	0	1	276,259
DFO <sup>maj-</sup> <sub>t-1</sub>	0.001	0	0.026	0	1	276,259
DFO <sup>min+</sup> <sub>t-1</sub>	0.002	0	0.040	0	1	276,259
DFO <sup>min-</sup> <sub>t-1</sub>	0.001	0	0.036	0	1	276,259

*Notes:*  $\Delta \log$  refers to one year log changes.  $\Delta$  indicates one-year changes.  $TFP^{WLP}$  is total factor productivity from a Cobb-Douglas (CD) production function estimated following [Wooldridge \(2009\)](#) by country-sector.  $TFP^{ACF}$  is total factor productivity from CD production function estimated following [Akerberg, Caves, and Frazer \(2015\)](#) by country-sector.  $TFP^{ACFTL}$  is total factor productivity from a translog (TL) production function estimated following [Akerberg, Caves, and Frazer \(2015\)](#) by sector.  $LP^{VA}$  is labor productivity (LP) measured as value added over number of employees.  $LP^Y$  is labor productivity (LP) measured as output over number of employees.  $\Delta \log(FO)$  is the yearly change in the  $\log(FO + 1)$  where FO stands for the percentage of foreign ownership divided by 100. DFO<sup>maj+</sup> is a dummy variable that equals one if the firm went from minority or domestically owned to majority owned (majority refers more 50% ownership). DFO<sup>maj-</sup> is a dummy variable that equals one if the firm went from foreign majority ownership to minority or domestic ownership. Nr\_For\_Owners stands for the number of foreign owners.

Table A.8: Summary Statistics: Matched Sample

	Mean	Median	SD	Min	Max	Observations
$\Delta \log_{TFP}^{WLP}$	-0.011	-0.001	0.160	-1.276	1.734	16,202
$\Delta \log_{TFP}^{ACF}$	-0.007	-0.005	0.159	-1.290	1.896	16,202
$\Delta \log_{TFP}^{ACFTL}$	-0.008	-0.003	0.173	-1.308	2.087	16,202
$\Delta \log_{LP}^{VA}$	0.003	0.004	0.239	-2.766	2.331	14,649
$\Delta \log_{LP}^Y$	0.006	0.009	0.240	-2.666	2.305	14,649
FO	0.137	0	0.310	0	1	16,202
$\log(FO)$	0.101	0	0.220	0	0.693	16,202
Nr_For_Owners	0.268	0	0.591	0	16	16,202
DFO <sup>maj+</sup>	0.033	0	0.178	0	1	16,202
DFO <sup>maj-</sup>	0.007	0	0.085	0	1	16,202
DFO <sup>min+</sup>	0.022	0	0.148	0	1	16,202
DFO <sup>min-</sup>	0.009	0	0.094	0	1	16,202
$\Delta \log(FO)_{t-4}$	0.011	0	0.089	-0.693	0.693	16,202
$\Delta \log(FO)_{t-3}$	0.014	0	0.102	-0.693	0.693	16,202
$\Delta \log(FO)_{t-2}$	0.018	0	0.122	-0.693	0.693	16,202
$\Delta \log(FO)_{t-1}$	0.019	0	0.127	-0.693	0.693	16,202
$\Delta \text{Nr\_For\_Owners}_{t-4}$	0.024	0	0.255	-2	8	16,202
$\Delta \text{Nr\_For\_Owners}_{t-3}$	0.031	0	0.274	-2	8	16,202
$\Delta \text{Nr\_For\_Owners}_{t-2}$	0.043	0	0.347	-3	16	16,202
$\Delta \text{Nr\_For\_Owners}_{t-1}$	0.044	0	0.352	-3	16	16,202
DFO <sup>maj+</sup> <sub>t-4</sub>	0.017	0	0.129	0	1	16,202
DFO <sup>maj-</sup> <sub>t-4</sub>	0.002	0	0.047	0	1	16,202
DFO <sup>min+</sup> <sub>t-4</sub>	0.012	0	0.110	0	1	16,202
DFO <sup>min-</sup> <sub>t-4</sub>	0.004	0	0.064	0	1	16,202
DFO <sup>maj+</sup> <sub>t-3</sub>	0.022	0	0.147	0	1	16,202
DFO <sup>maj-</sup> <sub>t-3</sub>	0.003	0	0.054	0	1	16,202
DFO <sup>min+</sup> <sub>t-3</sub>	0.014	0	0.118	0	1	16,202
DFO <sup>min-</sup> <sub>t-3</sub>	0.005	0	0.070	0	1	16,202
DFO <sup>maj+</sup> <sub>t-2</sub>	0.030	0	0.172	0	1	16,202
DFO <sup>maj-</sup> <sub>t-2</sub>	0.006	0	0.076	0	1	16,202
DFO <sup>min+</sup> <sub>t-2</sub>	0.021	0	0.143	0	1	16,202
DFO <sup>min-</sup> <sub>t-2</sub>	0.007	0	0.084	0	1	16,202
DFO <sup>maj+</sup> <sub>t-1</sub>	0.033	0	0.177	0	1	16,202
DFO <sup>maj-</sup> <sub>t-1</sub>	0.007	0	0.084	0	1	16,202
DFO <sup>min+</sup> <sub>t-1</sub>	0.023	0	0.149	0	1	16,202
DFO <sup>min-</sup> <sub>t-1</sub>	0.008	0	0.090	0	1	16,202

