European Bank
for Reconstruction and Development

# Ownership structure and productivity of multinationals

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**Summary**
We examine the ownership structure and productivity of multinational affiliates and their effects on domestic industry. We first separate plant-level efficiency into a physical productivity and a price component. Multinationals target plants with high physical productivity and prices. Upon acquisition they raise physical productivity but lower prices, leaving mark-ups unchanged, especially when they are majority owners. This pro-competitive effect means that multinationals' productivity effects may be previously underestimated. Multinational presence in an industry leads to tighter selection of surviving firms and increases physical productivity while lowering prices at domestic firms, especially when majority-owned affiliates are present. Ownership structure and foreign acquisitions therefore play an important role in driving aggregate productivity growth.

Keywords: productivity, acquisitions, ownership structure, foreign direct investment

*JEL Classification*: D23, F23, L23

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I am grateful to Alan Deardorff, Andrei Levchenko, Jan Svejnar, Linda Tesar, Jean-Louis Arcand, Erik Berglöf, Sergei Guriev, Beata Javorcik, Wilhelm Kohler, Rahul Mukherjee, Peter Neary, Armando Rungi, Frank Staehler, and participants at many seminars and conferences for helpful suggestions and discussion, and Sümeyra Korkmaz for her help with the data. The statistical analysis of plant-level data on multinational enterprises in Turkey reported in this paper was conducted at the Turkish Statistical Institute under arrangements that maintained legal confidentiality requirements.



**Working Paper No. 203** **Prepared in August 2017**

# 1 Introduction

Multinational companies frequently benefit from tax breaks and other incentives by host governments in the hope that they can generate benefits to the local economy. Many countries also require them to enter into joint ventures or licensing agreements with local producers in order to maximise efficiency gains at recipient firms. In fact, 80 per cent of all countries restrict majority ownership in at least one industry (UNCTAD, 2016). However, evidence is inconclusive as to whether and how multinational activity affects productivity and competitiveness in host economies. Do foreign owners actually improve technical efficiency at acquired firms or are they driven more by considerations of profitability and market power? Does multinational activity generate efficiency gains regardless of ownership structure or are some ownership structures more beneficial to the local economy than others?

This paper aims to answer these questions and document how multinational ownership affects productivity, competition and selection in the local economy. It has been a major challenge to isolate the productivity effects of multinational activity – and mergers and acquisitions (M&As) more generally – from market power and selection considerations. Whenever M&As and multinational activity in an industry affect market power, relying on traditional estimates of productivity becomes misleading. For instance, acquisitions that increase market power tend to raise output prices, which is reflected as a productivity gain in a typical revenue-based measure even in the absence of changes to technical efficiency (Braguinsky et al., 2015). We take advantage of a new dataset that helps us tackle well-known issues in the estimation of production functions and strip the effect of changes in market power on productivity. At the same time, our dataset provides variation in multinationals' ownership structure within plants and multinational activity within industries. This variation helps us document how multinationals affect measures of physical productivity, prices and mark-ups at acquired plants and the rest of the industry. We calculate alternative productivity measures that capture the role of capacity utilisation, inventory management, and within-industry price heterogeneity, which are typically confounded into more traditional estimates of efficiency. We then document how ownership structure of multinationals affects each of these components at investment targets and domestic plants operating in the same industries.

Our first set of findings documents the impact of multinational investment on acquired plants. Following acquisitions, revenue-based productivity at target plants rises by up to 5 per cent. However, this figure masks considerable variation in the underlying components of revenue-based productivity. Target plants in fact see large improvements in physical productivity by around 30 per cent, which is matched by similarly large drops in their average real output prices by around 25 per cent. Their mark-ups are unchanged, suggesting that most of the cost-savings reflected by the rise in productivity is passed on to acquired plants' customers. Part of the post-acquisition effect is due to multinationals' targeting of plants with relatively high levels of physical productivity and prices prior to acquisition even within narrowly defined industries. Our results suggest that this selection effect accounts for around a quarter of the observed differences in physical productivity and prices in the post-acquisition period.

We extend our analysis by studying minority-owned and majority-owned affiliates of multinationals to bring out the role of ownership structure. We find that physical efficiency gains and reductions in price are much higher in the case of majority-owned affiliates. When we tightly control for pre-acquisition characteristics, we find that most of the variation remains for plants that are majority owned by multinationals, but not for minority foreign-owned plants. This suggests that ownership structure affects how multinationals identify investment targets and what they change at acquired plants. We therefore look into several mechanisms that can explain the observed changes in physical efficiency and prices at the same time. We find that majority-owned affiliates are much more likely to start exporting and become importers of intermediate inputs. Following acquisition, the exported share of output at target plants is on average 3 percentage points higher and the imported share of intermediate inputs is 16 percentage points higher than under domestic ownership. Our estimates indicate that access to better or cheaper materials through imports plays a more prominent role than greater access to export markets in driving the productivity advantage of majority foreign-owned plants.

In contrast, plants under minority foreign ownership are not more or less likely to engage in international trade, but they are more likely to become multi-product firms following acquisition. Minority foreign owners are more likely to introduce new products and focus more on pricing than physical productivity as sources of their profitability. These results are consistent with the view that ownership structure affects the incentives of the investors to apply their resources, the level of investment, the degree of technology transfer, and the distribution of gains from foreign direct investment (FDI) (Asiedu and Esfahani, 2001). They also suggest that the effects may extend beyond the investment targets if the rest of the industry responds to price and employment dynamics due to multinational activity.

Our second set of findings goes in this direction and documents how multinationals impact on domestic plants operating in the same industry through so-called horizontal spillovers. Acquired plants lead to heightened industry competition, especially when they are able to increase own market shares by lowering output prices. This is expected to have two major effects. First, it may induce a price reduction at surviving domestic plants and corresponding increase in physical efficiency to meet the new higher profitability threshold for survival. Second, cut-off productivity for survival may increase and inefficient domestic businesses that cannot compete may be driven out.

Our results confirm both predictions. Greater presence of multinationals is associated with a higher level of physical productivity and lower level of prices at domestic plants in the same industry, especially when multinational affiliates are majority or fully-owned. Our point estimates show that surviving domestic plants are unable to increase their physical productivity by as much as they absorb price reductions, thereby leading to negative spillovers in revenue-based productivity. Nevertheless, increased multinational activity accounts for 10 per cent of the rise in average physical productivity of domestic plants over the sample period. Our results also show that physical productivity and prices play a joint and significant role in determining firm survival in our sample. This confirms findings by Foster et al. (2008), who emphasise the role of both technology and demand in determining selection. Domestic plants with higher physical productivity are more likely to survive, unless they operate in industries where multinationals are more prevalent, in which case a higher physical efficiency is less likely to ensure survival. Similarly, domestic plants charging higher output prices, presumably due to high demand for their products, are more likely to continue their operations on average. However, if they compete in the product and labour markets in an industry with high multinational presence, then higher prices do not lower the likelihood of exit by as much they do in an industry with minimal multinational presence.

We draw on a panel of plant-level observations from the census of manufacturers in Turkey to document these results. The census has the advantage of reporting the exact equity share owned by foreign investors. Data point to an active market in corporate equity targeted by multinationals and allow us to track these changes over time. A second advantage of the data is its wealth of information that allows us to estimate physical measures of productivity, also referred to as quantity-based productivity or technical efficiency in the literature. Separating physical productivity from the effect of firm-level prices is a major challenge that the literature on estimating production functions has sought to address. Even when prices on final goods products are observed, variation in input prices across plants may lead to misestimation. Our dataset provides product-level records of physical units of inputs employed and output produced alongside their purchase and sale values. These are matched to each plant in the census and can be traced across time. We take advantage of these data to construct appropriate plant-level deflators and estimate measures of physical productivity, prices and mark-ups.

Our first contribution is to the literature on acquisitions, multinationals, market power and productivity. We identify the sources of superior efficiency attributed to acquirers by separating a revenue-based productivity estimate into its price and physical productivity components for the entirety of a country's manufacturing sector. Existing studies on mergers and acquisitions (M&As) and market power tend to focus on individual industries, mainly because detailed firm- and product-level data are available only at this level.[1] Working with the near universe of plants operating in an industry is important to understand how acquirers select their investment targets and how they affect recipient plants across the industry. It also helps to explain mechanisms behind how ownership structure affects multinationals' observed efficiency advantage over their domestic counterparts and how aggregate productivity responds to FDI. To the best of our knowledge, this is the first paper to document a pro-competitive effect on prices and evidence on physical efficiency induced by multinational activity.[2]

In addition to within-plant effects, we document how firm survival and reallocation due to multinational activity shapes industry productivity. Foster et al. (2008) show that revenue-based productivity measures understate the importance of reallocation and firm turnover to industry productivity growth. Our findings similarly point to a more prominent role of selection and reallocation between plants in explaining the effects of multinationals on aggregate productivity than previously thought. When revenue-based productivity is used, both the within-plant effect of multinational investment and the cross-effect on domestic plants in the industry are underestimated. Multinational presence in an industry significantly contributes to improvement in physical productivity of domestic plants in the same industry as it raises the threshold for survival.

Our second contribution is methodological. We generate plant-level estimates of input elastic-

[1] See for instance Ashenfelter et al. (2013).

[2] Few other studies have looked at multinationals' pricing behaviour, albeit in a more limited context. Notably, Ge et al. (2015) find that foreign manufacturing firms in China charge higher export prices than domestic firms.

ities, productivity, and mark-ups by tackling several issues highlighted in the literature at the same time. First, we use extremely rich product-level data on inputs and outputs to correct for the input price and output price biases. These biases arise due to the well-documented dispersion in prices across firms even within narrowly defined industries (Foster et al., 2008; Kugler and Verhoogen, 2012; Atalay, 2014). Crucially, we can draw on input price data that allow us to side-step complications thrown up by input price heterogeneity. Second, we follow De Loecker and Warzynski (2012), De Loecker (2013), and De Loecker et al. (2016) to correct for the simultaneous determination of productivity, ownership and input demand, and the selection bias that may arise from using an unbalanced panel of single-product firms. Existing work tends to address these issues one at a time.[3] Third, we use information on actual consumption of material inputs and final goods production, as opposed to reported material purchases and revenue from sales typically found in firm-level data. This isolates the effect of inventory management, which can help explain differences in measured productivity (Braguinsky et al., 2015).

### 1.1 Related Literature

Our work is related to the literature on the effects of acquisitions and multinational activity, which documents mixed findings. A first strand of the literature looks at within-firm changes. Braguinsky et al. (2015) point to a profit-enhancing rather than efficiency-enhancing motive for acquisitions in the Japanese cotton spinning industry; nevertheless, acquisitions improve both productivity and profitability. Blonigen and Pierce (2016) show that domestic M&As in the United States raise mark-ups but not productivity, while Wang and Wang (2015) find that foreign acquisitions in China do not increase productivity any more than domestic acquisitions do. Similarly, Harris and Robinson (2002) and Benfratello and Sembenelli (2006) fail to find positive effects of foreign acquisitions in the United Kingdom and Italy, respectively. In contrast, Arnold and Javorcik (2009) and Guadalupe et al. (2012) find that foreign acquisitions improve productivity even after controlling for the selection of high-productivity firms in Indonesia and Spain, respectively.

