Ownership Structure and Productivity of Multinationals

Çağatay Bircan*
European Bank for Reconstruction and Development

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Abstract

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 prices and markups. Upon acquisition they raise physical productivity but lower prices, leaving markups unchanged, especially when they are majority owners. This pro-competitive effect means that multinationals' productivity effects may be previously under-estimated. Multinational presence in an industry 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.

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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. However, evidence is inconclusive on 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 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) – 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 markups 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 productivity at target plants rises by up to 9%. However, this figure masks considerable variation in the underlying components of revenue productivity. Target plants in fact see improvements in physical productivity by 13%, which is accompanied by a drop in real output prices by 4% on average. Their markups are only slightly higher following acquisition, suggesting that most of the cost-savings reflected by the rise in physical productivity is passed on to acquired plants' customers. A part of the post-acquisition effect is due to multinationals' targeting plants with relatively high levels of prices and markups prior to acquisition even within narrowly defined industries. Our results suggest that this selection effect accounts for less than a fifth of the observed differences in physical productivity in the post-acquisition period.

We extend our analysis by studying how ownership structure affects acquired plants. 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 find that majority-owned affiliates are much more likely to start exporting and become importers of intermediate inputs following an acquisition. We also find that multinationals from countries that invest more in research and development (R&D) or that are members of the European Union (EU) increase physical productivity more than revenue productivity in the sample. These results are consistent with the view that ownership structure affects 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 horizontal spillovers. Acquired plants increase competition by lowering output prices. This is expected to have two effects. First, it may induce a price reduction at surviving domestic plants and a corresponding increase in physical efficiency to meet the 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 provide strong evidence for the first prediction. Greater presence of multinationals is associated with higher physical productivity and lower prices at domestic plants in the same industry, especially when multinational affiliates are majority-owned. Physical efficiency at domestic plants responds by a larger extent than the drop in price, which translates into positive but insignificant spillovers of revenue productivity. A back-of-the-envelope calculation suggests that increased multinational activity accounts for just over 10% of the rise in average physical productivity of domestic plants over the sample period.

We also find suggestive evidence for the second prediction. Although estimates are noisy, 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 as they do in an industry with minimal multinational presence.

There are three separate theoretical frameworks that generate predictions consistent with these empirical findings. First, Shimomura and Thisse (2012) present a model in which a few big firms set prices strategically and compete with smaller firms that are unable to do so. Theoretically, they combine a Cournot oligopoly model with symmetrically differentiated products and a traditional monopolistic competition model in a so-called polarised industry. In the model, the entry of big firms leads them to sell more through a market expansion effect generated by the shrinking of the monopolistically competitive fringe. Big firms therefore have an incentive to lower prices and drive less efficient businesses out of the market, which leads to a reduction in the aggregate price index. As we show below, multinationals are typically big players in their industries and industry-level prices grow at a lower rate in industries with greater multinational presence.

Second, our results are in line with what Foster et al. (2016) call "demand accumulation by doing": new entrants in a market may lower prices today to attract buyers and build a customer base at the expense of current profits. They build a dynamic model in which plants mark up price less over marginal cost than in a static world to induce extra sales today and shift out their demand curve tomorrow. We show below that majority foreign-owned affiliates, for which we find a strong negative price drop following an acquisition, are also those that experience a considerable increase in market share.

Third, Chevalier and Scharfstein (1996) show that liquidity constraints affect pricing behaviour in a model of product market competition in which firms need to raise external funds to finance operations and they price for market share. In particular, a positive liquidity event lowers the threat of default and thereby allows firms to reduce prices and build market share. In line with the suggestion that financial frictions affect pricing behaviour, we find that acquired plants lower their prices by more in industries that are more dependent on external finance. We find this pro-competitive effect to be especially strong when multinationals take a majority equity share, which provides firms a healthy financial injection.

We draw on 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, allowing us to track ownership 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 prices is a major challenge that the literature on estimating production functions has sought to address. Even when prices on final goods 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. We take advantage of these data to construct appropriate product-level deflators and estimate measures of physical productivity, prices, and markups.

Our first contribution is to the literature on multinationals, productivity, and market power. 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. Working with census data is crucial to understand how acquirers select their investment targets, the mechanisms behind multinationals' efficiency advantage over domestic firms, 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.[1]

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 under-estimated.

Our second contribution is methodological. We generate productivity and markup estimates 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). Second, we follow De Loecker and Warzynski (2012) 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. 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,

[1] 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.

which can help explain differences in measured productivity (Braguinsky et al., 2015).

Our work is related to the literature on the effects of acquisitions and multinational activity. A first strand of the literature looks at within-firm changes. Braguinsky et al. (2015) find that acquisitions improved both productivity and profitability in the Japanese cotton spinning industry. Sheen (2014) finds that prices fall significantly at target firms relative to the industry in a sample of mergers in the United States (U.S.), while Blonigen and Pierce (2016) show that domestic M&As in the U.S. raise markups but not productivity.[2] 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. In contrast, Haskel et al. (2007) and Keller and Yeaple (2009) document positive spillovers in the same industry in the United Kingdom and U.S., respectively.[3] 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 show the existence of spillovers only in the case of partially owned multinationals.

Our findings help reconcile these mixed results. They suggest that the first strand of the literature under-estimates within-firm productivity improvements of foreign acquisitions and the second strand under-estimates the cross-firm spillovers from multinational activity. With the exception of Braguinsky et al. (2015), these studies all use traditional revenue-based productivity estimates, which may partly explain estimates that are economically small.

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 our spillover results. 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

[2] 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 in Indonesia and Spain, respectively. See also Wang and Wang (2015), who find that foreign acquisitions in China do not increase productivity any more than domestic acquisitions do.

[3] Alfaro and Chen (2018) provide cross-country evidence on positive FDI spillovers, while Jiang et al. (2018) find that productivity spillovers from joint ventures are larger than for wholly-owned FDI in China.

sampling of plants employing less than 20 workers. It provides detailed information on plant characteristics typically found in census data. Importantly, we observe the exact equity share held by multinational investors at each plant 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. Domestic plants are defined to have 0% 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. Multinational affiliates were large and important players over this period, employing around 12% 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.

The majority of multinationals in Turkey come from high R&D intensity countries.[4] Arguably, multinationals from countries with greater R&D spending are more likely to increase physical productivity and lower prices at target firms. This is because the technology gap between multinationals and domestic firms is likely to be larger for this group of affiliates. An even greater share of multinationals come from countries that were members of the EU during the sample period. In light of the customs union agreement between Turkey and the EU, which entered into force in 1996, affiliates of these multinationals likely have better access to both European product markets and cheaper and better quality inputs from Europe during this period. If scale economies and access to better inputs increase physical efficiency,

[4] R&D data come from the World Bank's World Development Indicators, which report total R&D expenditures as a share of GDP for 1996 onwards. We calculate the 1996-2001 average for each origin country and define high (low) R&D intensity countries as those with values above (below) the median.

we would expect this group of affiliates to benefit more in terms of productivity.

Table 1 points to an active market in ownership at multinational plants. In the sample, 122 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. Multinationals also sold 248 plants to domestic owners and shut down 134 plants during the sample period. Multinationals 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 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, licenses, 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). For instance, Jiang et al. (2018) find that technology transfer to international joint ventures in China is increasing in the foreign ownership share. 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% more than purely domestic firms from each dollar spent on imports. However, foreign firms need to balance technology transfer to a firm, especially one that might be a future competitor, with shared ownership with locals, which can help them avoid regulatory and cultural complexities inherent in entering a local market (Jiang et al., 2018).

Third, ownership structure helps relieve firms' financial constraints via multinationals' internal capital markets. On the one hand, a large injection of shareholder equity provides a firm with fresh funds to undertake investments and stimulate growth. On the other hand, it allows a firm to increase collateralisable assets and borrow more. Both effects can help multinational affiliates, especially majority-owned ones, to price their products more aggressively to build market share. To the extent that majority-owned affiliates are better able to tap into their parents' internal capital markets, they would be more willing to forego profits today to accumulate customers for the future.

Fourth, 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% 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. This is in line with the prediction of the model by Shimomura and Thisse (2012), in which the entry of a large firm leads to a shrinking of the monopolistically competitive fringe of small firms. 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

We rely on TurkStat's Industrial Analysis Database, introduced in the previous section. The database is a plant-level panel that contains detailed plant characteristics such as sales, materials, employment, wages, and assets for around 10,000 manufacturing plants per year with unique identifiers. A key advantage of this database is that it requires plants to report product-level data on their inputs and outputs. For each plant covered in the census, TurkStat collects annual information on every product produced by the plant and on every material input used in production. We are able to match the two datasets as they share the same plant identification codes.[5]

The product-level dataset provides information on the physical quantity, unit of measurement, and value of each firm's inputs and outputs at the product level following a highly disaggregated classification. This classification is at the 8-digit level: the first four digits refer to the International Standard Industrial Classification (ISIC) Rev. 2 and the last four digits are national. The classification includes more than 2,900 distinct products; however, Turkish plants produced 2,033 unique products during the sample period. These products, matched with each plant producing them, constitute our main unit of analysis. In the data the median plant produces a single product, while the average plant produces 2.4 products in any given year. Although single-product plants account for the majority of observations in the data, they account for 30% of total annual sales on average.

A 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 sales revenue or materials purchases 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 below how estimated productivity changes 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. Let P_{ijt}^{out} denote the price that plant i charges for product j in year t. We define $P_{ijt}^{out} \equiv Y_{ijt}/Q_{ijt}$ simply as the ratio of the total value of production, Y_{ijt}, to the physical quantity of production, Q_{ijt}. Similarly, we define the input price $P_{ist}^{inp} \equiv N_{ist}/M_{ist}$ for each input s used by plant i in year t as the ratio of the total value of material consumption, N_{ist}, to the physical quantity of consumption, M_{ist}. For each product j, we create a product-level output deflator by calculating the weighted geometric average of annual price changes across all plants producing that product. Likewise, for each input s, we create a product-level input deflator across all plants that use that input in production. We adjust

[5] Around 12% 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.

prices to a common 1993 basis using these deflators and use the logs of these real prices in the following analysis.[6] As plants typically use multiple inputs with varying units to produce a product, we sum across the real value of all inputs used in production and deflated in this way as our measure of plant-level materials, M_{ijt}.