*Notes:*  $\Delta \log$  indicates one year log changes.  $\Delta$  indicates one-year changes.  $TFP^{WLP}$  is total factor productivity from a Cobb-Douglas (CD) production function estimated following [Wooldridge \(2009\)](#) by country-sector.  $TFP^{ACF}$  is total factor productivity from CD production function estimated following [Akerberg, Caves, and Frazer \(2015\)](#) by country-sector.  $TFP^{ACFTL}$  is total factor productivity from a translog (TL) production function estimated following [Akerberg, Caves, and Frazer \(2015\)](#) by sector.  $LP^{VA}$  is labor productivity (LP) measured by value added over number of employees.  $LP^Y$  is labor productivity (LP) measured as output over number of employees.  $\Delta \log(FO)$  is the yearly change in the  $\log(FO + 1)$  where FO is the percentage of foreign ownership divided by 100. DFO<sup>maj+</sup> is a dummy variable that equals one if the firm went from minority or domestically owned to majority owned (i.e., majority refers to 50 or more percentage ownership). DFO<sup>maj-</sup> is a dummy variable that equals one if the firm went from foreign majority ownership to minority or domestic ownership. Nr\_For\_Owners is the number of foreign owners.

Table A.9: Correlation of TFP measures

PANEL A: FULL SAMPLE					
	$\Delta \log \text{TFP}^{\text{WLP}}$	$\Delta \log \text{TFP}^{\text{ACF}}$	$\Delta \log \text{TFP}^{\text{ACFTL}}$	$\Delta \log \text{LP}^{\text{VA}}$	$\Delta \log \text{LP}^{\text{Y}}$
$\Delta \log \text{TFP}^{\text{WLP}}$	1				
$\Delta \log \text{TFP}^{\text{ACF}}$	0.954	1			
$\Delta \log \text{TFP}^{\text{ACFTL}}$	0.892	0.931	1		
$\Delta \log \text{LP}^{\text{VA}}$	0.692	0.621	0.564	1	
$\Delta \log \text{LP}^{\text{Y}}$	0.537	0.452	0.412	0.866	1

PANEL B: MATCHED SAMPLE					
	$\Delta \log \text{TFP}^{\text{WLP}}$	$\Delta \log \text{TFP}^{\text{ACF}}$	$\Delta \log \text{TFP}^{\text{ACFTL}}$	$\Delta \log \text{LP}^{\text{VA}}$	$\Delta \log \text{LP}^{\text{Y}}$
$\Delta \log \text{TFP}^{\text{WLP}}$	1				
$\Delta \log \text{TFP}^{\text{ACF}}$	0.947	1			
$\Delta \log \text{TFP}^{\text{ACFTL}}$	0.893	0.936	1		
$\Delta \log \text{LP}^{\text{VA}}$	0.685	0.629	0.581	1	
$\Delta \log \text{LP}^{\text{Y}}$	0.546	0.468	0.433	0.877	1

*Notes:* The table shows the correlation among the five firm level productivity measures used in the paper. Panel A shows the correlation in the full sample and Panel B shows the correlation in the matched sample of firms.  $\Delta \log$  refers to one year log changes.  $\text{TFP}^{\text{WLP}}$  is total factor productivity from a Cobb-Douglas (CD) production function estimated following [Wooldridge \(2009\)](#) by country-sector.  $\text{TFP}^{\text{ACF}}$  is total factor productivity from CD production function estimated following [Akerberg, Caves, and Frazer \(2015\)](#) by country-sector.  $\text{TFP}^{\text{ACFTL}}$  is total factor productivity from a translog (TL) production function estimated following [Akerberg, Caves, and Frazer \(2015\)](#) by sector.  $\text{LP}^{\text{VA}}$  is labor productivity (LP) calculated as value added over number of employees.  $\text{LP}^{\text{Y}}$  is labor productivity (LP) calculated as output over number of employees.