A second strand of the literature looks at productivity spillovers to domestic firms and the role of ownership structure in explaining spillovers. In a seminal study, Aitken and Harrison (1999) document negative within-industry spillovers in Venezuela and emphasise the market-stealing effect of multinationals. Javorcik (2004) and Javorcik and Spatareanu (2008) fail to find within-industry spillovers, but they document positive spillovers in industries that supply to multinationals in Lithuania and Romania, respectively. They highlight the role of ownership structure in backward linkages by showing the existence of spillovers only in the case of partially owned multinationals, which source more of their inputs locally. In contrast, Haskel et al. (2007) and Keller and Yeaple (2009) document positive spillovers in the same industry in the United Kingdom and United States, respectively. Alfaro and Chen (2012) provide cross-country evidence on

[3] Ornaghi (2006), Eslava et al. (2013), and Atalay (2014) observe plant-specific prices in their data but they do not correct for endogenous productivity and input demand, or address the issue of multi-product firms. They estimate Cobb-Douglas production functions, which impose constant returns to scale and the assumption that factor shares are common within industries. Doraszelski and Jaumandreu (2013), De Loecker et al. (2016), and Grieco et al. (2016) propose methods that address these issues, with a specific focus on estimating production functions when input prices are unobserved.

positive FDI spillovers, which is driven by selection and market reallocation effects.

Our findings help reconcile these mixed results. They suggest that the first strand of the literature underestimates within-firm productivity improvements of foreign acquisitions and the second strand underestimates the cross-firm spillovers from multinational activity. With the exception of Braguinsky et al. (2015), these studies all use revenue-based productivity estimates, which may partly explain estimated impacts that are economically small. Similar to Braguinsky et al. (2015), we document a positive effect on physical productivity, but unlike them, we also document a strong and negative effect on prices. This pro-competitive effect is especially strong for majority-owned foreign affiliates, which induce a response from domestic plants operating in the same industry. We find that physical efficiency at domestic plants responds to a lesser extent than the drop in price, which translates into negative spillovers of revenue-based productivity but masks the larger gains in technical efficiency at surviving plants.

The rest of the paper is organised as follows. Section 2 documents ownership structure patterns at multinationals in Turkey and discusses how they might affect economic outcomes. Section 3 describes the data and our empirical strategy. Section 4 presents results on acquired plants, while Section 5 includes results on how multinational activity affects the rest of domestic industry. Section 6 concludes.

# 2 Ownership structure of multinationals

Our main data source is the Industrial Analysis Database provided by Turkey's Statistical Institute (TurkStat) for the period 1991-2001. It is an annual census of manufacturers with 10+ employees for the years 1993-2001 and 20+ employees in earlier years with random sampling of plants employing fewer than 20 workers. It provides detailed information on plant characteristics typically found in census data. Importantly, we can observe the exact equity share held by multinational investors at each plant and track them over time. A fully liberal equity framework has been in place in Turkish manufacturing during this period with minimal requirements on screening and prior approval, personnel or other operations (Kalinova et al., 2010), so that observed shareholding structures are not artificially induced by legal restrictions. This provides us with an ideal setting to study how variation in ownership structure across plants and time affect local economic outcomes.

We define a plant to be a multinational affiliate in any given year if it has a positive level of equity held by a foreign investor. In the data this ranges from 1 per cent to 100 per cent; domestic plants are defined to have 0 per cent foreign equity participation. We define plants with 50%+ foreign ownership as majority owned by multinationals and the rest as minority owned. Equity shareholdings provide cash flow and voting rights to multinationals and their domestic production partners. While cash flow rights typically follow the equity ownership breakdown, voting rights need not do so. As voting rights are unobserved, we assume that a foreign owner is much more likely to have control over strategic management decisions when they are majority owners.

Table 1 summarises the presence of multinationals in the sample and the breakdown by ownership structure. Multinational affiliates were large and important players over this period, employing around 12 per cent of the labour force and contributing close to a fourth of total manufacturing output. Multinationals acquired a total of 308 domestic plants and invested in 295 greenfield projects during the sample period. Acquired plants in the sample employed 247 workers on average, while greenfield plants employed 112 workers at the time of investment, suggesting that multinational activity largely derives from acquired companies. Both sets of plants were larger than the average domestic plant, which employed 44 workers.

Table 1 points to an active market in ownership at multinational plants. In the sample, 124 acquisitions were majority owned by multinationals and 186 were minority owned at the time of acquisition; 40 plants in the latter group have a 50-50 breakdown in ownership between domestic and foreign owners. In contrast, 132 greenfield plants were established with minority foreign ownership and 163 with majority foreign ownership. These figures indicate that most multinational affiliates operating in Turkey are partially owned by their parent companies, even though there are no legal restrictions or incentives in place for ownership sharing.[4] Multinationals also sold 248 plants to domestic owners and shut down 134 plants during the sample period. Multina-

[4]In unreported figures we confirm that the prevalence of partial ownership holds regardless of industry or size. This phenomenon is not unique to Turkey. Using SDC Thompson's International Mergers and Acquisitions database for 16 emerging countries over the period 1990-2007, Alquist et al. (2016) document that more than half of acquisitions by foreign investors entail partial ownership. Similarly, Fons-Rosen et al. (2013) use the Orbis database by Bureau van Dijk for 30 developed and emerging countries to show that the majority of foreign firms in manufacturing are partially owned.

tionals seem to regularly turn over their investments and the resulting activity may therefore lead to considerable effects within their industries.

There are several reasons to expect why the ownership structure of multinational affiliates should matter for recipient plants. First, multinational parents are more likely to share proprietary technologies and intangible assets (including brands, licences, and copyrights) when they acquire majority control of target plants, especially when there is weak investor protection and non-verifiable monitoring (Chari et al., 2010). If financial frictions exist in addition to these conditions, then equity ownership by multinationals arises naturally to monitor local producers (Antras et al., 2009). Ownership structure then affects both the extent to which financial constraints are relaxed and the level of technology transfer at the target firm. Second, technology transfer not only consists of intangible assets, but it also involves access to cheaper or higher quality imported inputs. This has a direct impact on productivity: Halpern et al. (2015) show that firms with majority foreign owners in Hungary benefit by 24 per cent more than purely domestic firms from each dollar spent on imports. Third, multinationals may be able to replace senior management and introduce their own management practices only when they have effective control of the company, and not as minority owners. Bloom and Van Reenen (2010) report that multinationals are able to adopt good management practices in almost every country they operate, which can have considerable impact on productivity. In a randomised control trial, Bloom et al. (2013) find that adopting good management practices led by consultants, most of which have previously worked for multinationals in India, led to an 11 per cent increase in productivity in their sample.

The effects of ownership structure at multinationals extend beyond target firms through their interactions with domestic firms on product and input markets. Aitken and Harrison (1999) show that foreign investments have negative horizontal spillover effects on domestic firms as output produced by the latter shrink in response to increased multinational activity. If majority-owned foreign affiliates are more successful in expanding their market shares, then their prevalence in an industry will have a direct impact on domestic plants through increased product market competition. However, an alternative explanation for negative spillovers is that there is less knowledge dissipation from majority-owned multinationals to domestic plants operating in the same industry. In that respect, Javorcik and Spatareanu (2008) find negative spillovers to be highest on local producers that compete with wholly owned multinationals. Javorcik (2004) suggests that ownership structure plays an important role in backward linkages, as partially owned multinationals are more likely to engage in knowledge transfers to their local suppliers, incentivise them to produce higher quality output, and help suppliers achieve economies of scale by increasing demand for inputs.

# 3 Empirical strategy

## 3.1 Data and measurement

We match the census of manufacturers with a product-level dataset provided by TurkStat for the same period with plant identification codes.[5] This second dataset provides annual information on the physical quantity and value of each firm's inputs and outputs at the product level following a highly disaggregated classification, which includes more than 2,900 distinct products.[6] Observing such detailed information at the product level is rare, especially on the input side. We use this unique information to correct for the output and input price biases in our production function estimation.

Another unique feature of this dataset is that it differentiates between what is actually involved in production and what is normally reported in census data. On the output side, we observe quantity and value information on final goods production and sales separately for each product, including change in inventories. On the input side, we observe purchases of materials and what is actually consumed in production, again separately at the product level. If plants actively manage their stock of final goods or materials, then using revenue from sales or materials purchases in production function estimation confounds the effect of inventory management into estimates of efficiency. For instance, a positive shock to productivity today may increase the real output of a firm immediately, but the firm may delay sales into the future and build up inventories instead. Using sales revenue as the measure of output will then underestimate both production function coefficients and true productivity. In our estimations, we use information on actual output and material inputs consumed in production. We discuss in the results section how estimates change when we use purchased materials and sales revenue instead.

We calculate unit values (or prices) for each product-plant-year observation using the reported values and quantities. For each input or output, we create a product-level deflator by calculating the weighted geometric average of annual price changes across all plants producing or consuming that product. We use as weights each plant's revenue (or cost) share of the product averaged across the current and previous years.[7] We adjust prices to a common 1993 basis using these deflators and use the logs of these real prices in the following analysis. Our measure of plant-level output is the sum of real production output across a plant's products deflated in this way. Similarly, our measure of plant-level materials is the sum of the real value of inputs.

Standard practice in the literature is to use industry deflators to calculate real values. This fails to account for the high variation in input and output prices within industries and leads to a price

[5]Around 12 per cent of observations from the census cannot be matched with the product-level dataset as the latter does not report information for some of the smaller plants in the sample. This affects 22 acquired plants, which slightly reduces the sample for our analysis.

[6]Turkey's product classification during the sample period is at the 8-digit level: the first four digits refer to ISIC Rev. 2 and the last four digits are national. We describe in the online data appendix how we construct our matched dataset in more detail.

[7]An alternative procedure that attaches weights simply based on the current year's market shares returns very similar results.

bias in the estimation of production functions and productivity. In order to highlight this bias, we alternatively deflate our measure of outputs and inputs by a 4-digit industry deflator. Our 4-digit industry deflator covers 85 distinct industries, which is relatively detailed.

The census provides data on several measures of labour input. Standard practice is to use stock of employment, which hides the variation in a plant's capacity utilisation throughout the year. Our dataset contains information on labour-hours for each plant in addition to the more traditional labour stock measure; we will use this extra piece of information in our baseline estimation. We measure capital as plants' reported book values of fixed assets, which includes all equipment and structures. Capital is deflated using an aggregate investment deflator provided by TurkStat.