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. In particular, 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.[7] 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.

3.2 Sample selection and data consistency

We follow a number of steps in order to ensure a consistent plant-product panel. First, we exclude plant-product-year observations for which product quantity, employment, materials, or capital stock are not reported or are equal to zero. Second, we need to ensure that quantities are comparable across plants producing the same product. For instance, a plant may report production in kilograms while another may report in tonnes. We therefore make the necessary decimal adjustments to reported quantities by using information on the units of measure included with each observation. Third, when we calculate the revenue- or cost-weighted geometric mean to construct our product-specific deflators, we exclude from this calculation changes in prices at the bottom and top 1 percentile of the distribution. Fourth, we exclude observations that refer to these outlier price changes.

3.3 Production function estimation

To compute total factor productivity and markups, we first need to estimate a production function. Consider a production function for plant i producing product j at time t:

[6] It is possible that new products enter the database later in the sample period. For products that enter the database after 1993, 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% of the plant-product-year observations. We deflate these observations with the 4-digit industry-level deflator.

[7] We adjust labour hours following (Foster et al., 2008) by multiplying them by the ratio of the total payroll to payroll for production workers. This adjustment helps correct for the composition of production workers in total workforce.

$$Q_{ijt} = F_{jt}(L_{ijt}, K_{ijt}, M_{ijt})\Omega_{it} \quad (1)$$

where Q is physical output, L denotes labour input, K denotes capital stock, and M denotes materials. All inputs are measured in physical units and the plant's physical productivity is given by Ω_{it}. While technology is assumed to be specific to product j, productivity is assumed to be specific to plant i. Taking logs and allowing for measurement error and idiosyncratic shocks to output yields:[8]

$$q_{ijt} = f_j(l_{ijt}, k_{ijt}, m_{ijt}; \beta) + \omega_{it} + \varepsilon_{ijt} \quad (2)$$

where β is the vector of coefficients on physical inputs and ω_{it} is productivity.

There are three main issues that affect the consistent estimation of β in (2). First, output price heterogeneity across plants gives rise to an output price bias if output is constructed by deflating firm revenues by an industry-level price index (Foster et al., 2008; De Loecker, 2011). Similarly, plants producing the same product often face different prices on their material inputs, which gives rise to an input price bias (Atalay, 2014; De Loecker et al., 2016). Second, we do not observe how multi-product plants allocate their inputs across products, which gives rise to an input allocation bias (De Loecker et al., 2016). Third, unobserved productivity leads to familiar simultaneity and selection biases: plants decide on their input use and operations once they know about their productivity, which the econometrician cannot see (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg et al., 2006). Moreover, input use and productivity may evolve endogenously, for instance in relation to a plant's participation in export markets (De Loecker, 2013). We address each of these potential biases using our detailed plant-product dataset and following insights from recent literature.

First, we tackle the output and input price biases by exploiting separate information on quantities and prices on each product and input. Specifically, we use the product-level output and input deflators calculated earlier to construct real values of output (q_{ijt}) and material inputs (m_{ijt}). Standard practice in the literature is to use industry deflators, which suffers from both price biases. In order to highlight the effect of these biases, we will alternatively construct q_{ijt} and m_{ijt} by a 4-digit industry deflator and calculate productivity using these alternative definitions below. We measure labour input (l_{ijt}) in physical units as production worker-hours. Capital stock (k_{ijt}) is only available in monetary values and cannot be measured in physical units, so we use deflated capital as described above.

Second, we tackle the input allocation bias by estimating (2) on an unbalanced panel

[8] Note that the production function is now indexed by product j only: the literature has traditionally assumed that the production function coefficients remain constant over the sample period.

of single-product plants. This way we do not need to make any assumption on how inputs are allocated to outputs. However, using the unbalanced panel of single-product plants may suffer from selection bias if plants' choice to become multi-product depends on unobserved productivity or their input use (De Loecker et al., 2016). We therefore follow the selection correction procedure by De Loecker et al. (2016) and include the predicted probability of remaining single-product in the law of motion for unobserved productivity.

Third, we follow the control function approach by Ackerberg et al. (2006) and De Loecker et al. (2016) based on a static input demand equation. Their methodology accounts for the simultaneity bias that arises due to the correlation between unobserved productivity and input use, while allowing future productivity to be affected by plant decisions today. Importantly for us, the methodology allows productivity to evolve endogenously with a plant's equity ownership dynamics and participation in international trade.

The online Appendix describes the step-by-step implementation of this procedure. In our estimation, we use a translog specification for the functional form of $f_j(.)$ because of its flexibility.[9] We form moments based on idiosyncratic shocks to productivity and identify the coefficient vector β in (2) by using standard GMM techniques on those moments.

3.4 Separating revenue and physical productivity

Armed with consistent estimates of β, we can compute productivity as the residual from the production function in (2):

$$\hat{\omega}_{it} = q_{ijt} - f_j(l_{ijt}, k_{ijt}, m_{ijt}; \hat{\beta}) \tag{3}$$

Before doing so, however, we need to tackle the issue of measuring productivity for multi-product plants. The issue arises because inputs to production are measured at the plant level, but output and prices are measured at the product level. At the same time, it is impossible to know how multi-product plants allocate inputs across their outputs. This is obviously not a problem for single-product plants, which use all of their inputs to produce a single output.

We follow Foster et al. (2008) and Atalay (2014) in tackling this issue and allocating inputs to each product j. First, we define the main product of each plant as the product with the highest share in a plant's total annual sales.[10] The main product accounts for 84% of a plant's total annual sales on average. Second, we restrict our sample to observations

[9] The translog specification allows output elasticities to vary across time and plants, even though the production coefficients are constrained to be the same across time and plants.

[10] For single-product plants, the main product is the only product they produce. For multi-product plants, we calculate the share of each product in total sales and select the product with the highest share.

for which the main product accounts for at least 50% of a plant's total sales. Third, we apportion labour, capital, and materials by the revenue share of the main product. In other words, we make the same assumption as Foster et al. (2008) and Atalay (2014) that the fraction of each input employed in producing a particular product equals the plant's share of revenue coming from that product.[11] Finally, we drop plants whose main product switches from one year to the next.

These sample restrictions and adjustments minimise measurement problems in the calculation of physical productivity. They further ensure that within-plant variation in physical productivity and prices can be consistently compared. We therefore calculate our productivity measures and conduct our econometric analysis on a panel of plants' main products following these steps. We will show in our robustness checks that focusing instead on single-product plants only does not change our results.

We calculate physical (or quantity-based) productivity, TFPQ, as in (3) using our production function estimates, $\hat{\beta}$, and physical measures of (logged) output, labour-hours, capital, and materials deflated at the input level. Standard efficiency measures typically work with output in revenues instead of physical units, which confounds output price differences into physical productivity. We calculate such revenue-based productivity, TFPR, by measuring output as the nominal production value deflated using product-level deflators and keeping everything else the same. As noted by Foster et al. (2008), TFPR satisfies the simple identity that it equals the sum of TFPQ (already in logs) and logged real prices: $TFPR = TFPQ + p_{ijt}^{real}$. Recall that we have calculated product-level deflators for each product j using revenue-weighted geometric mean prices. We deflate the price of each main product in the sample using these deflators and take logs. We work with these real prices, p_{ijt}^{real}, in the rest of our analysis.

We calculate three additional measures to highlight the roles of capacity utilisation, inventory adjustment, and price heterogeneity in studying productivity. First, we calculate physical productivity using reported labour stock instead of worker-hours in l_{ijt}. 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. Third, we calculate productivity by deflating our input and output measures (m_{ijt} and q_{ijt}) by 4-digit industry deflators instead of product-level deflators, and using reported measures of labour stock, sales from production, and purchases of materials. This traditional

[11] We selected a high threshold of 50% for the main product's share of revenue to increase the likelihood that this assumption is satisfied. However, we also conducted our analysis for a sample of plants whose main product accounts for at least 25% of total sales. Results are qualitatively unchanged in this case and available upon request.

measure, which we call TFPT and is extensively used in previous literature, ignores all variation that may arise from capacity utilisation, inventory adjustment, and input and output price heterogeneity.

Table A.1 in the online Appendix summarises our five productivity measures and lists what is in or out of each measure. TFPQ is our preferred measure as it correctly reflects variation in technical efficiency across plants. TFPR captures the variation in both TFPQ and price of a plant's main product, and it is a biased measure of efficiency if plants pass on technical efficiency gains into prices. TFPQ_U and TFPQ_I are unaffected by variation in prices, but reflect the extent to which capacity utilisation and inventory management play a role in determining technical efficiency. Finally, using TFPT will reveal how our results would look if we had access to standard census data.

3.5 Estimating markups

We follow De Loecker and Warzynski (2012) to estimate markups on the main product of each plant, defined as the ratio of price (P_{ijt}) to marginal cost (MC_{ijt}). Their methodology assumes that plants minimise costs for each product j and at least one input is fully flexible. Under these fairly reasonable assumptions, rearranging the first order condition of the cost minimisation problem with respect to the flexible input yields a consistent estimate of the plant-product-time variant markup:

$$\mu_{ijt} \equiv \frac{P_{ijt}}{MC_{ijt}} = \left(\frac{\partial Q_{ijt}}{\partial M_{ijt}} \frac{M_{ijt}}{Q_{ijt}}\right) / \left(\frac{P^M_{ijt} \cdot M_{ijt}}{P^{out}_{ijt} \cdot Q_{ijt}}\right) = \frac{\theta^M_{ijt}}{\alpha^M_{ijt}} \tag{4}$$

where θ^M_{ijt} is the output elasticity of product j with respect to the flexible input M (materials), and α^M_{ijt} is the expenditure share of material inputs in total value of production. θ^M_{ijt} is recovered from production function estimates, while α^M_{ijt} is directly calculated from the data for single-product plants. We follow the input apportionment procedure described above to calculate values for the main products of multi-product plants. Intuitively, the output elasticity equals the expenditure share only under perfect competition, leading price to equal marginal cost and markup to equal one.