Table A.10: Foreign Ownership and Productivity: Measuring Labor and Capital

DEPENDENT VARIABLE:  $\Delta \log$  FIRM PRODUCTIVITY

	(1)	(2)	(3)	(4)
LABOR MEASURE	Wagebill	Wagebill	Wagebill	Employment
CAPITAL MEASURE	Tangible FA	Tangible + Intangible FA	Tangible FA	Tangible FA
SAMPLE	Baseline	Baseline	Non-missing Employment	Non-missing Employment
PANEL A: FULL SAMPLE OF FIRMS				
$\Delta \log(\text{FO})_{t-4}$	0.027*** (0.006)	0.022** (0.007)	0.029*** (0.007)	0.034*** (0.008)
$\Delta \log(\text{FO})_{t-3}$	0.013** (0.006)	0.011* (0.006)	0.012** (0.006)	0.023** (0.008)
$\Delta \log(\text{FO})_{t-2}$	0.013** (0.005)	0.002 (0.006)	0.012** (0.005)	0.018** (0.007)
$\Delta \log(\text{FO})_{t-1}$	0.009* (0.005)	0.002 (0.006)	0.011** (0.005)	0.006 (0.006)
Observations	276,259	276,259	214,966	214,966
Year-FE	yes	yes	yes	yes
Cntry $\times$ Sec4-FE	yes	yes	yes	yes
PANEL B: MATCHED SAMPLE OF FIRMS				
$\text{DFO}^{\text{maj}+}_{t-4}$	0.012** (0.006)	0.015** (0.007)	0.022*** (0.006)	0.026** (0.009)
$\text{DFO}^{\text{maj}+}_{t-3}$	0.003 (0.006)	0.004 (0.006)	0.002 (0.006)	0.013 (0.008)
$\text{DFO}^{\text{maj}+}_{t-2}$	-0.005 (0.005)	-0.010* (0.005)	-0.007 (0.005)	-0.002 (0.006)
$\text{DFO}^{\text{maj}+}_{t-1}$	-0.006 (0.005)	-0.008 (0.005)	-0.005 (0.005)	-0.004 (0.006)
Observations	16,202	16,202	14,647	14,647
Year-FE	yes	yes	yes	yes
Cntry $\times$ Sec4-FE	yes	yes	yes	yes

*Notes:* The dependent variable is the change in log revenue firm-level total productivity at time  $t$  ( $\Delta \log \text{TFP}_{i,t}$ ).  $\Delta$  indicates one-year changes. Column (1) shows our baseline results where TFP is estimated using wage bill as the measure of labor and tangible fixed assets for capital. Columns (2) and (3) show results for TFP estimated using wage bill as a measure of for labor. In column (2) TFP is estimated using the sum of tangible and intangible fixed assets for capital. Column (3) uses the same measure of TFP as used in column (1) but for the sample of firms reporting employment. In column (4), the dependent variable is TFP is estimated using employment as the measure of labor and tangible fixed assets as the measure of capital. Panel A reports our main results for the total sample of firms, while Panel B reports results for the matched sample of firms.  $\Delta \log(\text{FO})$  is the yearly change in the  $\log(\text{FO} + 1)$  where FO is the percentage of foreign ownership.  $\text{DFO}^{\text{maj}+}$  is a dummy variable that equals one if the firm went from minority or domestically owned to majority owned (majority refers to more than 50% ownership). Standard errors are clustered at the firm level. Results are obtained by a weighted (GLS) regression where the weights are the square roots of each firm's mean squared predicted residuals from an initial OLS estimation. All specifications include the lag one, two, three, and four change in number of owners and lag one log firm productivity. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