We estimate a plant-level translog production function following De Loecker and Warzynski (2012). Their methodology allows one to not take a stand on the exact model of competition to recover estimates of productivity and mark-ups. Following De Loecker (2013), we complement De Loecker and Warzynski (2012)'s methodology by allowing productivity to evolve endogenously with equity ownership dynamics, exporting and importing status, and the probability of remaining single-product. If input use systematically adjusts when ownership (or either of the other variables) changes, then standard approaches to measuring productivity effects of acquisitions, which assume productivity evolves exogenously, could bias the estimates by attributing too much of output gains to input use rather than changes in productivity (Braguinsky et al., 2015). We therefore correct for the simultaneous determination of input use and productivity dependent on ownership status, involvement in international trade, and single- versus multi-product status.

Consider the gross output production function for plant $i$ in year $t$:

$$\begin{aligned} y_{it} &= \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{lk} l_{it} k_{it} \\ &\quad + \beta_{lm} l_{it} m_{it} + \beta_{km} k_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it} + \omega_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

where $y$ is output produced, $l$ is worker-hours, $k$ is capital stock, and $m$ is material input consumption, all in logs and appropriately deflated as described above. $\omega_{it}$ denotes productivity and it evolves according to the following law of motion:

$$\omega_{it+1} = g_t(\omega_{it}, FO_{it}, Exp_{it}, Imp_{it}, SP_{it+1}) + \xi_{it+1} \tag{2}$$

where $FO_{it}$ is a vector that captures a plant's history of foreign ownership and $\xi_{it+1}$ captures shocks to productivity. We assume, as in Braguinsky et al. (2015):

$$g(\omega_{it}, FO_{it}) = \sum_{j=1}^{3} \gamma_j \omega_{it}^j + \vartheta_1 preFO_{it} + \vartheta_2 earlyFO_{it} + \vartheta_3 lateFO_{it} \tag{3}$$

We define the dummy variable $preFO_{it}$ to indicate the two years preceding an acquisition. Similarly, $earlyFO_{it}$ indicates the acquisition year and the following year, while $lateFO_{it}$ indicates all subsequent years that the plant remains under foreign ownership. In (2), $Exp_{it}$ and $Imp_{it}$ are indicators for exporting and importing, respectively, while $SP_{it+1}$ is the probability of remaining single-product next period. This specification allows not only current foreign ownership status but also a near-future acquisition event to have an effect on productivity. For instance, a multinational parent may acquire a high equity stake at its affiliate today in anticipation of future transfers of headquarter assets that could impact on productivity. As pointed out by De Loecker et al. (2016), however, including these terms in the law of motion for productivity does not assume a result that they will definitely impact productivity.

We estimate the production function for each 2-digit ISIC industry using an unbalanced sample of single-product plants.[8] Since more productive plants are more likely to become multi-product in the next period, we carry out a correction procedure following De Loecker et al. (2016). We define an indicator term that equals 1 if the plant remains a single-product in the next period and 0 otherwise. We run a probit model of this indicator on all variables included in (1) and we include the predicted probability, $SP_{it+1}$, in the estimation.

Estimation is done in two stages. In a first stage, predicted output is obtained by estimating (1) alongside variables potentially affecting input demand and year dummies. We allow foreign ownership dynamics, exporting and importing status, and the probability of remaining single-product to affect current input demand as in (2). In a second stage, we compute $\omega_{it}$ using predicted output and regress it on a third-order polynomial approximation of past productivity and variables affecting input demand to recover the productivity shocks $\xi_{it}(\beta)$. The coefficients are then identified by using standard GMM techniques on the following moment conditions:

$$E\left[\xi_{it}(\beta) \mid \mathbf{B}\right] = 0$$

where $\mathbf{B} = (l_{it-1}, k_{it}, m_{it-1}, l^2_{it-1}, k^2_{it}, m^2_{it-1}, l_{it-1}k_{it}, m_{it-1}k_{it}, l_{it-1}m_{it-1}, l_{it-1}m_{it-1}k_{it})'$. Since we estimate a translog specification, output elasticities $(\theta^L_{it}, \theta^K_{it}, \theta^M_{it})$ are computed using the estimated $\beta$'s and current inputs, so they vary across plants and time. For instance, the output elasticity of labour is given by $\theta^L_{it} = \beta_l + 2\beta_{ll}l_{it} + \beta_{lk}k_{it} + \beta_{lm}m_{it} + \beta_{lkm}k_{it}m_{it}$; $\theta^K_{it}$ and $\theta^M_{it}$ are similarly defined.

We use these estimates to calculate (log) revenue-based productivity, TFPR, and we subtract from it the revenue-weighted average (log) output price to calculate (log) physical productivity, TFPQ. We recover plant-time variant mark-ups from $\mu_{it} = \theta^M_{it}/\alpha^M_{it}$, where $\alpha^M_{it}$ is the share of expenditures on material inputs in total value of production (De Loecker and Warzynski, 2012).[9] We calculate three additional measures of productivity to highlight the importance of capacity utilisation, inventory adjustment, and price heterogeneity. First, we calculate physical productivity using reported labour stock instead of worker-hours. We call this measure TFPQ_U as it does not take into account the utilisation rate. Second, instead of using values of actual production and materials consumed, we use sales from production and purchases of materials. We call this TFPQ_I since it does not reflect the role of inventories. Finally, we calculate a traditional mea-

[8] In the sample, 57 per cent of all observations belong to a single-product plant and they account for 30 per cent of annual sales on average.

[9] Note that we could also recover the mark-up from the labour elasticity and labour's share of expenditures. We prefer to use materials as they are much less prone to adjustment costs than labour and we side-step any issues of inventory adjustment by using data on consumption of materials.

sure of productivity by deflating our input and output measures using 4-digit industry deflators and not taking into account the role of utilisation or inventories. We call this TFPT; it has been extensively used in previous literature.

### 3.2 Effects of foreign acquisitions

Our empirical setup follows variants of a difference-in-differences estimation. Using different samples, we estimate:

$$y_{it} = \beta_0 + \beta_1 Acq_i \times post - Acq_t + \beta' \mathbf{X}_{it} + \gamma_i + \delta_t + \sum_j \eta_j \times \delta_t + \varepsilon_{it} \qquad (4)$$

where $y_{it}$ is an outcome for plant $i$ in year $t$. Our main outcomes of interest are the productivity measures described earlier alongside mark-ups and prices. In (4), $Acq_i$ indicates plants acquired by multinationals and $post - Acq_t$ indicates the years following acquisition spent under foreign ownership. We include plant and year fixed effects to capture within-plant changes stripped from shocks common to all plants. We initially run this regression on the set of plants that were subject to takeovers by multinationals so that $\beta_1$ identifies within-plant changes arising from changes in ownership. In order to understand how ownership structure affects the outcomes of interest, we estimate (4) after splitting the term $Acq_i \times post - Acq_t$ into minority and majority foreign ownership at the time of acquisition.

The main threat to interpreting within-plant results is the issue of selection. It is possible that multinationals target certain plants based on a set of observable or unobservable characteristics and any effect that we document may be driven by this selection issue. For instance, multinationals may target particular industries that experience high productivity growth or increasing competitiveness due to market consolidation or other economic forces. It is also well known that they target well-performing companies even within narrowly defined industries (Arnold and Javorcik, 2009). Although our within-plant results eliminate influences that arise from factors that are constant over time, they may still be subject to non-random targeting.

In order to guard against this issue, we follow two strategies. First, we include a set of time trends based on industry and pre-acquisition plant characteristics, $\sum_j \eta_j \times \delta_t$, to control for the effect of unobservables. Industry trends are included at the detailed 4-digit level. We divide pre-acquisition plants into four plant size categories by employment: [0,19], [20,49], [50,249], and 250+. Similarly, they are divided into four categories by age: [0,4], [5,9], [10,14], and 15+. These size and age categories enter (4) interacted with a linear time trend. Any trends in efficiency, market power or pricing behaviour due to industry-wide changes or individual plants' size or life cycles should all be captured.[10] In addition, we include a set of plant-time variant controls in $\mathbf{X}_{it}$, which control for plant size, age, capital intensity, real average wage, skill intensity, and exporter, importer and single-product status. Any effects we document are therefore stripped off the influence of a plant's international involvement and its ability to attract a more skilful

[10] For instance, Foster et al. (2008) show that young businesses charge lower prices than their older competitors and they are more physically productive than incumbents.

workforce.

Although we control for these trends and covariates, part of the post-acquisition effect may be due to multinationals' targeting of certain industries or plants with already high levels of productivity, or their superior ability to select promising projects even within narrowly defined industries. In our second exercise, we therefore carry out a matching procedure and include a set of control group plants in (4) based on the matches. This mimics a more traditional difference-in-differences estimation with matching intended to ensure similarity between treated and control plants prior to acquisition. Our control group comes from a propensity score matching procedure on all private domestic plants that were not subject to a foreign takeover following a logit estimation of $Acq_{it}$ on $f(\mathbf{X}_{i,t-1})$, where $\mathbf{X}_{i,t-1}$ now contains TFPQ, price and mark-up in addition to plant-level controls. As such, we select control plants that have similar physical productivity and pricing power to acquired targets. The function $f(.)$ is flexibly specified to accommodate quadratic terms and interactions so that we can better predict acquisitions. We require matches to be selected from the same 4-digit industry-by-year cell and we select five nearest neighbours. Our robustness checks will show that results are immune to different matching specifications. We cluster the standard errors at the plant level for both of our exercises. Results from these two exercises help us isolate the effect of a change in ownership from the effect of selection.

# 4 Results

We briefly discuss our production function estimates before turning to the main results. Table 2 reports the average output elasticities of labour, capital, and materials, and the returns to scale for each industry, alongside standard deviations, which capture variation across plants within an industry. Output elasticities are generally estimated with reasonably small variation. Since we estimate a translog specification, some plants are estimated to have decreasing returns to scale while others have increasing returns to scale. Most sectors have constant returns to scale on average. According to the estimates, the average mark-up is 1.31, which indicates that the average plant in the sample charges a price that is 31 per cent greater than its marginal cost of production spread across its products.[11] This is smaller compared with the median firm-level mark-up of 1.60 reported by De Loecker et al. (2016) for their sample of large Indian manufacturers. It reflects the fact that our sample is the census of Turkish manufacturers, many of which are small- and medium-sized enterprises facing tough competition. The average mark-up is higher for multinationals at 1.45 compared with 1.29 for domestic plants.

We use our production function estimates to create a set of productivity measures as described above. Table B.2 in the online Appendix shows the correlations between the different productivity measures we calculate, output prices, and mark-ups. These correlations are derived from OLS regressions that control for plant size, single-product status, and a full set of industry-by-year fixed effects. Revenue-based productivity is positively correlated with both physical productivity and output prices as expected. It is even more highly correlated with the traditional measure; however, a correlation of 0.72 suggests that part of the variation in measured productivity arises simply from price variation across plants within narrowly defined industries. Plants with higher revenue-based productivity seem to charge lower mark-ups on average. However, this correlation is low and only marginally significant. Larger plants and multi-product plants do charge significantly higher mark-ups and prices. In the data, physical productivity is very strongly and negatively correlated with the average plant-level output price. These are consistent with earlier findings in the literature (Foster et al., 2008) and with more efficient plants having lower marginal costs, which tend to be younger and smaller, charging lower prices.