3.6 Estimating the effects of foreign acquisitions

Our empirical setup follows variants of a difference-in-differences estimation. Using different samples, we estimate:[12]

[12]We drop subscript j from the rest of the notation as we focus on the main product of each plant.

$$y_{it} = \beta_0 + \beta_1 Acq_i \times postAcq_t + \beta' \mathbf{X}_{it} + \gamma_i + \delta_t + \sum_k \eta_k \times \delta_t + \varepsilon_{it} \tag{5}$$

where y_{it} is an outcome for plant i in year t. Our main outcomes of interest are the productivity measures described earlier alongside markups and prices. In (5), Acq_i indicates plants acquired by multinationals and $postAcq_t$ indicates the years following acquisition. 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 β_1 identifies within-plant changes arising from changes in ownership. In order to understand how ownership structure affects the outcomes of interest, we estimate (5) after splitting the term $Acq_i \times postAcq_t$ into minority and majority foreign ownership at the time of acquisition. Alternatively, we split it by low- vs. high-R&D intensity or the EU membership of the acquiring multinational's origin country.

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. 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, $\sum_k \eta_k \times \delta_t$, 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 (5) 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.[13] 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 skillful workforce.

Although we control for these trends and covariates, part of the post-acquisition effect may be due to multinationals' targeting of plants with certain characteristics 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 (5) based on the matches. This mimics a more traditional difference-in-differences estimation with matching intended to ensure simi-

[13] 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.

larity 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 markup 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 start by discussing the relationship between the main variables in our analysis derived from the production function estimation.[14] Table 2 shows correlations between the five productivity measures we calculate, output prices, and markups in panel A. We remove product-year fixed effects before calculating correlations, so heterogeneity across products or aggregate movements do not drive these statistics. Our three physical productivity measures are very highly correlated with each other, while they are highly correlated with the two revenue-based productivity measures as well. Most notably, there is a strong and negative correlation between TFPQ and output price, meaning that plants with higher physical efficiency pass on some of their lower marginal costs to their consumers.[15] In addition, TFPR is positively correlated with price and markups, while TFPQ is also positively correlated with markups.

These correlations are similar to those reported by Foster et al. (2008) and Atalay (2014). The former also present a model of imperfect competition that generates the above correlations. In general, these are consistent with more efficient businesses having lower marginal costs and, in turn, charging lower prices but having higher markups, which is a common implication of models of imperfect competition. Panel B of Table 2 provides further evidence in this respect and reports average markups across the distributions of TFPQ and

[14]Table A.2 in the online Appendix reports average output elasticities and the returns to scale by industry, while Table A.3 provides summary statistics of all variables used in the analysis. We trim productivity and markup observations at the bottom and top 1st percentiles to guard against outliers.

[15]That TFPQ and prices are negatively correlated suggests that we are picking up variation reflecting demand shifts rather than quality across producers. Foster et al. (2008) argue it is far from obvious that TFPQ and prices would be negatively correlated if price variation simply reflected output quality differences.

prices. It shows that high TFPQ plants have higher than average markups. Moreover, the average markup for plants with high efficiency (top TFPQ quartile) and low prices (bottom price quartile) is similar to the average markup for firms with low efficiency (bottom TFPQ quartile) and high prices (top price quartile). In other words, plants seem to retain similar levels of markups as they move from being less efficient to being more efficient and passing on efficiency gains via lower prices.

Overall, these statistics suggest a market structure similar to a polarised industry as described by Shimomura and Thisse (2012). The average markup in the data is 1.33; that is, the average plant in the sample charges a price that is 33% greater than its marginal cost of production for its main product. The average markup is higher for multinationals at 1.45 compared with 1.29 for domestic plants, suggesting that multinationals command greater market power than domestic plants.

4.1 Foreign acquisitions and plant-level outcomes

4.1.1 Baseline estimates

Table 3 shows results of our within-acquired plants estimation of (5) in panel A.[16] The first column shows that TFPR at acquired plants rose by 8.5% (or 0.082 in log units; $e^{0.082} = 1.085$) above its pre-acquisition level on average. The next two columns reveal that the two constituents of revenue productivity in fact move in opposite directions (recall that $TFPR = TFPQ + p_{ijt}^{real}$). Physical productivity (TFPQ) at acquired plants rose on average by 13.1%, while the average price on plants' main products dropped by 4.1% in real terms compared with their pre-acquisition levels. The impact on TFPR and TFPQ is estimated with high statistical significance, while that on price is not. Thus, acquisitions by multinationals seem to improve physical productivity considerably while exerting a 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 markups to go up. Column (4) shows that plant-level markups are indeed higher by 2.8% in the post-acquisition stage, albeit statistically insignificantly. This suggests that multinationals pass on the effect of improved productivity imperfectly to consumers and plants that their subsidiaries serve.

These results show that revenue-based productivity measures may under-estimate improvements in acquired plants' technical efficiency. Although TFPR and TFPQ are highly correlated, this discrepancy arises due to the fact that 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 U.S. data. It is consistent with models

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

where producers set prices and more efficient producers pass along their cost savings through lower prices. In our case, this pass-through is incomplete.

Revenue-based measures of productivity under-estimate improvements in efficiency by a greater degree 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 measure (TFPT), which rose by 6.2% following acquisitions. This is lower than the estimate for TFPR, meaning that using a traditional revenue-based productivity measure may hide multinationals' advantageous pricing in input and output markets, higher rates of capacity utilisation, and superior inventory management. Furthermore, it under-estimates the increase in TFPQ substantially and masks the corresponding drop in price that comes with cost savings.

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 against column (2), 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 2.2 percentage points higher when inventory management is neglected, which explains nearly a fifth of the variation in TFPQ. 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.

4.1.2 Role of ownership structure

We now test whether these changes are related to the ownership structure of the acquired plant. Table 3 shows results of the within-acquired plants estimation when $Acq_i \times postAcq_t$ is split by minority versus majority shareholding by the multinational parent at the time of acquisition in panel B. Column (1) shows that TFPR was 10.1% higher than its pre-acquisition level at acquired plants where the foreign owner held a minority share, compared with 4.7% 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 18.5% and prices dropped by 13.2% in real terms on average at plants with majority foreign ownership. These estimates are highly statistically significant. In contrast, we find that TFPQ rose by 10.2%, while prices were unchanged at minority foreign-owned plants. Hence, revenue productivity under-estimates true efficiency gains by a large margin especially in the case of greater equity financing by multinationals.

These results suggest that ownership structure affects the extent to which multinationals pass on the effect of their productivity improvement to their prices. Minority foreign-owned plants seem to leave their prices unchanged despite an increase in physical productivity. Correspondingly, column (4) shows that markups are 3% higher at their affiliates following acquisition. Markups rise by a smaller amount at majority foreign-owned plants, indicating that cost savings are partially passed through to prices in these cases.

Columns (5)-(7) of Table 3 in panel B show the usefulness of working with different measures of efficiency. Working with a traditional productivity measure reveals that TFPT rises by 8.5% for minority foreign-owned plants, while it does not change at all for majority foreign-owned plants. In the absence of more detailed data and estimation, one may therefore wrongly conclude that ownership structure does not matter or that minority foreign-owned acquisitions deliver greater efficiency gains. Column (6) reveals small differences in TFPQ_U compared against TFPQ, while column (7) shows that the post-acquisition effect on TFPQ_I is 3.9 percentage points higher for minority foreign-owned acquisitions. In short, 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 technical 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.4 in the Appendix reports results from a logit estimation of multinational acquisition on all plants in the sample, while Table A.5 reports the balancing test for 227 acquired plants for which appropriate matches are found. Within narrowly defined industries, multinationals target relatively larger plants that command higher prices and markups, but have lower physical productivity. For instance, the average acquired plant charges a markup of 1.38 prior to acquisition compared with the average domestic plant's markup of 1.17. Balance tests indicate that acquired plants are very similar to their matched controls prior to the investment year.

Table 4 reports the results of estimating (5) on the matched sample in panel A. These are our preferred estimates as they compare outcomes at acquired plants with those at similar domestic plants. We find that foreign acquisitions raise revenue productivity by 9.2% and physical productivity by 11%, while they lower prices by 1.7% on average. The estimate for TFPR is similar to the one reported earlier, while estimates for TFPQ and prices are slightly lower. This suggests that multinationals target certain plants based on their pre-investment trends in TFPQ and prices. In particular, around 16% ($= (13.1\% - 11\%)/13.1\%$) of the average improvement in TFPQ is due to multinationals' ability to select investment targets. Importantly, however, we continue to find a significant impact on TFPQ of foreign acquisitions that exceeds the impact on TFPR. We also continue to find similar, if slightly smaller, effects on TFPT, TFPQ_U, and TFPQ_I.

Panel B of Table 4 shows that this selection effect is stronger for minority foreign-owned acquisitions, while it does not affect estimates for majority foreign-owned acquisitions. The positive impact of acquisitions on revenue-based measures remain for minority owners, but they no longer experience a statistically significant increase in TFPQ compared with their matched control plants. In fact, our estimates reveal that minority foreign-owned plants see a rise in their relative prices following acquisitions, which means their TFPR gains exceed their TFPQ gains. This suggests that minority-owned acquisitions target firms that are on a downward real price trajectory, but they do not lower real prices as much as their competitors. This also results in a slightly higher markup following acquisition. Although results for minority-owned affiliates are not always precisely estimated, they are informative in revealing that – once the selection effect is removed – sources of the gains in revenue productivity differ by ownership structure.

In contrast, plants with majority foreign ownership experience a 17.5% increase in TFPQ and a 15.9% decrease in output prices on average compared with their matched domestic counterparts. In light of earlier estimates from columns (2)-(3) of Table 4 in panel B, these figures show that selection explains only 5% of the total gains in TFPQ and 15% of the total reduction in prices for majority foreign-owned plants. Most of the improvement in TFPQ and prices can thus be causally attributed to the change from domestic owners to majority-owned multinational owners. In line with this, we find that markups barely rise at these plants, which indicates that most of the cost reductions are passed on to buyers.

We continue to find that part of the total gains in TFPQ is 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)). Nearly half of the variation in physical productivity at minority-owned plants is accounted for by inventory management, as they see their TFPQ_I rise by 11.5% but their TFPQ by 7.1% compared with their domestic counterparts. Thus, minority foreign owners seem especially invested in improving the management of the stock of final goods and materials used in production.