Table A.11: Foreign Ownership and Productivity: Choice of Lag Length

DEPENDENT VARIABLE: $\Delta \log$ FIRM REVENUE TFP				
	(1)	(2)	(3)	(4)
$DFO^{\text{maj}+}_{t-5}$				-0.005 (0.008)
$DFO^{\text{maj}+}_{t-4}$	0.012** (0.006)	0.010 (0.006)		0.011* (0.006)
$DFO^{\text{maj}+}_{t-3}$	0.003 (0.006)	-0.001 (0.006)	0.005 (0.005)	0.005 (0.005)
$DFO^{\text{maj}+}_{t-2}$	-0.005 (0.005)	-0.008* (0.004)	-0.006 (0.005)	-0.005 (0.005)
$DFO^{\text{maj}+}_{t-1}$	-0.006 (0.005)	-0.008* (0.004)	-0.002 (0.004)	-0.007 (0.005)
$\Delta \text{Nr\_For\_Owners}_{t-4}$	-0.005 (0.003)	-0.005* (0.003)		-0.006* (0.004)
$\Delta \text{Nr\_For\_Owners}_{t-3}$	0.003 (0.003)	0.002 (0.003)	0.003 (0.002)	0.002 (0.003)
$\Delta \text{Nr\_For\_Owners}_{t-2}$	0.005*** (0.002)	0.004** (0.002)	0.006*** (0.002)	0.004** (0.002)
$\Delta \text{Nr\_For\_Owners}_{t-1}$	0.005** (0.002)	0.004* (0.002)	0.004 (0.002)	0.005** (0.002)
$\Delta \text{Nr\_For\_Owners}_{t-5}$				0.001 (0.004)
$\log \text{TFP}_{t-1}$	-0.096*** (0.003)		-0.096*** (0.003)	-0.095*** (0.003)
Observations	16,202	16,202	18,841	13,673
Year-FE	yes	yes	yes	yes
Cntry $\times$ Sec4-FE	yes	yes	yes	yes

*Notes:* The dependent variable is the change in log revenue firm-level productivity at time  $t$  ( $\Delta \log \text{TFP}_{i,t}$ ).  $\Delta$  indicates one-year changes.  $DFO^{\text{maj}+}$  is a dummy variable that equals one if the firm went from minority or domestically owned to majority owned (majority refers to 50% or more ownership).  $\text{Nr\_For\_Owners}$  is the number of foreign owners. Results are obtained from the matched sample of firms by a weighted (GLS) regression. The regression weights are the square roots of each firm's mean squared predicted residuals from an initial OLS estimation. The corresponding lag one, two, three, four, and five change in number of owners is included according to each specification. Lag one log firm productivity is included in all specifications except in column (2). \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

Table A.12: Foreign Ownership and Productivity: Levels by Sub-periods

DEPENDENT VARIABLE: log FIRM REVENUE TFP

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Sample	(1) all years	(2) up to 2007	(3) from 2008
log(FO)	0.026*** (0.005)	0.020** (0.006)	0.017** (0.006)
Nr_For_Owners	0.001 (0.001)	0.001 (0.001)	0.001** (0.001)
log TFP <sub>1</sub> × FIRM TREND	-0.026*** (0.000)	-0.030*** (0.000)	-0.045*** (0.000)
Obs.	745,128	478,860	255,735
Firm-FE	yes	yes	yes
Year-FE	yes	yes	yes
Cntry×trend	yes	yes	yes
Sec4×trend	yes	yes	yes
Cntry×Sec4×trend	yes	yes	yes

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*Notes:* The dependent variable is log revenue firm-level productivity at time  $t$ . The main regressor is  $\log(\text{FO} + 1)$  where FO is the percentage of foreign ownership, `Nr_For_Owners` is the number of foreign owners in the firm, and  $\log \text{TFP}_1$  is productivity of the firm the first year the firms is in the regression sample. `FIRM TREND` is the number of years since firm  $i$  was first observed in the data *in the given time sub-sample* (all years, up to and including 2007, starting from 2008); i.e., it equals unity the first time we observe the firm in the sub-sample, regardless of the actual calendar year. Standard errors are clustered at the firm level. Results are obtained by GLS estimation using as weights the square root of each firm's mean squared predicted residuals from an initial OLS estimation. \*\*\* denotes 1% significance; \*\* denotes 5% significance; \* denotes 10% significance.

## C.2 Estimation Results

Table C.1 reports summary statistics for the output elasticities estimated using the Wooldridge (2009) approach. The results are consistent across countries with no major differences except for Belgium, where the number of observations is slightly lower and the coefficient on labor is on average marginally lower (0.625) and the average coefficient on capital marginally higher (0.102).<sup>19</sup> Summary statistics are computed excluding sectors in which the WLP procedure delivers either missing, negative, or zero coefficients. These cases are few and mainly correspond to sectors 12 “Manufacture of Tobacco products” and 19 “Manufacture of coke and refined petroleum products,” which have very few observations and contribute little to overall manufacturing output.

Table C.1: Summary Statistics of the Production Function Output Elasticities

	Labor Elasticity ( $\beta_\ell$ )	Capital Elasticity ( $\beta_k$ )
Mean	0.734	0.081
Median	0.730	0.078
Standard Deviation	0.059	0.023
Max	0.919	0.338
Min	0.453	0.003

<sup>19</sup>Similarly, the average coefficient on capital is slightly higher in Germany (0.102).