## 4.1 Foreign acquisitions and plant-level outcomes

Table 3 shows the baseline results of our within-acquired plants estimation of (4).[12] The first column shows that revenue-based productivity (TFPR) at acquired plants rose by 4.4 per cent ($e^{0.043} = 1.044$) above its pre-acquisition level on average. This is a difference that is statistically highly significant. The next two columns reveal much larger impact on the two constituents of TFPR. Physical productivity (TFPQ) at acquired plants rose on average by 30 per cent following acquisitions, while average plant-level prices dropped by 25 per cent in real terms compared with their pre-acquisition levels. Thus, acquisitions by multinationals seem to improve physical

[11] Table B.1 in the Appendix provides summary statistics of all variables used in the analysis.

[12] Estimates on plant-level controls are not reported to conserve space throughout the analysis.

productivity considerably at the same time as having a strong pro-competitive effect of lowering prices. If improvement in physical productivity is matched by similarly declining marginal costs but a smaller decrease in prices, then one would expect mark-ups to go up. Column (4) shows that plant-level mark-ups are on average higher by 0.02 log points in the post-acquisition stage. However, this estimate is both statistically insignificant and economically small. Therefore, multinationals seem to pass on the effect of improved productivity more or less fully to consumers and other plants served by their acquired plants.

These results show that revenue-based productivity measures may greatly underestimate improvements in acquired plants' technical efficiency. Although TFPR and TFPQ are highly correlated, this discrepancy arises because TFPQ is negatively correlated with plant-level output prices, while TFPR is positively correlated with prices. This fact was first observed by Foster et al. (2008) in the context of US data. It is consistent with models where producers set prices and more efficient producers pass along their cost savings through lower prices.[13] In our case, this pass-through is high.

Revenue-based productivity still underestimates true improvements in technical efficiency if we do not take into account within-industry price heterogeneity, capacity utilisation or inventory management. Column (5) shows the result for such a traditional productivity measure (TFPT), which rose by 7.4 per cent following acquisitions. This is higher than the estimate for TFPR. In fact, nearly half of the improvement – $(7.4\% - 4.4\%)/7.4\% = 0.41$ – attributed to a foreign acquisition using a revenue-based measure can be explained by multinationals' advantageous pricing in input and output markets, their higher rates of capacity utilisation, and their superior inventory management. However, it still masks the substantial increase in physical productivity and the corresponding drop in price that goes with it.

How much of the improvement in TFPQ is due to higher capacity utilisation or better management of inventories? In columns (6) and (7), we look at the effects on TFPQ_U and TFPQ_I, which do not control for the role of utilisation and inventory management, respectively. Compared with column (2), we find that physical productivity is little changed when capacity utilisation is neglected. This suggests that multinationals do not necessarily increase working hours or introduce new shifts at a plant following a takeover. However, physical productivity is 7 percentage points higher when inventory management is neglected, which explains around 18 per cent of the variation in physical productivity. Thus, foreign ownership appears to improve the management of the stock of final goods and materials used in production. This result is in line with Braguinsky et al. (2015), who show that acquirers increase productivity and profitability at acquired plants by improving inventory management and lowering the incidence of unrealised output.

#### *4.1.1 Role of ownership structure*

We now test whether these changes are related to the ownership structure of the acquired plant. Table 4 shows results of the within-acquired plants estimation when $Acq_i \times post-Acq_t$ is split

[13] Standard errors for TFPQ and prices are also much greater than those for TFPR, reflecting the fact that TFPQ is more dispersed than TFPR in our data. This fact is documented by both Foster et al. (2008) and Atalay (2014) for US data.

by minority versus majority shareholding by the multinational parent at the time of acquisition. Column (1) shows that TFPR was 5.6 per cent higher than its pre-acquisition level at acquired plants where the foreign owner held a minority share, compared with 1.9 per cent higher at acquired plants with majority foreign ownership. However, TFPR again masks the variation in its underlying components. Column (2) shows that TFPQ in fact rose by 65 per cent on average at plants with majority foreign ownership compared with 15 per cent at plants with minority foreign ownership. Similarly, average plant-level prices dropped by 64 per cent at majority foreign-owned plants compared with 9 per cent at minority foreign-owned plants. Hence, revenue-based productivity underestimates true efficiency gains especially in the case of greater equity financing by multinationals.

Our results suggest that ownership structure also affects the extent to which multinationals pass on the effect of their productivity improvement to their prices. Although estimates are noisy, minority foreign-owned plants seem to reduce their prices by less than they increase physical productivity. Correspondingly, column (4) shows that mark-ups are 3.3 per cent higher at their affiliates following acquisition, while there is hardly any effect on mark-ups at majority foreign-owned plants. Cost savings seem to be fully passed through to prices at majority foreign-owned plants, but only partially at minority foreign-owned plants.

Columns (5)-(7) of Table 4 show the usefulness of working with different measures of efficiency. Working with a traditional productivity measure reveals a small difference between the estimated effect of minority versus majority foreign-owned acquisitions: TFPT rises by 7.8 per cent and 5.9 per cent, respectively. In the absence of more detailed data and estimation, one may therefore wrongly conclude that ownership structure does not matter or that minority-owned acquisitions deliver greater efficiency gains. Comparing with the effects on TFPR in column (1), we see that almost all of the increase in TFPT at majority foreign-owned acquisitions is driven by a combination of within-industry price heterogeneity, capacity utilisation, and inventory management. Column (6) reveals small differences in TFPQ_U compared with TFPQ, while column (7) shows that the post-acquisition effect on TFPQ_I is 8 and 5 percentage points higher for minority and majority foreign-owned acquisitions, respectively (although some results for minority acquisitions are noisy). Altogether, these results suggest that (i) foreign ownership is linked with better management of inventories, especially at minority foreign-owned plants; and (ii) ownership structure is strongly related to pricing behaviour and the main driver of efficiency at majority foreign-owned plants.

### 4.2 Estimates from the matched sample

We next discuss the results of our matching exercise and the difference-in-differences estimates on the matched sample. Table A.1 reports results from a logit estimation of multinational acquisition on all plants in the sample. Multinationals target young domestic plants with relatively higher TFPQ and prices even within narrowly defined industries. The estimate of the quadratic term on price shows that they avoid plants that charge the highest prices. They also seem to target larger plants with lower mark-ups, but they do not seem to target plants based on their skill intensity, exporting and importing activity, or multi-product status. Table A.2 reports the balancing test for 227 acquired plants for which appropriate matches are found. The t-tests indicate that acquired plants are very similar to their matched controls prior to the investment year.[14]

Table 5 reports the results of estimating (4) on the matched sample. We find that acquisitions raise revenue-based productivity measures by around 9 per cent, but the average impacts on physical productivity and prices we identified earlier are no longer there. This suggests that while multinationals' ability to select investment targets does not explain away gains in TFPR or TFPT compared with their domestic counterparts, it can partially explain away gains in TFPQ, which are now positive but not precisely estimated. In line with the logit estimation results, multinationals seem to target domestic plants with particularly favourable trends in physical productivity and prices.

Table 6 shows that this selection effect is driven by ownership structure and primarily by minority foreign-owned acquisitions. While the positive impact of acquisitions on TFPR and TFPT remains for both minority and majority foreign-owned plants, the positive impact on TFPQ measures and the negative impact on prices hold only for the latter group. In fact, our estimates reveal that plants that undergo minority foreign-owned acquisitions experience a slight decrease in TFPQ and a larger increase in prices, which is the main driver of their gains in revenue-based productivity. This suggests that minority-owned acquisitions target firms that are on a downward price trajectory, but they do not lower prices as much as the rest of the plants in the same industry. This also results in a slightly higher mark-up following acquisition. Although results for minority-owned affiliates are not precisely estimated, they are informative in revealing that – once the selection effect is removed – sources of the gains in revenue-based productivity differ by ownership structure.

In contrast with the effects of minority owners, plants with majority foreign ownership experience on average a 49 per cent increase in TFPQ and a 46 per cent decline in output prices compared with their matched domestic counterparts. In light of our earlier estimates from columns (2)-(3) of Table 4, these figures show that selection explains a quarter of the total gains in TFPQ and 28 per cent of the total reduction in prices for majority foreign-owned plants. The remaining variation (which accounts for around three-quarters of the total) in TFPQ and prices can therefore be attributed to the change from domestic owners to majority-owned multinational owners. We continue to find that part of the total gains in TFPQ are explained by multinationals' superior inventory management (as captured by TFPQ_I in column 7), and less so by their capacity utilisation (as captured by TFPQ_U in column 6). Around 13 per cent of the variation in physical productivity at majority-owned plants is accounted for by inventory management. Mark-ups are higher by 0.03 log points after acquisition, which indicates that most of the cost reductions are passed on to buyers.

#### *4.2.1 Robustness*

We carry out two robustness checks on our matching exercise. First, to ensure that acquired plants are not on different productivity and price trends to their matched controls, we complement our

[14] We ensure that our acquisition and control groups are balanced for all the results reported in the following analysis.

logit estimation with the growth rate of TFPQ and price prior to acquisition. This is a more stringent matching procedure and the extra data requirements mean that results of this exercise come from 151 acquisitions for which similar matches can be found. Table 6 shows that our main results remain. Imposing more stringent matching criteria in fact increases the point estimates on the post-acquisition effects of majority-owned plants' TFPQ and prices, while it decreases the estimated effect of minority-owned acquisitions on prices. Selection of targets based on growth in these covariates seems to matter little according to these estimates. The effects on TFPR and TFPT are similar to earlier results, while mark-ups rise by more in this specification even though they are not precisely estimated. As earlier, post-acquisition mark-ups are higher at minority-owned plants than at majority-owned plants.

Second, we match each acquired plant with three control group plants instead of five. Selecting fewer matches is aimed at decreasing the average distance in propensity scores of acquisition between target and control plants, but it increases the chance that we inadvertently select domestic plants that may be in direct competition with multinationals.[15] The risk is that if multinational activity induces negative spillovers to domestic plants in the outcome of interest (and indeed the next section will demonstrate this to be the case for some outcomes), then the stable unit treatment value assumption (SUTVA) that underlies the consistency of propensity score matching estimates may be violated. Balancing tests (unreported) do not point to a meaningful change in the average propensity score between acquired plants and their matched controls when we work with three neighbours instead of five. Table A.4 shows that our coefficient estimates and standard errors are little affected when compared with our estimates from Table 6. It is comforting to find similar results with different sets of matched controls since it is less likely that SUTVA is violated with a greater number of matches, while a smaller number of matches are by definition more similar to acquired plants in the run-up to acquisition.