4.3 Robustness

We carry out several robustness checks on our matching exercise for the impact of ownership structure. First, we restrict our matched sample to single-product plants. This eliminates any issue that might arise from adjusting production inputs by the main product's share in total sales. Results are shown in panel A of Table 5. The point estimates and standard errors are very similar to those reported in Table 4 despite the reduction in the number of observations. The estimated effect of a minority foreign-owned acquisition on TFPR is now slightly smaller, driven by a lower effect on both TFPQ and P. As earlier, post-acquisition markups are mostly unchanged.

Second, to ensure that acquired plants are not on different productivity and price trends to their matched controls, we complement our 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. Panel B in Table 5 shows that our main results remain. Imposing more stringent matching criteria leaves the estimated impact of a majority foreign-owned acquisition on our outcome variables virtually unchanged. With these extra criteria, none of the quantity-based productivity measures seem to rise in a statistically significant sense at minority foreign-owned plants. This suggests that a good part of the rise in technically efficiency at minority foreign-owned plants is likely driven by pre-investment selection.

Third, we match each acquired plant with three control group plants instead of five. Selecting fewer matches decreases 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. The risk is that if multinational activity induces spillovers to domestic plants in the outcome of interest, 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 5 panel C shows that our estimates are little affected when compared with earlier ones. 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.

Fourth, we match on TFPR instead of matching on TFPQ and prices separately. The results, shown in Table A.6 in the Appendix, are mainly unchanged from our baseline findings. Interestingly, this exercise reveals that the average price drop at majority foreign-owned plants may ever so slightly exceed the increase in TFPQ.

4.4 Alternative specifications & explanations

In this sub-section we dig deeper into why ownership structure at multinationals matters for productivity and pricing. As our focus is on teasing out why some multinationals deliver greater gains in physical productivity and produce stronger pro-competitive effects than others, we focus on potential mechanisms to explain these two effects.

Multinationals' headquarter countries can be identified from the data as the manufacturing census asks plants to list the countries of their top 3 shareholders.[17] We use this information in two ways. First, we look at multinationals' origin countries' R&D intensity, which can indicate their ability to transfer better technologies to their affiliates. As Turkey's R&D intensity is quite low compared with the origin countries', multinationals from countries that invest more in R&D are likely to transfer higher quality machinery and equipment. We expect this to positively affect physical productivity. Second, we classify shareholder countries into those from the EU and the rest. If multinationals from the EU allow their Turkish affiliates to increase their customer base and access higher quality inputs, then physical productivity should be higher following an acquisition by an EU multinational.

We test these two mechanisms by re-estimating our regressions on the baseline matched sample and split $Acq_i \times postAcq_t$ by origin country characteristics. Table 6 shows the results. In panel A, we find that a cross-border acquisition leads to a greater increase in both TFPR and TFPQ when the acquiring multinational is from a high R&D intensity origin country. As expected, revenue-based measures under-estimate gains in physical efficiency for these acquisitions. Most notably, we find that the traditional revenue-based measure used in earlier literature, TFPT, rises significantly in the post-acquisition period only for multinationals from low R&D intensity origin countries. This shows again the importance of correcting for the biases in standard productivity measures. In the absence of product-level information on quantity and prices, one would get results that are both unintuitive and exact opposite of the true effects.

In panel B, we find strong evidence that the gains in physical efficiency and the pro-competitive impact on prices are driven by multinationals from EU member countries. In particular, TFPQ rises by 18.4% and prices drop by 9.8% at plants acquired by EU multinationals when compared with their domestic competitors. Post-acquisition TFPQ_U and TFPQ_I are similarly higher when the acquirer is from the EU. In contrast, multinationals from non-EU member countries increase plant-level prices by more than TFPQ, although these estimates are noisy. This group of plants sees its revenue productivity rise thanks to an increase in prices. These results suggest that the underlying mechanism for the pro-

[17] In the data, only around 10% of all foreign plants have shareholder from multiple countries. In these cases, we define the origin country to be that of the shareholder with the highest equity share.

competitive effect of multinationals is likely a combination of a market size effect and access to better intermediate inputs. We will return to this in the next sub-section.[18]

In general, 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. Similarly, they 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 markups. 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 and are applicable to all relations between related parties.

4.5 Mechanisms

What kind of plant-level changes are related to both acquisitions and differences in productivity and pricing? Our findings indicate that the productivity advantage of majority foreign-owned plants is due to their ability to raise physical productivity while lowering prices. We explore two main mechanisms, which can can be effective at the same time, for why efficiency gains are passed on via lower prices.

First, theoretical models by Chevalier and Scharfstein (1996), Shimomura and Thisse (2012), and Foster et al. (2016) all emphasise strategic price-setting to build market share. In these models, firms can use their cost advantage – which can be derived from financial strength, firm size, or input choices – to charge lower prices than competitors in a bid to increase sales. Reaching more customers allows firms to increase scale and move down their average cost curve, which makes investments in building market share worthwhile.

Second, Guadalupe et al. (2012) construct a model of heterogeneous firms and CES preferences with constant markups, 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 markups. 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 technology, access to export markets can incentivise a plant to invest in technology upgrading

[18] We ran our analysis on the sample of single-product plants as a robustness check of our estimates in Table 6. Results are unchanged and available upon request.

(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 we can track each plant's market share, participation in trade, and innovative activity. We calculate a plant's market share as the ratio of its annual sales to total industry sales at the 4-digit level. In addition, 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 baseline matching exercise using these measures as our dependent variables.[19]

Table 7 shows the results. We find that plants acquired by majority foreign owners experience a considerable rise in their market share, while those acquired by minority foreign owners do not. According to column (1), the former see their market share rise by 0.5 percentage points on average following acquisition. This is a sizable increase; in the data, the average (median) plant has a market share of 0.9% (0.1%). Recall that multinationals target plants that are large with some market power. These figures therefore show, consistent with theories of strategic pricing, that acquired plants use their ability to set prices to grow even larger and command sizable market shares.

Ownership structure also 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 10% greater likelihood of being an exporter in the post-acquisition stage, and they see a 1.8 percentage points 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 11% more likely to be importing at least one intermediate input, and the share of imports in their total input consumption rises by 5.7 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 TFPQ and drop in prices is inno-

[19] 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.

vative activity. Acquired plants may have an incentive to invest in new technologies if the foreign parent brings lower innovation costs (Guadalupe et al., 2012), either through direct technology transfer or by increasing scale. As the manufacturing census reports on plants' spending on R&D and intangible assets, we can test for changes in these directly. Columns (6) and (7) show that acquired plants see a significant rise in their innovative activity. We find that majority foreign-owned plants are 7.9% more likely to spend on R&D following acquisition, while this probability is unchanged for minority foreign-owned plants. We also find that both types of plants are 10% more likely to use intangibles, including royalties, patents, know-how, and licenses. These results indicate that plants' engagement in R&D activities, rather than their access to royalties and licenses, are what really drives their advantage in physical productivity.

We explore underlying mechanisms further by replicating our analysis on matched subsamples defined by exogenous industry characteristics. First, we use data from Manova (2013) to classify industries into above vs. below median external financial dependence and estimate equation (5) on these two split samples. If multinationals help relieve financial constraints of acquired firms, for instance by leveraging their internal capital markets, then we would expect the average effect of acquisitions to be stronger in industries with greater dependence on external finance. This is indeed what we find in Table 8, panels A and B. All productivity measures are higher for acquired plants in industries that are more dependent on external finance and the decrease in price more pronounced. These results are consistent with greater foreign equity ownership relieving plants' financial constraints and giving them room to cut prices without worries of default.

Second, we follow Ge et al. (2015) and classify industries into above vs. below median R&D intensity.[20] If multinationals increase physical productivity by engaging in technology transfer, then we would expect the largest impact in industries that are more intensive in R&D. This is because it is these industries, especially in manufacturing, in which the technology gap between foreign and local firms tends to be the largest (Jiang et al., 2018). Panels C and D in Table 8 show that all productivity measures are estimated to be higher for acquisitions in industries that are more intensive in R&D. This is especially so for physical productivity measures, and accordingly the decline in price seems to be greater in this subset of industries. As R&D-intensive industries have greater scope for transfer of better technologies but also product differentiation, results suggest that the positive impact of R&D activities on technical efficiency outweighs their positive effect on quality.

[20] In particular, we collect data on industry-level R&D intensity using the U.S. data from OECD statistics for the year 1996-2001. We calculate the average R&D intensity for each U.S. industry across these years and then calculate the median value.

Third, we test further for the possible effect of quality variation. In particular, we assume that differentiated goods represent a good proxy for the scope for quality variation in outputs. We use the classification of goods by Rauch (1999), who classifies each good as (i) sold on an exchange, (ii) reference priced, or (iii) neither. We define goods that are classified neither as differentiated.[21] Rauch's original classification includes 1,189 industries according to the 4-digit SITC Rev. 2 system, which is more detailed than the 4-digit ISIC industry classification in Turkey. We therefore use existing concordances between SITC and ISIC to calculate the share of goods that are differentiated in each 4-digit Turkish industry and take a simple average. We classify an industry that has more than half of the goods classified as differentiated to be a differentiated industry.

Panels E and F of Table 8 show the estimation results on these two subsets of industries. We find that acquired plants in less differentiated industries see greater increases in both revenue and physical productivity than those in more differentiated industries. The average decline in prices following an acquisition is smaller for more differentiated industries, suggesting that a possible accompanying increase in quality may keep the pro-competitive effect on prices limited. However, existing research on how M&A activity affects product market behaviour shows that any impact on quality is narrow. For instance, Sheen (2014) finds that relative prices at acquired brands fall relative to competition but quality is unchanged.

5 Impact on domestic industry

The previous section documented a strong and positive effect of multinational acquisitions on plant-level physical efficiency, while leading to decreases in output prices. 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 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 to survive. This will be the case especially if they compete with majority foreign-owned affiliates. If domestic plants can raise their physical productivity by more than the reduction in prices, then we would expect to find positive spillovers in revenue productivity within the same industry. Otherwise, domestic

[21] Rauch (1999) provides a conservative and a liberal estimate for each good. We use the liberal estimate to define differentiated industries but using his conservative estimates leaves results unchanged.

plants will experience negative revenue 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 a significant factor in determining survival (Foster et al., 2008). On the other hand, in trade models with firm heterogeneity, 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 product market competition. Prices therefore reflect both demand and cost factors, and multinational activity may affect domestic plant exit through either channel.

5.1 Intra-industry spillovers

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

$$MNEPresence_{kt} = \left(\sum_{i \in k} FEP_{it} \times Employment_{it} \right) / \sum_{i \in k} Employment_{it} \tag{6}$$

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 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:

$$\begin{aligned} y_{it} \;=\; & \beta_0 + \beta_1 MNEPresence_{kt} + \beta_2 HHI_{kt} + \beta_3 MS_{it} + \beta_4 Markup_{it} \\ & + \beta' \mathbf{X}_{it} + \gamma_i + \delta_t + \psi_k \times \delta_t + \varepsilon_{it} \end{aligned} \tag{7}$$

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_{kt}), plant's market share (MS_{it}), and markup on its main product. As earlier, we include a set of plant controls, 4-digit industry-time trends, and plant and year fixed effects. We estimate (7) on all domestic plants included in the sample using our productivity, price, and markup measures on their main products as outcome variables.

Table 9 shows the results of this exercise. Greater presence of multinationals in an industry is associated with a positive, but statistically insignificant, impact on TFPR of domestic plants operating 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 $MNEPresence$ by 5 percentage points – increases its revenue productivity by 0.9% on average. This effect again masks the large variation in physical productivity and prices induced by multinational activity. The same hypothetical plant in fact sees an increase in TFPQ by 3%, while it sees a reduction in its output price by 2.1%. Both of these effects are estimated with high statistical significance. The spillover effect on TFPQ is therefore much larger than the effect on TFPR, which is masked by a considerable pro-competitive effect on output prices.

Table 9 does not reveal a significant association between changes in multinational presence and domestic plants' markups, indicating that competition from multinationals forces domestic plants to pass on their cost reductions from productivity improvements to their buyers. We next test whether multinational entry and expansion of acquired plants induce domestic plants to reduce X-inefficiencies and improve management practices. For instance, one might expect that domestic plants increase capacity utilisation or improve their inventory management in light of competition from multinationals, which would show up in their TFPQ_U or TFPQ_I. Columns (5) and (6) show that increased multinational presence leads to a greater increase in TFPQ_I than in TFPQ at domestic plants by an extra 0.2 percentage points; however, there is no discernible additional impact on TFPQ_U. This indicates that domestic plants improve their inventory management in an attempt to raise efficiency and keep up with new competition from multinationals, while they seem to have been working at a high utilisation rate already.

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 (6). Our estimates indicate that TFPQ at the average domestic plant increased by 0.12 log units during the same period. Using our estimate from column (2) of Table 9, these figures mean that spillovers from multinational activity accounted for around 11% of physical productivity growth at domestic plants over the sample period. This is a large effect considering that multinationals often constitute less than 4% of plants in an average industry. Moreover, it is a considerably larger effect than what one obtains working with revenue productivity.

These results suggest that horizontal spillovers documented previously miss the impact of multinationals on domestic plants that operates through the pro-competitive channel. They trace the non-existence of spillovers in revenue productivity to the finding that domestic plants have to pass on any efficiency gains more or less fully to their customers via lower 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. To test whether the latter is at work, we estimate (7) with average plant wages as our outcome. The last column of Table 9 shows that greater multinational activity is in fact correlated with lower average real wages at domestic plants in the same industry. When taken together with the finding that input utilisation is unchanged, this result suggests that domestic plants are forced to offer lower real wages to their workers to keep up with competition.

As a robustness check, we replicate our spillovers analysis on a sample of single-product domestic plants only. The results are reported in Table A.7. Using this sample, we continue to find that there is a positive spillover in terms of TFPR, but this significantly underestimates true efficiency gains measured by TFPQ and hides the accompanying drop in output prices. We also find that positive spillovers on both TFPQ_U and TFPQ_I are larger, while the negative spillover on wages is larger as well. As single-product domestic plants are generally smaller than the rest of the industry, they are faced with the toughest competition from multinationals to increase their efficiency and reduce costs. Overall, this evidence is consistent with the model of a polarised industry described by Shimomura and Thisse (2012), in which a few large players drive industrial restructuring by forcing the competitive fringe of small firms to either, keep up with product market competition by lowering prices, or exit. We turn to the exit channel next.

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 markups to identify the determinants of plant survival. We then interact these with the horizontal presence measure in (6) 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:[22]

$$Exit_{i,t+1} = \beta_0 + \beta_1 y_{it} + \beta_2 MNEPresence_{kt} \times y_{it} + \beta' \mathbf{X}_{it} + \psi_{kt} + \varepsilon_{it} \tag{8}$$

This specification controls for a full set of 4-digit industry-by-time fixed effects, ψ_{kt}, which subsumes $MNEPresence_{kt}$ 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.[23]

Table 10 presents baseline results, which exclude the interaction term in (8). We find that plants with lower revenue-based productivity, either measured by TFPR or TFPT, are more likely to exit in the next period. A unit increase in TFPR and TFPT is associated with a decline in exit probabilities of 1.8 and 1.3 percentage points, respectively. TFPR therefore has a 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). Note that these estimated magnitudes are economically meaningful, as the unconditional probability of plant exit in the data is around 8%.

We find that TFPQ or prices are not strongly associated with the likelihood of exit when included in (8) 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 2 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 markups do not help predict

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

[23] In unreported results, we estimated (10) without plant-level controls, $\mathbf{X}_{it}$, and found our estimates on the effect of productivity, prices and markups to be larger, which would capture long-run determinants of survival.

the probability of exit, keeping all else constant.

Table 11 presents results with the interaction term included in (8), which show how productivity and prices affect exit probabilities in the presence of multinationals. In general, we do not always find statistically significant evidence that greater multinational presence affects the magnitudes of how productivity and price dynamics impact exit probabilities. Although price dynamics appear to play a significant role in column (4), the estimated impact is small and downward biased when TFPQ is not controlled for. Nevertheless, multinational presence seems to affect chances of survival as expected. For instance, a unit increase in TFPR raises a domestic plant's chances of survival by 2 percentage points in industries with no multinational presence, while the same TFPR increase raises chances of survival by 1.7 percentage points if a tenth of industry workers is employed by multinationals. This reduction of 0.3 percentage points in the survival probability indicates that a higher TFPR does not always guarantee survival in the presence of multinationals and points at tougher competition. In terms of economic magnitude, it accounts for close to a fifth of the variation in exit probability driven by TFPR.

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, while keeping the other constant, raises a domestic plant's chances of survival by around 2 percentage points in industries with no multinationals. But the same increase raises chances of survival by around 1.6 percentage points if multinationals employ 10% 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 markups 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. To the extent that markups 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. As a robustness check on these results, we estimate the impact of multinational presence on exit probabilities using the sample of single-product domestic plants. Results are presented in Table A.8 and very much similar to those discussed above.

5.3 Impact on the industry price index

We have identified three channels through which multinational activity affect prices in an industry: (i) a direct impact on acquired plants; (ii) a pro-competitive impact on domestic plants operating in the same industry; and (iii) a selection impact on the exit probability of high-price plants. Our results indicate strong evidence for the first two channels and suggestive evidence for the third. This sub-section tries to quantify the overall impact on the aggregate industry price index.

In order to construct an aggregate producer price index (PPI), we typically assume that the sample containing the price observations come from a representative set of plants and products. We would further assume that these price changes reflect genuine cost differences, rather than changes in product quality, as new plants and products enter the market to replace older ones. In other words, one would assume a fixed "basket" of products. One then attaches revenue weights to these price changes to calculate an aggregate index. In our case, we can be confident of the representativeness of our sample as it is drawn from the manufacturing census. However, we should note that the potential impact of multinationals on the selection of exiting plants – and possibly also entrants – may violate the assumption about changes in the plant and product scope.

With this caveat in mind, we construct aggregate prices using discrete Divisia (Törnqvist) indexes for each industry.[24] The overall price index for an industry is given by:

$$\Delta P_{kt} = \sum_{o} \sum_{i \in I_{kt}^{o}} w_{ikt} \Delta p_{ikt}$$

where p_{ikt} is the nominal price (in logs) charged by plant i in industry k at time t, w_{ikt} is a corresponding revenue-based weight, and $o = \{D, F\}$ sorts plants by ownership (D=Domestic, F=Foreign) within each industry. The weights w_{ikt} are calculated as the average revenue share of each plant i in an ISIC 3-digit industry k in time t and $t-1$.[25] This construction allows us to calculate narrower price indexes for foreign and domestic plants as ΔP_{kt}^{F} and ΔP_{kt}^{D}, respectively, as components of the aggregate index. While ΔP_{kt}^{F} captures the direct impact on acquired plants, ΔP_{kt}^{D} captures the pro-competitive impact on domestic plants. The aggregate index, ΔP_{kt}, satisfies the property that it is a revenue-weighted sum of the foreign and domestic plant price indexes.

[24] The results are robust to the use of Laspeyres or Paasche indices alternatively.

[25] We calculate the price index at the 3-digit industry level to minimise the problem of entry and exit of plants into industries, while observing variation in multinational presence at a detailed enough level. There are seven industries at the 3-digit level in which multinationals did not operate during the sample period, and we exclude these from the analysis in this sub-section.

Table 12 reports results from OLS regressions of the industry-level price index and its sub-components. These regressions include a full set of industry and year fixed effects, and cluster standard errors at the industry level. Column (1) shows that increasing multinational presence in an industry by 5 percentage points is associated with a 5.6 percentage points lower growth in the industry's aggregate price index. We find that the direct impact on foreign plants outweighs the pro-competitive impact on domestic plants as expected, but both are sizable and economically significant. An increase in multinational presence by 5 percentage points leads to a 6.9 percentage points reduction in ΔP^F_{kt} and a 4.1 percentage points reduction in ΔP^D_{kt}. Turkey was plagued with extremely high levels of inflation in the 1990s, with the aggregate PPI averaging an annual growth rate of 61.4%. Our estimates therefore suggest that a one standard deviation change in multinational activity corresponds to approximately a tenth of aggregate PPI growth. Most importantly, we find that industries with greater multinational presence experienced lower rates of producer price inflation due to the pro-competitive effect induced by multinational entry.