A potential concern in interpreting our results may be transfer pricing. Multinationals may be tempted to inflate their revenues and profits in Turkey if they face lower corporate taxes there than where they are headquartered. This may lead to a higher estimate of revenue-based productivity and mark-ups (Javorcik and Poelhekke, 2017). Similarly, multinationals may help their Turkish affiliates import inputs at lower intra-group prices, effectively decreasing the cost of materials in production. A switch from domestic to foreign ownership would then overestimate revenue-based productivity and mark-ups. Our results are fairly immune to this issue for several reasons. First, we work with a quantity-based productivity measure and we deflate both inputs and outputs with highly disaggregated product-level deflators. Second, we work with output prices that plants charge their customers and output volumes, and not overall revenue or profit figures that come from balance sheet data. Third, Turkish legislation on transfer pricing follows the arm's-length principle established by the OECD, applicable to all relations between related parties.[16] As a result, multinationals are required to report transactions between associated enterprises at prices that would prevail between unrelated parties. We therefore think that transfer pricing is unlikely to affect our results.

[15] Fewer matches may also come at the cost of higher standard errors due to the reduction in sample size.

[16] See http://www.pwc.com/gx/en/international-transfer-pricing/assets/turkey.pdf.

#### *4.2.2 Mechanisms*

What kind of plant-level changes are related to both ownership structure and differences in productivity and pricing? Our earlier findings indicate that the productivity advantage observed at majority foreign-owned plants is primarily due to their ability to raise physical productivity at the same time as lowering prices. A potential mechanism that can explain this outcome is suggested by Guadalupe et al. (2012), although they do not study ownership structure or pricing power. Instead, they construct a standard model of heterogeneous firms and CES (constant elasticity of substitution) preferences with constant mark-ups, in which multinationals give their affiliates access to technology and export opportunities. Better technology should then raise productivity and lower marginal costs, which implies lower prices under constant mark-ups. This is in line with the findings of Halpern et al. (2015), who document substantial productivity gains from importing and especially under multinational ownership. Even in the absence of importing new technologies, access to export markets can incentivise a plant to invest in technology upgrading (Bustos, 2011) and help achieve economies of scale, both of which would lower marginal costs and prices at home.

Our dataset allows us to test these mechanisms as it contains information on plants' involvement in international trade. In particular, we observe across the panel whether the plant exported any of its output and exports' share in total output, and whether the plant imported any inputs and imports' share in total input consumption. This information is available at the product level and we aggregate up to the plant level to construct the share of exports and imports. We replicate our matching exercise using these measures as our dependent variables.[17]

Table 7 shows the results in columns (1)-(4). Ownership structure affects the extent to which affiliates participate in their parent companies' global network. Compared with their matched domestic counterparts, majority foreign-owned plants are associated with a 7.7 per cent greater likelihood of being an exporter in the post-acquisition stage and they see a 2.7 percentage point increase in the share of exports in total output. However, the latter result is not estimated with enough precision, suggesting that affiliates continue to serve the domestic market primarily even after they start exporting. Majority foreign-owned plants are also 10.3 per cent more likely to be importing at least one intermediate input and the share of imports in their total input consumption rises by 15.6 percentage points following an acquisition. Considering that only 1 in 5 plants in the sample use any imported intermediate inputs, these estimates reflect large economic effects on a plant's access to foreign technology. The results suggest that access to better or cheaper materials through imports plays a more prominent role than greater access to export markets in driving the productivity advantage of majority foreign-owned plants. In contrast, we do not find a statistically significant difference in the exporting and importing patterns of minority foreign-owned plants following an acquisition.

A related mechanism that can explain the increase in physical productivity and drop in prices is innovative activity and changes to product scope. On the one hand, acquired plants may have an incentive to invest in new technologies if the foreign parent brings lower innovation costs

[17] Recall that we identify matched controls based on plants' involvement in trade alongside a host of other variables, so that acquired plants are similar to their matches in terms of exporting and importing activity.

(Guadalupe et al., 2012). On the other hand, multinationals may bring with them brands or licences that allow them to market a new product or they may choose to streamline operations in a few products for cost-efficiency purposes. Column (5) shows whether ownership structure affects the probability of plants becoming multi-product following acquisition. We find that minority foreign-owned plants are 6 per cent less likely to be single-product following acquisition. In other words, they are more likely to introduce new products and expand scope. In light of our earlier findings, however, the introduction of new products by minority foreign-owned affiliates helps increase revenue-based productivity but not technical efficiency. As such, it suggests that minority ownership helps affiliates re-position themselves in the product market. There is no significant change in the single- or multi-product status of majority foreign-owned plants. This suggests that gains in physical productivity or drops in output prices observed after acquisition cannot be explained by changes in product scope, for instance if plants switched to lower-priced products.

# 5 Impact on domestic industry

The previous section documented a strong and negative effect of multinational acquisitions on plant-level output prices, while leading to increases in physical efficiency. This pro-competitive effect is especially strong for acquired plants with majority foreign owners. If the price effect of multinational activity extends beyond acquired plants, then ownership structure may play a much larger role in driving industry dynamics than previously thought. In this section we focus on two mechanisms through which this takes place.

First, we study so-called horizontal spillovers from multinational activity by identifying changes at domestic plants operating within the same industry. On the output side, domestic plants operating in similar product lines as multinational affiliates may be forced into lowering their output prices and raising their physical efficiency in order to survive. This will be the case especially if they compete with majority foreign-owned affiliates. If domestic plants are able to raise their physical productivity by more than the reduction in prices, then we would expect to find positive spillovers in revenue-based productivity within the same industry. Otherwise, domestic plants will experience negative revenue-based productivity growth and suffer drops in profitability. On the input side, greater multinational activity may raise factor prices and lead to negative spillovers in measured productivity even if domestic plants continue to employ the same physical volume of inputs and produce the same level of physical output as before.

Second, we ask whether increased multinational activity induces greater exit of domestic plants in the same industry. We focus especially on the adjustment mechanism operating through output prices. On the one hand, price dispersion across plants reflect variations in demand, with high-demand plants charging higher prices. Such demand variation is shown to be a significant factor in determining survival (Foster et al., 2008). On the other hand, in trade models with firm heterogeneity (Melitz, 2003), more productive firms typically charge lower prices and command larger market shares than less productive firms. Higher prices are then a reflection of relatively less productive domestic plants, which are driven out of industry either through an increase in wages or direct product market competition. Prices therefore reflect both demand and cost factors. Multinational activity may affect domestic plant exit through either channel, so we will use information on price, physical productivity, and mark-ups to differentiate between them.

## 5.1 Intra-industry spillovers

We define industry-level multinational presence, $Horizontal_{jt}$, as the share of multinational affiliates in total industry $j$ employment in year $t$, weighted by each plant $i$'s foreign equity participation to capture the role of ownership structure:

$$Horizontal_{jt} = \left( \sum_{i \in j} FEP_{it} \times Employment_{it} \right) / \sum_{i \in j} Employment_{it} \tag{5}$$

This construction attaches greater weight to multinational affiliates with higher foreign equity stakes in calculating multinational presence in the industry. We take into account both greenfield establishments and plants that came under multinational control through acquisitions in this calculation. Although plants acquired by multinationals are on average larger than those they established as greenfield projects, the latter group also provides direct competition in input and output markets to domestic plants. We calculate the horizontal presence measure for each 4-digit industry and estimate the plant-level model:

$$y_{it} = \beta_0 + \beta_1 Horizontal_{jt} + \beta_2 HHI_{jt} + \beta_3 MS_{it} + \beta_4 Markup_{it} + \beta' \mathbf{X}_{it} + \gamma_i + \delta_t + \psi_j \times \delta_t + \varepsilon_{it} \quad (6)$$

It is important to control for the level of market competition faced by domestic plants in order to isolate spillovers from multinationals. We therefore include a measure of industry-level concentration captured by the Herfindahl-Hirschman Index ($HHI_{jt}$), plant's industry market share ($MS_{it}$), and plant-level mark-ups. As earlier, we include a set of plant controls, 4-digit industry-time trends, and plant and year fixed effects. We estimate (6) on the sample of all manufacturing domestic plants.

Table 8 shows the results of this estimation for revenue-based productivity in column (1), physical productivity in column (2), and prices in column (3). We find that greater presence of multinationals in an industry is associated with a negative, but economically small, impact on TFPR of domestic plants in the same industry. The point estimate suggests that moving a hypothetical domestic plant from an industry in the 25th percentile of the distribution in multinational presence to an industry in the 75th percentile – which corresponds to an increase in $Horizontal$ by 5 percentage points – reduces its revenue productivity by 0.3 per cent on average. This effect is small but precisely estimated; however, it again masks the large variation in physical productivity and prices induced by multinational activity. The same hypothetical plant in fact sees a reduction in its average output price by 4.3 per cent, while it sees an increase in its physical productivity by 4.1 per cent. The spillover effect on TFPQ is therefore larger by an order of magnitude than the effect on TFPR. Our results in column (4) do not reveal a significant association between multinational presence and domestic plants' mark-ups, indicating that competition from multinationals forces domestic plants to pass on their cost reductions from productivity improvements to their buyers.

How important are these spillovers from multinationals in explaining productivity growth at domestic plants? The share of employment at multinational affiliates in Turkish manufacturing rose by 2.2 percentage points over the sample period as measured by (5). Our physical productivity estimates indicate that TFPQ at the average domestic plant increased by 0.17 log units (or by 0.18 if we weight plants by their real output). Using our spillover estimate of 0.8114 from column (2) of Table 8, these figures mean that spillovers from multinational activity accounted for 10 per cent of physical productivity growth at domestic plants over the sample period. This is a large effect considering that multinationals often constitute less than 4 per cent of plants in an average industry. Moreover, it is a considerably larger effect than what one obtains working with revenue-based productivity. Our estimates suggest that average TFPR at domestic plants in fact decreased by 0.06 log units during the sample period and multinational activity accounted for 2 per cent of that decline.

These results suggest that horizontal spillovers documented in previous literature miss the impact of multinationals on domestic plants that operates through the pro-competitive channel. They further trace the existence of negative spillovers in revenue productivity to the finding that domestic plants are unable to increase their physical productivity by as much as the reduction in their output prices. This resonates with the market-stealing effect of multinationals in the product markets, but it could also come about via an increase in industry-level wages. In order to test whether the latter is at work, we estimate (6) with average plant wages as our outcome. The last column of Table 8 shows that greater multinational activity is in fact correlated with lower average real wages at domestic plants in the same industry. However, this negative effect is small. Point estimates suggest that it is limited to 1 per cent of the average real wage for domestic workers going from the 25th percentile of the distribution in multinational presence to an industry in the 75th percentile. In any case, evidence points to product market competition rather than labour market competition as the main driver behind industrial restructuring.