One might expect that the effect of multinationals on aggregate industry prices should be muted in industries where prices are set on world markets. However, in more open industries, there is also greater scope for firms to grow larger and multinationals to increase their scale, which may allow them to charge lower prices. We therefore check how multinational presence affects the aggregate price index and its sub-components depending on the trade openness of industries. In particular, we calculate the ratio of total exports and imports to output for each industry and year during the sample period, and calculate the average openness of each industry across the years. We then define industries as more open if their average openness exceeds the sample median and as less open otherwise. We interact multinational presence with these indicators and report results in columns (4)-(6).

We find that the overall impact of multinational activity on the aggregate PPI is the same, although we identify a much more precise estimate for less open industries. This suggests that the ability of multinationals to manipulate aggregate industry prices may indeed be muted in more open industries. Interestingly, we find larger point estimates for the effect of multinational presence on both ΔP^F_{kt} and ΔP^D_{kt} in more open industries, but these estimates are noisy. It is quite possible that more open industries also see greater firm entry and exit, which would render our assumption of a fixed basket of products invalid. For less open industries, where this assumption is more likely to be satisfied, we find multinational presence to have a highly significant impact on both industry-level prices both through the direct and the pro-competitive channels.

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 use 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 show that multinationals target plants with high prices and markups, but their post-acquisition impact differs by ownership structure. While majority foreign-owned affiliates increase revenue productivity by raising their physical productivity, minority foreign-owned affiliates increase revenue 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 markups. Our findings suggest that majority owners increase their affiliates' access to imported inputs and ability to export, which enables them to charge lower prices and increase their market shares.

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 productivity into a physical productivity component and prices reveals that the effects of foreign direct investment on productivity growth may be previously under-estimated. Ownership structure is linked to foreign affiliates' ability to lower prices and affect market shares, which affects the selection of domestic plants for survival. More importantly, domestic plants that compete in the same product markets with multinationals have to raise their technical efficiency in order to survive. Our back-of-the-envelope calculations show that multinational activity accounted for just over 10% 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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Table 1: Multinationals in Turkish Manufacturing, 1991-2001

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Panel A: 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
Panel B: 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
Panel C: Multinationals by R&D intensity of their origin countries											
High R&D intensity	117	132	177	189	198	187	230	259	256	257	255
Low R&D intensity	117	125	124	123	128	148	148	158	168	179	187
Panel D: Multinationals by EU membership of their origin countries											
EU member	142	162	214	228	239	239	270	293	292	299	314
Non-EU member	92	95	87	84	87	96	108	124	132	137	128
Panel E: 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
Panel F: 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. See text for the definitions of R&D intensity and EU membership of origin countries.

Table 2: Relationships between productivity, prices and markups

Panel A: Sample correlations conditional on product-year effects

	TFPR	TFPQ	TFPQ_U	TFPQ_I	TFPT	Price	Markup
TFPR	1.00						
TFPQ	0.27	1.00					
TFPQ_U	0.29	0.99	1.00				
TFPQ_I	0.14	0.97	0.97	1.00			
TFPT	0.73	0.22	0.36	0.25	1.00		
Price	0.16	-0.90	-0.85	-0.92	0.07	1.00	
Markup	0.16	0.05	0.06	0.04	0.17	0.03	1.00

Panel B: Average markups across TFPQ and price quartiles

		Prices				
		Bottom quartile	2nd quartile	3rd quartile	Top quartile	Total
TFPQ	Bottom quartile	1.31	1.25	1.21	1.31	1.29
	2nd quartile	1.18	1.20	1.26	1.37	1.29
	3rd quartile	1.22	1.26	1.37	1.58	1.32
	Top quartile	1.34	1.40	1.59	1.45	1.40
	Total	1.31	1.30	1.32	1.38	1.33

Notes: Panel A reports pairwise correlations between productivity measures, prices, and markups (all measured in logs). We remove product-year fixed effects before computing the statistics. All correlations are statistically significant at the 5% level. Panel B reports average markups for plants across the distribution of TFPQ and prices. TFPQ and price quartiles are defined within each product-year and the top quartile refers to plants with the highest values.

Table 3: Baseline Estimates of Acquisitions on Efficiency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPT	TFPQ_U	TFPQ_I
Panel A: Average impact of acquisitions							
Acquired×Post-acquisition	0.0822*	0.1228**	-0.0406	0.0275	0.0597**	0.1200**	0.1422***
	(0.0441)	(0.0490)	(0.0435)	(0.0169)	(0.0301)	(0.0493)	(0.0519)
R-squared	0.25	0.25	0.19	0.14	0.22	0.24	0.24
Observations	1,412	1,412	1,412	1,513	1,515	1,412	1,412
Panel B: Minority vs. majority ownership							
Minority-owned×Post-acquisition	0.0965*	0.0973*	-0.0008	0.0298	0.0820**	0.1008*	0.1323**
	(0.0506)	(0.0585)	(0.0522)	(0.0190)	(0.0320)	(0.0594)	(0.0610)
Majority-owned×Post-acquisition	0.0457	0.1694***	-0.1237**	0.0243	0.0023	0.1550**	0.1558**
	(0.0639)	(0.0642)	(0.0583)	(0.0263)	(0.0492)	(0.0632)	(0.0689)
R-squared	0.25	0.25	0.20	0.14	0.25	0.24	0.23
Observations	1,412	1,412	1,412	1,513	1,515	1,412	1,412
Panels A and B:							
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports within-acquired plant estimation results of (5) in panel A, and results when $Acq_i \times postAcq_t$ is split by minority vs. majority foreign ownership at the time of acquisition in panel B. The sample consists of plants subject to a foreign acquisition during the sample period. 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% level, respectively.

Table 4: Impact of Acquisitions and Ownership Structure on Efficiency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPT	TFPQ_U	TFPQ_I
Panel A: Average impact of acquisitions							
Acquired×Post-acquisition	0.0882**	0.1047**	-0.0164	0.0149	0.0493**	0.1215**	0.1334***
	(0.0401)	(0.0483)	(0.0451)	(0.0215)	(0.0215)	(0.0478)	(0.0471)
R-squared	0.14	0.14	0.08	0.06	0.14	0.16	0.13
Observations	5,900	5,900	5,900	6,222	6,214	5,900	5,900
Panel B: Minority vs. majority ownership							
Minority-owned×Post-acquisition	0.1367***	0.0688	0.0679	0.0261	0.0755***	0.0896	0.1088*
	(0.0492)	(0.0628)	(0.0548)	(0.0250)	(0.0254)	(0.0622)	(0.0626)
Majority-owned×Post-acquisition	0.0135	0.1616**	-0.1481**	0.0059	0.0048	0.1707**	0.1686**
	(0.0631)	(0.0745)	(0.0717)	(0.0372)	(0.0359)	(0.0733)	(0.0683)
R-squared	0.14	0.14	0.08	0.06	0.14	0.16	0.13
Observations	5,900	5,900	5,900	6,222	6,214	5,900	5,900
Panels A and B:							
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports estimation results of (5) in panel A, and results when $Acq_i \times postAcq_t$ is split by minority vs. majority foreign ownership at the time of acquisition in panel B. The sample consists of plants acquired by multinationals and their matched controls. 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% level, respectively.

Table 5: Robustness checks: Impact of Ownership Structure on Efficiency using Different Samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPT	TFPQ_U	TFPQ_I
Panel A: Single-product plants only							
Minority-owned×Post-acquisition	0.0908**	0.0510	0.0398	0.0096	0.0532**	0.0659	0.1007*
	(0.0440)	(0.0533)	(0.0477)	(0.0238)	(0.0247)	(0.0577)	(0.0544)
Majority-owned×Post-acquisition	0.0166	0.1532**	-0.1368**	0.0029	0.0165	0.1577**	0.1444**
	(0.0610)	(0.0717)	(0.0625)	(0.0353)	(0.0334)	(0.0727)	(0.0624)
R-squared	0.13	0.13	0.07	0.05	0.13	0.14	0.12
Observations	3,937	3,937	3,937	4,397	4,376	3,937	3,937
Panel B: Matching on productivity and price trends							
Minority-owned×Post-acquisition	0.1076**	0.0384	0.0692	-0.0029	0.0477*	0.0552	0.0479
	(0.0503)	(0.0655)	(0.0692)	(0.0244)	(0.0280)	(0.0649)	(0.0627)
Majority-owned×Post-acquisition	0.0184	0.1604**	-0.1420*	-0.0121	0.0186	0.1740**	0.1938**
	(0.0757)	(0.0786)	(0.0814)	(0.0437)	(0.0396)	(0.0801)	(0.0779)
R-squared	0.16	0.18	0.12	0.05	0.16	0.20	0.17
Observations	4,195	4,195	4,195	4,378	4,354	4,195	4,195
Panel C: Matching with three nearest neighbours							
Minority-owned×Post-acquisition	0.1127**	0.0411	0.0715	0.0284	0.0656***	0.0564	0.0546
	(0.0504)	(0.0596)	(0.0550)	(0.0248)	(0.0252)	(0.0592)	(0.0557)
Majority-owned×Post-acquisition	0.0189	0.1619**	-0.1430**	-0.0005	-0.0012	0.1678**	0.1507**
	(0.0634)	(0.0724)	(0.0696)	(0.0372)	(0.0361)	(0.0709)	(0.0659)
R-squared	0.16	0.16	0.10	0.06	0.16	0.18	0.16
Observations	4,237	4,237	4,237	4,455	4,449	4,237	4,237
Panels A, B, and C:							
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports results of (5) when $Acq_i \times postAcq_t$ is split by minority vs. majority foreign ownership at the time of acquisition, estimated on a sample that consists of plants acquired by multinationals and their matched controls. See text for the construction of the matched sample in each panel. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, exporter, importer, and single-product status (excluded in Panel A). Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 6: Impact of Origin Countries on Efficiency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPT	TFPQ_U	TFPQ_I
Panel A: R&D intensity							
High R&D origin×Post-acquisition	0.1343**	0.1487**	-0.0145	0.0219	0.0306	0.1664**	0.1185*
	(0.0525)	(0.0662)	(0.0471)	(0.0332)	(0.0263)	(0.0658)	(0.0667)
Low R&D origin×Post-acquisition	-0.0163	0.0350	-0.0512	0.0551	0.0773**	0.0573	0.1015
	(0.0745)	(0.0776)	(0.0941)	(0.0370)	(0.0316)	(0.0789)	(0.0723)
R-squared	0.14	0.14	0.08	0.06	0.14	0.16	0.13
Observations	5,900	5,900	5,900	6,222	6,214	5,900	5,900
Panel B: EU membership							
EU member×Post-acquisition	0.0761	0.1693***	-0.0932*	0.0193	0.0522**	0.1955***	0.1363**
	(0.0495)	(0.0567)	(0.0522)	(0.0277)	(0.0227)	(0.0564)	(0.0579)
Non-EU member×Post-acquisition	0.0992*	0.0166	0.0827	-0.0175	0.0466	0.0388	0.0530
	(0.0583)	(0.0721)	(0.0739)	(0.0333)	(0.0312)	(0.0717)	(0.0719)
R-squared	0.14	0.14	0.08	0.06	0.14	0.16	0.13
Observations	5,900	5,900	5,900	6,222	6,214	5,900	5,900
Panels A and B:							
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports results of (5) when $Acq_i \times postAcq_t$ is split by the R&D intensity and EU membership of the origin country of the foreign parent at the time of acquisition in panels A and B, respectively, estimated on a sample that consists of plants acquired by multinationals and their matched controls. 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% level, respectively.