### 5.2 Selection and reallocation

Multinational activity may impact on aggregate productivity through selection of relatively more productive plants for survival and the subsequent reallocation of production factors. It is important to control for plant attributes related to chances of survival when documenting how multinationals affect this type of industrial restructuring. We therefore start by regressing a plant-level exit indicator on our measures of productivity, prices and mark-ups to identify the determinants of plant survival. We then interact these with the horizontal presence measure in (5) to document whether multinational activity toughens competition and reinforces the selection mechanism. In particular, we estimate the following linear probability model of domestic plant exit on productivity and prices:[18]

$$Exit_{i,t+1} = \beta_0 + \beta_1 y_{it} + \beta_2 Horizontal_{jt} \times y_{it} + \beta' \mathbf{X}_{it} + \psi_{jt} + \varepsilon_{it} \quad (7)$$

This specification controls for a full set of 4-digit industry-by-time fixed effects, $\psi_{jt}$, which subsumes $Horizontal_{jt}$ and helps us isolate the effect of plant-specific attributes on the likelihood of exit. As before, we control for a set of plant-level covariates, $\mathbf{X}_{it}$. This includes capital stock, which reflects persistent components of survival because it captures accumulated effects of a plant's past profitability draws (Foster et al., 2008), alongside other variables such as a plant's involvement in international trade. Hence, our estimates reflect the short-run determinants of plant survival in the face of multinational competition.[19]

Table 9 presents baseline results, which exclude the interaction term in (7). We find that plants with lower revenue-based productivity, either measured by TFPR or TFPT, are more likely to

[18] A probit model (unreported) returns very similar results.

[19] In unreported results, we estimated (9) without plant-level controls, $\mathbf{X}_{it}$, and found our estimates on the effect of productivity, prices and mark-ups to be larger, which would capture long-run determinants of survival.

exit in the next period. A one-standard-deviation increase each in TFPR and TFPT is associated respectively with a decline in exit probabilities of 1.1 and 0.3 percentage points. TFPR therefore has a considerably larger impact on survival prospects than TFPT. This implies that price heterogeneity within industries, which is unaccounted for in TFPT, plays an important role in determining survival and is a potentially omitted variable in column (2).

We find that plant-level TFPQ or prices are not strongly associated with the likelihood of exit when included in (7) on their own, but they are both very strongly related to exit probabilities when included together. This is expected given the strong correlation between TFPQ and prices. When only one of these measures is included, the implied omitted variable bias obscures the true effect of each measure (Foster et al., 2008). When included together, our estimates imply that both higher TFPQ and higher prices are associated with lower likelihood of exit. Plants with higher TFPQ and therefore lower cost are more likely to survive; a unit increase in TFPQ lowers the probability of exit by close to 7 percentage points. Controlling for TFPQ, the estimated impact of price brings out plant-specific demand factors, which affect the likelihood of exit in a similar magnitude as TFPQ. Plants facing higher demand for their products are more likely to survive. Our estimates indicate that plants with higher mark-ups – likely reflecting higher demand again – are also more likely to survive, but this result is not precisely estimated.

Table 10 presents results with the interaction term included in (7), which show how productivity and prices affect exit probabilities in the presence of multinationals. A unit increase in TFPR raises a domestic plant's chances of survival by 11 percentage points in industries with no multinational presence, while the same TFPR increase raises chances of survival by 5 percentage points if a tenth of industry workers are employed by multinationals. This indicates that a higher TFPR does not always guarantee survival in the presence of multinationals and points at tougher competition. The impact of TFPT on exit probabilities does not seem to change significantly by multinational presence, thereby masking the role of price variation in determining survival.

Indeed, we continue to find that both TFPQ and prices are strong determinants of survival when they are jointly estimated, but their impacts vary by multinational presence. A unit increase in either TFPQ or prices raises a domestic plant's chances of survival by 9 percentage points in industries with no multinationals, but the same increase raises chances of survival by 4 percentage points if multinationals employ 10 per cent of the industry workforce. This suggests that exiting domestic plants in industries with higher foreign presence are more likely to have higher TFPQ and charge higher prices than surviving domestic plants. As a result, industries with greater multinational presence are more likely to see a reallocation of economic activity towards domestic plants with relatively higher levels of physical productivity and lower prices.

Finally, our results indicate that plant-level mark-ups are not correlated with the likelihood of exit in an economically meaningful size, even for domestic plants operating in industries with a large multinational presence. In such industries, for instance when half the industry workforce is employed by multinationals, a 10 per cent rise in a domestic plant's mark-up is associated with only a 0.2 percentage point rise in chances of survival. To the extent that mark-ups capture the variation in demand faced by domestic plants, this result indicates that demand may not play as strong a role as productivity in determining plant survival when competing with multinationals. In other words, selection appears to be driven by cost efficiency rather than market power.

# 6 Conclusion

We know relatively little about ownership structures at multinational affiliates and how they translate into economic outcomes at the firm and industry level. In this paper we used a unique dataset to provide evidence on how ownership structure at multinational affiliates affects a number of important economic outcomes at recipient plants and the rest of the industry. We showed that multinationals target plants with relatively high levels of productivity and demand, but their post-acquisition impact differs by ownership structure. While majority foreign-owned affiliates increase revenue-based productivity by raising their physical productivity, minority foreign-owned affiliates increase revenue-based productivity through relatively higher prices. We document a pro-competitive effect of majority foreign ownership, which leads to reductions in output prices following acquisition with no concurrent change in mark-ups. Our findings suggest that majority owners increase their affiliates' access to imported inputs and ability to export, which enables them to charge lower prices.

These findings have important implications for the evolution of aggregate productivity and the role multinational activity plays in driving it. Separating the impact on revenue-based productivity into a physical productivity component and prices reveals that the effects of foreign direct investment on productivity growth may be previously underestimated. Ownership structure is linked to foreign affiliates' ability to lower prices and affect market shares, which leads to tighter selection of domestic plants for survival. Domestic plants that compete in the same product markets with multinationals had to raise their technical efficiency in order to survive. Our back-of-the-envelope calculations show that multinational activity accounted for 10 per cent of physical productivity growth at domestic plants in Turkish manufacturing over the sample period.

Our findings have implications for theoretical models in the literature. As Atalay (2014) notes, if variation in the traditionally used revenue productivity is driven by technical efficiency, then models of learning-by-doing, innovation, and management practices may be particularly relevant, but if productivity differences are instead driven by price dispersion across plants, then models of market structure would be more salient. Our results point to the possibility of both types of models being relevant, but perhaps dependent on ownership structure. This has a bearing on the interaction between sources of productivity growth in domestic industry and multinational activity. Future empirical and theoretical research can shed light on the details of this interaction.

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## Tables

Table 1: **Multinationals in Turkish manufacturing**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Number of plants by ownership:* | | | | | | | | | | | |
| Multinational | 234 | 257 | 301 | 312 | 326 | 335 | 378 | 417 | 424 | 436 | 442 |
| Minority-owned | 120 | 132 | 145 | 153 | 153 | 160 | 191 | 211 | 207 | 208 | 192 |
| Majority-owned | 114 | 125 | 156 | 159 | 173 | 175 | 187 | 206 | 217 | 228 | 250 |
| Domestic | 5,096 | 5,717 | 10,266 | 9,815 | 9,903 | 10,255 | 10,987 | 11,904 | 10,838 | 10,678 | 10,869 |
| *Share of multinational plants in total:* | | | | | | | | | | | |
| Employment | 0.12 | 0.12 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.13 |
| Output | 0.21 | 0.21 | 0.23 | 0.20 | 0.22 | 0.22 | 0.22 | 0.21 | 0.22 | 0.24 | 0.24 |
| *Multinational investments by mode of entry:* | | | | | | | | | | | |
| Acquisitions | 26 | 17 | 27 | 28 | 26 | 28 | 29 | 31 | 33 | 31 | 32 |
| Minority-owned | 16 | 12 | 15 | 16 | 15 | 17 | 19 | 20 | 21 | 19 | 16 |
| Majority-owned | 10 | 5 | 12 | 12 | 11 | 11 | 10 | 11 | 12 | 12 | 16 |
| Greenfield | 21 | 28 | 34 | 9 | 20 | 22 | 48 | 40 | 20 | 21 | 32 |
| Minority-owned | 6 | 13 | 8 | 5 | 9 | 14 | 26 | 22 | 9 | 8 | 12 |
| Majority-owned | 15 | 15 | 26 | 4 | 11 | 8 | 22 | 18 | 11 | 13 | 20 |
| *Divestments by multinationals:* | | | | | | | | | | | |
| Domestic sale | 31 | 12 | 13 | 12 | 22 | 29 | 20 | 22 | 21 | 22 | 44 |
| Shutdown | 6 | 7 | 8 | 7 | 9 | 18 | 18 | 25 | 20 | 16 | - |

Notes: A multinational plant is defined as any plant with a positive share of foreign equity. Acquisitions indicate plants sold by domestic owners to multinationals. Greeenfield indicates plants newly established by multinationals. Domestic sale indicates plants sold by multinationals to domestic owners. Shutdown indicates plant closures by multinationals in the next period; it is not defined for 2001 as we do not observe data for 2002.
Source: Author's calculations.

Table 2: **Average output elasticities**

| Sector | | Observations | Labour | Capital | Materials | RTS |
|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) |
| 31 | Food, beverages, and tobacco | 3,428 | 0.27 | 0.05 | 0.71 | 1.03 |
| | | | [0.05] | [0.03] | [0.05] | [0.04] |
| 32 | Textile, wearing apparel and leather | 5,781 | 0.23 | 0.04 | 0.73 | 1.00 |
| | | | [0.06] | [0.02] | [0.05] | [0.06] |
| 33 | Wood and wood products, incl. furniture | 825 | 0.26 | 0.07 | 0.68 | 1.02 |
| | | | [0.10] | [0.03] | [0.10] | [0.06] |
| 34 | Paper and paper products, printing and publishing | 1,157 | 0.27 | 0.08 | 0.67 | 1.01 |
| | | | [0.12] | [0.03] | [0.10] | [0.02] |
| 35 | Chemicals, petroleum, coal, rubber and plastic products | 2,794 | 0.32 | 0.06 | 0.67 | 1.06 |
| | | | [0.13] | [0.05] | [0.10] | [0.05] |
| 36 | Non-metallic mineral products | 3,023 | 0.48 | 0.06 | 0.50 | 1.04 |
| | | | [0.10] | [0.04] | [0.06] | [0.16] |
| 37 | Basic metal industries | 1,076 | 0.31 | 0.04 | 0.79 | 1.14 |
| | | | [0.17] | [0.06] | [0.25] | [0.10] |
| 38 | Fabricated metal products, machinery and equipment | 7,581 | 0.37 | 0.09 | 0.62 | 1.08 |
| | | | [0.05] | [0.05] | [0.07] | [0.05] |
| 39 | Other manufacturing | 438 | 0.37 | 0.07 | 0.57 | 1.01 |
| | | | [0.20] | [0.05] | [0.11] | [0.13] |

Notes: This table reports average output elasticities by sector for our baseline production function estimation. Column 1 reports the number of observations included in each estimation. Columns 2-4 report average output elasticities $\theta^L$, $\theta^K$ and $\theta^M$ derived from the translog production function across all plants; standard deviations are reported in brackets. Column 5 reports the average returns to scale.
Source: Author's calculations.