Table 7: Mechanisms: Impact of Ownership Structure on Plant-level Changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	Market share	Exporter	Share of exports	Importer	Share of imported inputs	R&D spending	Intangible use
Minority-owned×Post-acquisition	-0.0027	-0.0584	0.0035	-0.0099	0.0125	0.0149	0.1096***
	(0.0025)	(0.0371)	(0.0186)	(0.0415)	(0.0185)	(0.0303)	(0.0312)
Majority-owned×Post-acquisition	0.0052*	0.1008**	0.0181	0.1104**	0.0569**	0.0793*	0.0957***
	(0.0031)	(0.0475)	(0.0235)	(0.0462)	(0.0255)	(0.0416)	(0.0320)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.13	0.04	0.03	0.04	0.04	0.12	0.04
Observations	8,827	8,827	8,827	8,827	8,827	8,827	8,827

Notes: This table reports results of (5) when $Acq_i \times postAcq_t$ is split by minority vs. majority foreign ownership at the time of acquisition, estimated on a sample that consists of plants acquired by multinationals and their matched controls. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), and skill intensity. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 8: Mechanisms: Impact of Acquisitions by Industry Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPT	TFPQ_U	TFPQ_I
Panel A: Industries that are more dependent on external finance							
Acquired×Post-acquisition	0.1230**	0.1621**	-0.0391	0.0369	0.0678**	0.1537**	0.1544**
	(0.0572)	(0.0723)	(0.0556)	(0.0358)	(0.0298)	(0.0726)	(0.0683)
R-squared	0.14	0.15	0.08	0.08	0.18	0.17	0.15
Observations	3,117	3,117	3,117	3,383	3,358	3,117	3,117
Panel B: Industries that are less dependent on external finance							
Acquired×Post-acquisition	0.0503	0.0536	-0.0034	-0.0131	0.0295	0.0960*	0.1129*
	(0.0545)	(0.0540)	(0.0681)	(0.0205)	(0.0302)	(0.0530)	(0.0575)
R-squared	0.15	0.14	0.09	0.05	0.12	0.16	0.13
Observations	2,783	2,783	2,783	2,839	2,856	2,783	2,783
Panel C: Industries that are more intensive in R&D							
Acquired×Post-acquisition	0.1277*	0.1707**	-0.0431	0.0333	0.0719**	0.1647**	0.1804**
	(0.0676)	(0.0856)	(0.0659)	(0.0390)	(0.0339)	(0.0828)	(0.0802)
R-squared	0.12	0.15	0.08	0.07	0.17	0.16	0.14
Observations	2,322	2,322	2,322	2,537	2,536	2,322	2,322
Panel D: Industries that are less intensive in R&D							
Acquired×Post-acquisition	0.0576	0.0537	0.0040	0.0003	0.0334	0.0857	0.0922*
	(0.0486)	(0.0523)	(0.0584)	(0.0218)	(0.0272)	(0.0536)	(0.0544)
R-squared	0.16	0.15	0.09	0.06	0.14	0.17	0.14
Observations	3,578	3,578	3,578	3,685	3,678	3,578	3,578
Panel E: Industries with more product differentiation							
Acquired×Post-acquisition	0.0430	0.0688	-0.0259	0.0133	0.0308	0.0600	0.1105**
	(0.0454)	(0.0525)	(0.0455)	(0.0267)	(0.0248)	(0.0556)	(0.0495)
R-squared	0.13	0.13	0.08	0.07	0.16	0.14	0.13
Observations	4,239	4,239	4,239	4,520	4,501	4,239	4,239
Panel F: Industries with less product differentiation							
Acquired×Post-acquisition	0.1184*	0.1644**	-0.0460	-0.0356	0.0722**	0.2012***	0.1836**
	(0.0634)	(0.0745)	(0.0804)	(0.0271)	(0.0363)	(0.0720)	(0.0766)
R-squared	0.18	0.19	0.10	0.06	0.14	0.22	0.18
Observations	1,661	1,661	1,661	1,702	1,713	1,661	1,661
Panels A-F:							
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports results of (5) estimated on samples that consist of plants acquired by multinationals and their matched controls and split into two by the acquired plant's industry characteristics. 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% level, respectively.

Table 9: Horizontal Spillovers to Domestic Plants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPQ_U	TFPQ_I	Wages
Multinational presence	0.1888	0.5931***	-0.4043**	0.1884	0.5994***	0.6353***	-0.2975**
	(0.1506)	(0.1834)	(0.1765)	(0.1363)	(0.1801)	(0.1967)	(0.1332)
Industry HHI	0.1562	-0.3153	0.4716	0.0439	-0.2543	-0.3033	0.4699
	(0.3621)	(0.4054)	(0.4183)	(0.2864)	(0.4006)	(0.4323)	(0.2960)
Market share	-0.2422	0.0389	-0.2811	-0.1298	-0.0915	-0.0950	-1.4347***
	(0.4947)	(0.5498)	(0.5135)	(0.5405)	(0.5543)	(0.5770)	(0.4251)
Markup	0.3922***	0.3082***	0.0840***		0.2952***	0.2785***	0.0440***
	(0.0125)	(0.0133)	(0.0116)		(0.0132)	(0.0144)	(0.0078)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.16	0.11	0.06	0.02	0.12	0.09	0.38
Observations	49,169	49,169	49,169	49,854	49,169	49,169	49,854

Notes: This table reports results from estimating (7) on a sample of domestic plants. Multinational presence is measured as in (6). HHI stands for the Herfindahl-Hirschman Index. Markup is measured in logs. Market share is a plant's share of employment in a 4-digit industry. 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 markup and column (7) excludes average real wage from controls. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 10: Domestic Plant Exit, Productivity, and Prices

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:			$y = 1$ if plant exits next period, 0 otherwise			
TFPR	-0.0182***					
	(0.0029)					
TFPT		-0.0127***				
		(0.0030)				
TFPQ			-0.0004		-0.0180***	
			(0.0008)		(0.0029)	
Price				-0.0011	-0.0185***	
				(0.0008)	(0.0030)	
Markup						0.0006
						(0.0035)
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.08	0.08	0.08	0.08	0.08	0.08
Observations	44,180	44,165	44,180	44,180	44,180	44,165

Notes: This table reports linear probability estimation results of (8) without the interaction term on a sample of domestic plants. All variables are measured in logs. 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% level, respectively.

Table 11: 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	-0.0197***					
	(0.0035)					
TFPR × Multinational presence	0.0320					
	(0.0341)					
TFPT		-0.0135***				
		(0.0035)				
TFPT × Multinational presence		0.0169				
		(0.0361)				
TFPQ			0.0001		-0.0192***	
			(0.0010)		(0.0035)	
TFPQ × Multinational presence			-0.0066		0.0280	
			(0.0075)		(0.0341)	
Price				-0.0022**	-0.0207***	
				(0.0010)	(0.0036)	
Price × Multinational presence				0.0136*	0.0394	
				(0.0076)	(0.0348)	
Markup						0.0039
						(0.0045)
Markup × Multinational presence						-0.0673
						(0.0491)
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.09	0.08	0.08	0.08	0.09	0.08
Observations	44,180	44,165	44,180	44,180	44,180	44,165

Notes: This table reports linear probability estimation results of (8) on a sample of domestic plants. Multinational presence is measured as in (6). All variables are measured in logs. 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% level, respectively.