Table 3: **Impact of acquisitions on plant-level efficiency**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | TFPT | TFPQ_U | TFPQ_I |
| Acquired×post-acquisition | 0.0426*** | 0.2680* | -0.2259* | 0.0191 | 0.0714*** | 0.2708** | 0.3197** |
| | (0.0081) | (0.1366) | (0.1367) | (0.0335) | (0.0061) | (0.1371) | (0.1375) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.36 | 0.07 | 0.07 | 0.06 | 0.46 | 0.07 | 0.07 |
| $N$ | 2,480 | 2,067 | 2,067 | 2,479 | 2,482 | 2,067 | 2,068 |

Notes: This table reports within-acquired plant estimation results of (4). The sample consists of plants subject to a foreign acquisition during the sample period. Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table 4: **Impact of ownership structure on plant-level efficiency**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | TFPT | TFPQ_U | TFPQ_I |
| Minority-owned×post-acquisition | 0.0545*** | 0.1481 | -0.0865 | 0.0327 | 0.0754*** | 0.1448 | 0.2112 |
| | (0.0096) | (0.1686) | (0.1696) | (0.0456) | (0.0080) | (0.1694) | (0.1677) |
| Majority-owned×post-acquisition | 0.0192* | 0.5042** | -0.4996** | 0.0048 | 0.0575*** | 0.5151*** | 0.5310*** |
| | (0.0112) | (0.1965) | (0.1959) | (0.0450) | (0.0089) | (0.1963) | (0.1992) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.36 | 0.07 | 0.07 | 0.06 | 0.45 | 0.07 | 0.07 |
| $N$ | 2,480 | 2,067 | 2,067 | 2,479 | 2,482 | 2,067 | 2,068 |

Notes: This table reports within-acquired plant estimation results of (4) when $Acq_i \times post - Acq_t$ is split by minority versus majority ownership by the foreign parent at the time of acquisition. The sample consists of plants subject to a foreign acquisition during the sample period. Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table 5: **Difference-in-differences estimates for the impact of acquisitions on plant-level efficiency**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | TFPT | TFPQ_U | TFPQ_I |
| Acquired×post-acquisition | 0.0803*** | 0.0634 | 0.0059 | 0.0406 | 0.0994*** | 0.0686 | 0.1100 |
| | (0.0072) | (0.1082) | (0.1088) | (0.0310) | (0.0060) | (0.1087) | (0.1083) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.39 | 0.03 | 0.03 | 0.04 | 0.43 | 0.03 | 0.03 |
| $N$ | 9,395 | 8,340 | 8,339 | 9,394 | 9,397 | 8,340 | 8,340 |

Notes: This table reports results of (4) estimated on a sample that consists of plants acquired by multinationals and their matched controls. For each acquired plant five matches are selected from plants that remain under domestic ownership throughout the sample period, from the same 4-digit ISIC industry and year cell, and following a flexible specification of plant-time-variant variables (see Table A.1). Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. Source: Author's calculations.

Table 6: **Difference-in-differences estimates for the impact of ownership structure on plant-level efficiency**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | TFPT | TFPQ_U | TFPQ_I |
| Minority-owned×post-acquisition | 0.0776*** | -0.1135 | 0.1877 | 0.0402 | 0.0954*** | -0.1151 | -0.0715 |
| | (0.0089) | (0.1566) | (0.1579) | (0.0461) | (0.0079) | (0.1577) | (0.1561) |
| Majority-owned×post-acquisition | 0.0479*** | 0.3998** | -0.3805* | 0.0289 | 0.0764*** | 0.4090** | 0.4474** |
| | (0.0137) | (0.2005) | (0.2002) | (0.0501) | (0.0111) | (0.2009) | (0.2005) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.37 | 0.03 | 0.03 | 0.04 | 0.41 | 0.03 | 0.03 |
| $N$ | 9,395 | 8,340 | 8,339 | 9,394 | 9,397 | 8,340 | 8,340 |

Notes: This table reports results of (4) when $Acq_i \times post - Acq_t$ is split by minority versus majority ownership by the foreign parent at the time of acquisition, estimated on a sample that consists of plants acquired by multinationals and their matched controls. For each acquired plant five matches are selected from plants that remain under domestic ownership throughout the sample period, from the same 4-digit ISIC industry and year cell, and following a flexible specification of plant-time-variant variables (see Table A.1). Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table 7: **Mechanisms: impact of ownership structure on plant-level changes**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Dependent variable: | Exporter | Share of exports | Importer | Share of imported inputs | Single-product |
| Minority-owned×post-acquisition | -0.0425 | 0.0132 | -0.0300 | 0.0331 | -0.0599* |
| | (0.0341) | (0.0242) | (0.0357) | (0.1184) | (0.0330) |
| Majority-owned×post-acquisition | 0.0774* | 0.0271 | 0.1031** | 0.1558* | 0.0328 |
| | (0.0455) | (0.0224) | (0.0464) | (0.0856) | (0.0416) |
| Year effects | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.03 | 0.03 | 0.04 | 0.02 | 0.06 |
| $N$ | 9,406 | 9,404 | 9,406 | 9,405 | 9,406 |

Notes: This table reports results of (4) when $Acq_i \times post - Acq_t$ is split by minority versus majority ownership by the foreign parent at the time of acquisition, estimated on a sample that consists of plants acquired by multinationals and their matched controls. For each acquired plant five matches are selected from plants that remain under domestic ownership throughout the sample period, from the same 4-digit ISIC industry and year cell, and following a flexible specification of plant-time-variant variables (see Table A.1). Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, and single-product status for columns (1)-(4), and additionally exporter and importer status for column (5), which excludes single-product status as a control. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table 8: **Horizontal spillovers to domestic plants**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | Wages |
| | | | | | |
| Multinational presence | -0.0458*** | 0.8114* | -0.8620* | 0.0304 | -0.2200*** |
| | (0.0177) | (0.4728) | (0.4715) | (0.1416) | (0.0820) |
| Industry HHI | -0.2647*** | 0.6218 | -0.5805 | 0.6136** | -0.1822 |
| | (0.0418) | (1.1447) | (1.1399) | (0.2835) | (0.1765) |
| Market share | 0.2105*** | 0.2709 | -0.2025 | -0.7982*** | -0.4444** |
| | (0.0584) | (0.9587) | (0.9511) | (0.2975) | (0.2112) |
| Mark-up | -0.0015** | -0.2724*** | 0.2767*** | | 0.0160*** |
| | (0.0008) | (0.0222) | (0.0225) | | (0.0022) |
| | | | | | |
| Year effects | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.38 | 0.04 | 0.04 | 0.02 | 0.36 |
| $N$ | 96,988 | 75,672 | 75,429 | 96,988 | 96,988 |

Notes: This table reports results from estimating (6) on a sample of domestic plants. Multinational presence is measured as in (5). HHI stands for the Herfindahl-Hirschman Index. Mark-up is measured in logs. Market share is a plant's share of employment in a 4-digit industry. Industry trends are included for ISIC 4-digit industries. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Column (4) excludes average real wage and column (5) excludes mark-up from controls. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table 9: **Domestic plant exit, productivity and prices**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent variable: | $y = 1$ if plant exits next period, 0 otherwise | | | | | |
| TFPR | -0.0736*** | | | | | |
| | (0.0116) | | | | | |
| TFPT | | -0.0221* | | | | |
| | | (0.0119) | | | | |
| TFPQ | | | -0.0003 | | -0.0667*** | |
| | | | (0.0003) | | (0.0121) | |
| Price | | | | 0.0002 | -0.0664*** | |
| | | | | (0.0003) | (0.0121) | |
| Mark-up | | | | | | -0.0010 |
| | | | | | | (0.0015) |
| Industry × year effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| $N$ | 86,782 | 86,732 | 68,325 | 68,244 | 68,113 | 86,748 |

Notes: This table reports linear probability estimation results of (7) without the interaction term on a sample of domestic plants. All variables are measured in logs. A full set of industry-by-year effects is included for ISIC 4-digit industries. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table 10: **Domestic plant exit, productivity and prices in the presence of multinationals**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent variable: | | | $y = 1$ if plant exits next period, 0 otherwise | | | |
| TFPR | -0.1065*** | | | | | |
| | (0.0136) | | | | | |
| TFPR × multinational presence | 0.5525*** | | | | | |
| | (0.0984) | | | | | |
| TFPT | | -0.0251* | | | | |
| | | (0.0138) | | | | |
| TFPT × multinational presence | | 0.0477 | | | | |
| | | (0.1281) | | | | |
| TFPQ | | | -0.0003 | | -0.0939*** | |
| | | | (0.0004) | | (0.0143) | |
| TFPQ × multinational presence | | | -0.0009 | | 0.4702*** | |
| | | | (0.0039) | | (0.1088) | |
| Price | | | | 0.0001 | -0.0937*** | |
| | | | | (0.0004) | (0.0144) | |
| Price × multinational presence | | | | 0.0018 | 0.4712*** | |
| | | | | (0.0039) | (0.1082) | |
| Mark-up | | | | | | 0.0008 |
| | | | | | | (0.0018) |
| Mark-up × multinational presence | | | | | | -0.0426** |
| | | | | | | (0.0208) |
| Industry × year effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| $N$ | 86,782 | 86,732 | 68,325 | 68,244 | 68,113 | 86,748 |

Notes: This table reports linear probability estimation results of (7) on a sample of domestic plants. Multinational presence is measured as in (5). All variables are measured in logs. A full set of industry-by-year effects is included for ISIC 4-digit industries. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

## A. Appendix

This Appendix contains additional results mentioned in the text.

Table A.1: **Predicting acquisitions by multinationals**

| Dependent variable: | $y = 1$ if acquired by a multinational, 0 otherwise | | |
|---|---|---|---|
| TFPQ | 0.0461*** | Employment | 0.0041** |
| | (0.007) | | (0.0019) |
| $TFPQ^2$ | 0.0011*** | $Employment^2$ | -0.0003 |
| | (0.0003) | | (0.0002) |
| TFPQ × plant age | -0.0086*** | Capital intensity | 0.0006*** |
| | (0.0023) | | (0.0002) |
| Price | 0.0463*** | Capital $intensity^2$ | -0.00004*** |
| | (0.0071) | | (0.00002) |
| $Price^2$ | -0.0011*** | Average wage | -0.0014 |
| | (0.0003) | | (0.0013) |
| Price × plant age | -0.0086*** | Average wage × plant age | 0.0018*** |
| | (0.0023) | | (0.0005) |
| Mark-up | -0.0024 | Skill intensity | 0.0088 |
| | (0.0015) | | (0.0056) |
| $Mark\text{-}up^2$ | -0.0003 | Skill $intensity^2$ | -0.0060 |
| | (0.0002) | | (0.0066) |
| Mark-up × plant age | 0.0013** | Share of exports | -0.0002 |
| | (0.0006) | | (0.0012) |
| Plant age | -0.0052*** | Share of imported inputs | -0.00005 |
| | (0.0019) | | (0.0002) |
| Plant $age^2$ | -0.0008** | Single-product status | 0.0003 |
| | (0.0004) | | (0.0007) |
| Pseudo-$R^2$ | | 0.17 | |
| $N$ | | 50,603 | |

Notes: This table reports logit estimation results of foreign acquisitions; marginal effects evaluated at the mean are reported. 4-digit industry and year fixed effects are included. All variables are in logs except skill intensity, share of exports, share of imported inputs, and single-product status. Standard errors are given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table A.2: **Balancing test of the nearest-neighbour matching exercise**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Matched sample: | Acquisitions | Controls | *t*-test | *p*-value |
| TFPQ | -0.3194 | -0.4344 | 0.35 | 0.73 |
| Price | 0.4355 | 0.5093 | -0.23 | 0.82 |
| Mark-up | 0.3935 | 0.3748 | 0.31 | 0.76 |
| Age | 2.4791 | 2.5703 | -1.15 | 0.25 |
| Employment | 4.8918 | 4.8465 | 0.40 | 0.69 |
| Capital intensity | 5.0562 | 4.9668 | 0.50 | 0.62 |
| Average wage | 4.2851 | 4.1983 | 1.12 | 0.26 |
| Skill intensity | 0.3022 | 0.2835 | 1.07 | 0.28 |
| Share of exports | 0.1382 | 0.1379 | 0.01 | 0.99 |
| Share of imported inputs | 0.2552 | 0.2778 | -0.13 | 0.90 |
| Single-product status | 0.3973 | 0.3777 | 0.43 | 0.67 |

Notes: This table reports t-tests of equality of means for variables used in the logit estimation for predicting acquisitions (see Table A.1) after constructing our nearest-neighbour control group. Column (1) reports means for foreign acquisitions; column (2) reports means for their matched controls; and columns (3)-(4) report the results of a t-test between the two groups. All variables are in logs except skill intensity, share of exports, share of imported inputs, and single-product status. The control group is formed by plants that remained under domestic ownership throughout the sample period, from the same 4-digit ISIC industry and year cell, and following a flexible specification of plant-time-variant variables (see Table A.1).
Source: Author's calculations.

Table A.3: **Robustness check: controlling for pre-acquisition trends in TFPQ and price**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | TFPT | TFPQ_U | TFPQ_I |
| Minority-owned×post-acquisition | 0.0860*** | 0.0382 | 0.0445 | 0.0729 | 0.1025*** | 0.0328 | 0.0692 |
| | (0.0103) | (0.1739) | (0.1757) | (0.0503) | (0.0094) | (0.1755) | (0.1744) |
| Majority-owned×post-acquisition | 0.0437*** | 0.5101** | -0.4683* | 0.0417 | 0.0657*** | 0.5218** | 0.5719** |
| | (0.0144) | (0.2417) | (0.2415) | (0.0596) | (0.0111) | (0.2424) | (0.2372) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.34 | 0.03 | 0.03 | 0.04 | 0.39 | 0.03 | 0.03 |
| $N$ | 7,238 | 6,611 | 6,611 | 7,237 | 7,239 | 6,611 | 6,610 |

Notes: This table reports results of (4) when $Acq_i \times post-Acq_t$ is split by minority versus majority ownership by the foreign parent at the time of acquisition, estimated on a sample that consists of plants acquired by multinationals and their matched controls. For each acquired plant five matches are selected from plants that remain under domestic ownership throughout the sample period, from the same 4-digit ISIC industry and year cell, and following a flexible specification of plant-time-variant variables (see Table A.1) including the growth rate of TFPQ and price in the run-up to acquisition. Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

Table A.4: **Robustness check: matching with three nearest neighbours**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable: | TFPR | TFPQ | Price | Mark-up | TFPT | TFPQ_U | TFPQ_I |
| Minority-owned×post-acquisition | 0.0770*** | -0.1012 | 0.1801 | 0.0430 | 0.0934*** | -0.1015 | -0.0609 |
| | (0.0091) | (0.1549) | (0.1563) | (0.0465) | (0.0079) | (0.1559) | (0.1537) |
| Majority-owned×post-acquisition | 0.0472*** | 0.3993** | -0.3749* | 0.0307 | 0.0746*** | 0.4076** | 0.4383** |
| | (0.0139) | (0.1995) | (0.1994) | (0.0504) | (0.0109) | (0.1994) | (0.1994) |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Age and size trends | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Plant-level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.36 | 0.04 | 0.04 | 0.05 | 0.41 | 0.05 | 0.04 |
| $N$ | 6,916 | 6,208 | 6,208 | 6,915 | 6,920 | 6,208 | 6,209 |

Notes: This table reports results of (4) when $Acq_i \times post - Acq_t$ is split by minority versus majority ownership by the foreign parent at the time of acquisition, estimated on a sample that consists of plants acquired by multinationals and their matched controls. For each acquired plant three matches are selected from plants that remain under domestic ownership throughout the sample period, from the same 4-digit ISIC industry and year cell, and following a flexible specification of plant-time-variant variables (see Table A.1). Industry trends are included for ISIC 4-digit industries. Age and size trends are included for four categories each (see text). Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's calculations.

## B. Online appendix

### *B.1 Data appendix*

This section provides a detailed description of the dataset used in the paper. All data come from TurkStat's Industrial Analysis database and are available in a machine-readable format at TurkStat's premises in Turkey. The database provides information on plants with more than 20 employees for 1990-92 and plants with more than 10 employees for 1993-2001, which is a close approximation of the universe of Turkish plants in manufacturing. All variables in the dataset are measured in 1993 prices (in millions of Turkish liras). Product-level data are provided at the level of TurkStat's national product classification, which classifies products into more than 2,900 categories at the 8-digit level, with the first four digits referring to the ISIC Rev. 2. Inclusion of firm identification codes allows us to match the plant-level data to the product-level data, which include information on intermediate inputs and final products.

We measure labour input in annual production-worker hours for our production function estimation. In the raw data, for each production shift we observe the average number of workers employed, number of employment days in a year, and the length of the shift in hours. The product of these variables summed across the shifts gives us total annual production-worker hours. We adjust labour hours following (Foster et al., 2008) by multiplying them by the ratio of the total payroll to payroll for production workers.

### *B.2 Product-level data*

We use unit values obtained by dividing total value of production (consumption for inputs) by the total quantity of production (consumption for inputs) as our measure of prices. Misreporting in the data may generate prices that are far from accurate. For instance, a plant may report production in kilograms while another may report in tonnes. In order to guard against this, we first make the necessary decimal adjustments to reported quantities by using information on the units of measure included with each observation. This ensures that all observations relating to a product are expressed in terms of the same physical unit of measure. Second, when we calculate the revenue- or cost-weighted geometric mean to construct our product-specific deflators, we exclude from this calculation prices that show a drop less than -25 per cent or a rise greater than 500 per cent. Turkey experienced particularly high levels of inflation during the sample period, which ranged from 39 per cent to 99 per cent annually, so large year-on-year price changes are not uncommon in the data. We use the product-specific deflators we construct in this way for inputs and outputs separately to arrive at the real values of consumption and production.

It is possible that new products enter the database later in the sample period. For products that enter the database after 1990, we are not able to create a product-specific deflator that allows us to translate prices in later years to a common 1993 basis. This affects less than 10 per cent of the plant-product-year observations. We deflate these observations with the 4-digit industry-level deflator. The implicit assumption here is that any new products follow the same price trend as the remaining products within the 4-digit industry over the sample period. This seems reasonable as the 4-digit industry classification spans 85 distinct industries, which is fairly disaggregate.

There is one final issue to tackle, which concerns observations for which physical quantity is not reported but total value is. Plants that report no physical quantity in any given year for any final product are excluded from the analysis, since we are unable to calculate TFPQ for such plants. These plants account for 8 per cent of total manufacturing sales on average in a given year. If the plant reports quantity information for some products but not others, then we calculate the firm-level revenue-weighted average price using only the available information. This is a safe assumption as long as the product without the quantity information has a low share of the revenue or its real price is close to the real price of the plant's remaining products. As a robustness check, we further exclude plants that do not report full information on quantities and find our results to be unchanged (available upon request).

### *B.3 Additional tables*

Table B.1: **Summary statistics**

| | Mean | Median | Standard deviation | Inter-quartile range | Observations |
|---|---|---|---|---|---|
| TFPR | -0.0134 | -0.0038 | 0.1506 | 0.1193 | 97,099 |
| TFPQ | 0.3566 | 0.2434 | 3.3982 | 5.2331 | 75,760 |
| Price | -0.3652 | -0.2325 | 3.3914 | 5.1957 | 77,768 |
| Mark-up | 0.2671 | 0.1553 | 0.7295 | 0.5598 | 97,051 |
| TFPT | 0.0053 | -0.0031 | 0.1166 | 0.1211 | 97,081 |
| TFPQ_U | 0.3093 | 0.1678 | 3.3987 | 5.2323 | 75,760 |
| TFPQ_I | 0.3154 | 0.2037 | 3.3987 | 5.2204 | 75,750 |
| Multinational presence | 0.0503 | 0.0231 | 0.0716 | 0.0473 | 115,698 |
| Inventory to sales | 0.1380 | 0.0260 | 5.8357 | 0.1036 | 115,619 |
| Labour | 3.8189 | 3.6109 | 1.1223 | 1.4469 | 115,698 |
| Capital intensity | 3.8458 | 3.9569 | 1.7839 | 2.1538 | 111,078 |
| Average wage | 3.5627 | 3.4427 | 0.6922 | 0.8748 | 115,696 |
| Skill intensity | 0.1866 | 0.1489 | 0.1611 | 0.1784 | 115,698 |
| Age | 2.2694 | 2.3026 | 0.9071 | 1.0986 | 115,697 |
| Exporter | 0.1767 | 0 | 0.3814 | 0 | 115,698 |
| Importer | 0.1907 | 0 | 0.3929 | 0 | 115,698 |
| Single-product | 0.5721 | 1 | 0.4948 | 1 | 101,017 |
| Share of exports | 0.0627 | 0 | 0.1950 | 0 | 115,453 |
| Share of imported inputs | 0.0585 | 0 | 0.1749 | 0 | 115,453 |

Notes: All variables in logs except inventory to sales, skill intensity, exporter, importer, single-product, share of exports, and share of imports.
Source: Author's calculations.

Table B.2: **Correlations of plant characteristics**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent variable: | TFPQ | Output price | Mark-up | TFPT |
| TFPR | 0.5148** | 0.4795** | -0.0762 | 0.7189*** |
| | (0.2013) | (0.2016) | (0.0484) | (0.0185) |
| Employment | -0.2049*** | 0.2053*** | 0.0597*** | 0.0191*** |
| | (0.0210) | (0.0210) | (0.0035) | (0.0009) |
| Single-product | 0.2602*** | -0.2597*** | -0.0240*** | -0.0005 |
| | (0.0396) | (0.0396) | (0.0064) | (0.0010) |
| Industry $\times$ year effects | Yes | Yes | Yes | Yes |
| $R^2$ | 0.33 | 0.32 | 0.22 | 0.61 |
| $N$ | 75,760 | 75,516 | 97,051 | 96,992 |

Notes: This table reports pairwise correlations between revenue-based productivity and other plant-level productivity measures, output prices and mark-ups. All variables are measured in logs except for single-product. A full set of industry-by-year effects is included for ISIC 4-digit industries.
Source: Author's calculations.