Table 12: Impact of Multinational Presence on the Industry Price Index

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	P^k	P^k_F	P^k_D	P^k	P^k_F	P^k_D
Multinational presence	-111.8510**	-139.7465**	-82.5496*			
	(48.4386)	(60.7910)	(44.1805)			
Multinational presence ×				-111.6759	-174.6024	-119.0289
More open				(100.2357)	(122.4805)	(122.1690)
Multinational presence ×				-111.9355***	-122.9448***	-64.9654***
Less open				(34.5619)	(39.9005)	(21.9753)
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.81	0.77	0.78	0.81	0.77	0.78
Observations	216	216	216	216	216	216

Notes: This table reports OLS estimates of how multinational presence affects the aggregate price index at the industry level. Multinational presence is measured as in (6). See text for the calculation of the industry price index and its sub-components. Standard errors are clustered at the industry level and given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Online Appendix

"Ownership Structure and Productivity of Multinationals"

This Appendix describes the details of the productivity estimation outlined in the main paper and presents additional results of the econometric analysis. The main text outlines the steps we follow to derive consistent estimates for output elasticities in a production function. Here we provide a step-by-step description. To recap, consider a production function for plant i producing product j at time t:

$$Q_{ijt} = F_{jt}(L_{ijt}, K_{ijt}, M_{ijt})\Omega_{it} \tag{9}$$

where Q is physical output, L denotes labour input, K denotes capital stock, and M denotes materials, all measured in physical units. Plant-level physical productivity is given by Ω_{it}; that is, while technology is assumed to be specific to product j, productivity is assumed to be specific to plant i. Taking logs and allowing for measurement error and idiosyncratic shocks to output yields:

$$q_{ijt} = f_j(l_{ijt}, k_{ijt}, m_{ijt}; \beta) + \omega_{it} + \varepsilon_{ijt} \tag{10}$$

where β is the vector of coefficients on physical inputs and ω_{it} is unobserved (to the econometrician) productivity. We use a translog specification for the functional form of $f_j(.)$ because of its flexibility:

$$\begin{aligned} q_{ijt} \quad = \quad & \beta_l l_{ijt} + \beta_k k_{ijt} + \beta_m m_{ijt} + \beta_{ll} l_{ijt}^2 + \beta_{kk} k_{ijt}^2 + \beta_{mm} m_{ijt}^2 + \beta_{lk} l_{ijt} k_{ijt} \\ & + \beta_{lm} l_{ijt} m_{ijt} + \beta_{km} k_{ijt} m_{ijt} + \beta_{lkm} l_{ijt} k_{ijt} m_{ijt} + \omega_{it} + \varepsilon_{ijt} \end{aligned} \tag{11}$$

As described in the main text, we follow Ackerberg et al. (2006) and De Loecker et al. (2016), who extend the control function approach of Olley and Pakes (1996) and Levinsohn and Petrin (2003). This methodology controls for the simultaneity bias that arises due to the correlation between unobserved productivity and input use, while allowing future productivity to be affected by plant decisions today. In particular, we control for unobserved productivity in (11) using a control function based on a static input demand equation. The materials demand function is assumed be a function of productivity and additional variables that affect material demand: $m_{it} = m(\omega_{it}, k_{it}, l_{it}; \mathbf{z}_{it})$, where $\mathbf{z}_{it}$ include a plant's ownership dynamics, participation in international trade, and time dummies (note that we drop the product subscript j as we focus on single-product plants for the estimation of the production function). Inverting the material demand function gives the control function for productivity: $\omega_{it} = h_t(m_{it}, k_{it}, l_{it}; \mathbf{z}_{it})$. Accordingly, we allow productivity to evolve endogenously with a plant's equity ownership dynamics and participation in international trade. For instance, if input use systematically adjusts following an acquisition, then standard approaches, 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). In other words, standard approaches would underestimate productivity if productivity gains from an acquisition also lead to an increase in capital stock.

To estimate the production coefficients, we form moments based on the idiosyncratic shocks to productivity. Accommodating the single-product selection correction and endogenous productivity dynamics, we consider the following law of motion for productivity:

$$\omega_{it+1} = g_t(\omega_{it},\, FO_{it},\, Exp_{it},\, Imp_{it},\, SP_{it+1}) + \xi_{it+1} \tag{12}$$

where FO_{it} is a vector that captures a plant's history of foreign ownership, Exp_{it} and Imp_{it} are indicators for exporting and importing, SP_{it+1} is the probability of remaining single-product next period[26], and ξ_{it+1} captures shocks to productivity. We assume, as in Braguinsky et al. (2015):

$$g(\omega_{it},\, FO_{it}) = \sum_{k=1}^{3} \gamma_k \omega_{it}^k + \vartheta_1 preFO_{it} + \vartheta_2 earlyFO_{it} + \vartheta_3 lateFO_{it} \tag{13}$$

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. 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.

Estimation proceeds in two stages. In a first stage, predicted output is obtained from the regression:

$$q_{it} = \phi_t(l_{it}, k_{it}, m_{it}, \mathbf{z}_{it}) + \varepsilon_{it} \tag{14}$$

[26] We estimate this probability using a probit model by each 2-digit ISIC industry. We define an indicator term that equals 1 if the plant remains a single-product in the next period and 0 otherwise, and regress this indicator on all inputs in (11), year dummies, and the plant's ownership, exporting, and importing status.

where the vector $\mathbf{z}_{it}$ includes all variables that affect intermediate input demand as described above, except for input expenditures and productivity. In practice, we regress physical output (q_{it}) on all the inputs in a translog specification as in (11) and proxy variables included in $\mathbf{z}_{it}$.

In a second stage, we can compute ω_{it} using expected output ($\hat{\phi}_{it}$) and any value of the vector β:

$$\begin{aligned}\omega_{it}(\beta) \;=\; & \hat{\phi}_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} - \beta_{ll} l_{it}^2 - \beta_{kk} k_{it}^2 - \beta_{mm} m_{it}^2 \\ & -\beta_{lk} l_{it} k_{it} - \beta_{lm} l_{it} m_{it} - \beta_{km} k_{it} m_{it} - \beta_{lkm} l_{it} k_{it} m_{it}\end{aligned}$$

We then regress $\omega_{it}(\beta)$ non-parametrically on past productivity, $\omega_{it-1}(\beta)$, and indicators for a plant's ownership history, exporting, importing, and probability of remaining single-product next period. We use a third-order degree polynomial to approximate the law of motion for productivity. This approximates the law of motion in (12) and gives us the shocks to productivity, $\xi_{it}(\beta)$. The coefficient vector β is then identified by using standard GMM techniques on the following moment conditions:

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

where $\mathbf{B} = (l_{it-1},\, k_{it},\, m_{it-1},\, l_{it-1}^2,\, k_{it}^2,\, m_{it-1}^2,\, l_{it-1}k_{it},\, m_{it-1}k_{it}\,, l_{it-1}m_{it-1},\, l_{it-1}m_{it-1}k_{it})'$. These are valid instruments as they are chosen before shocks to productivity are observed. Following standard convention, we estimate the production function for each 2-digit ISIC industry. Since we estimate a translog specification, output elasticities ($\theta_{it}^L, \theta_{it}^K, \theta_{it}^M$) are computed using the estimated β's and current inputs, so they vary across plants and time. For instance, the output elasticity of labour is given by $\theta_{it}^L = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lk} k_{it} + \hat{\beta}_{lm} m_{it} + \hat{\beta}_{lkm} k_{it} m_{it}$; θ_{it}^K and θ_{it}^M are similarly defined.

Additional Tables & Results

Table A.1: Calculation of Various Productivity Measures

Variable	Description	*Measure used in the calculation of TFP:*				
		Output	Labour	Materials	Capital	Deflator
TFPQ	Quantity-based measure that reflects physical efficiency	Production in physical units	Worker-hours	Consumption of inputs	Fixed assets	Product
TFPR	Revenue-based measure that combines physical efficiency and prices; *TFPR = TFPQ + price*	Production value	Worker-hours	Consumption of inputs	Fixed assets	Product
TFPQ_U	Quantity-based measure that confounds utilisation into physical efficiency	Production in physical units	Number of workers	Consumption of inputs	Fixed assets	Product
TFPQ_I	Quantity-based measure that confounds inventories into physical efficiency	Sales in physical units	Worker-hours	Purchases of inputs	Fixed assets	Product
TFPT	Revenue-based measure that confounds utilisation, inventories, and price heterogeneity across plants	Revenues from sales	Number of workers	Purchases of inputs	Fixed assets	Industry

Notes: This table describes the various productivity measures used in the analysis and lists the variables used in their construction. All productivity measures are in logs. TFPR is measured as the sum of TFPQ and (log) real price. Product deflators are at the 8-digit level following the national classification; industry deflators are at the 4-digit ISIC Rev. 2 level.

Table A.2: Average Output Elasticities

		(1)	(2)	(3)	(4)	(5)
ISIC	Sector	Observations	Labour	Capital	Materials	RTS
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. ISIC is the International Standard Industrial Classification Rev. 2. Column 1 reports the number of observations included in each estimation. Columns 2-4 report average output elasticities θ^L, θ^K, and θ^M derived from the translog production function across all plants; standard deviations are reported in brackets. Column 5 reports the average returns to scale.

Table A.3: Summary statistics

	Mean	Median	Standard deviation	Inter-quartile range	Observations
TFPR	5.82	5.99	3.54	3.64	77,413
TFPQ	9.05	9.01	4.98	5.04	77,413
TFPQ_U	9.08	9.02	4.99	5.00	77,413
TFPQ_I	8.98	8.94	4.98	5.03	77,424
TFPT	5.58	5.70	3.55	3.56	96,463
Price	-3.25	-3.34	3.36	3.45	77,413
Markup	1.33	1.09	0.81	0.52	94,722
Multinational presence	0.05	0.02	0.07	0.05	101,016
Inventory to sales	0.15	0.03	6.24	0.11	101,006
Labour	3.88	3.69	1.14	1.49	101,016
Capital intensity	3.92	4.03	1.77	2.13	97,572
Average wage	3.59	3.47	0.70	0.92	101,014
Skill intensity	0.19	0.16	0.16	0.18	101,016
Age	2.32	2.40	0.89	1.15	101,015
Exporter	0.20	0.00	0.40	0.00	101,016
Importer	0.22	0.00	0.41	0.00	101,016
Single-product	0.54	1.00	0.50	1.00	101,016
Share of exports	0.07	0.00	0.19	0.00	101,016
Share of imported inputs	0.06	0.00	0.17	0.00	101,016

Notes: All variables in logs except markup, multinational presence, inventory to sales, skill intensity, exporter, importer, single-product, share of exports, and share of imported inputs.

Table A.4: Predicting Acquisitions by Multinationals

Dependent variable:	$y = 1$ if acquired by a multinational, 0 otherwise		
TFPQ	0.0002	Average wage	-0.0002
	(0.0004)		(0.0012)
TFPQ × Plant age	0.00005	Average wage × Plant age	0.0015***
	(0.00007)		(0.0005)
Price	0.0004	Capital intensity	0.0003*
	(0.0004)		(0.0002)
Markup	0.0013*	Capital intensity^2	0.00003**
	(0.0007)		(0.00001)
Plant age	-0.0050***	Skill intensity	0.0075
	(0.0019)		(0.0055)
Plant age^2	-0.0009**	Skill intensity^2	-0.0039
	(0.0004)		(0.0063)
Employment	0.0023	Share of exports	0.0029**
	(0.0017)		(0.0013)
Employment^2	-0.0001	Share of imported inputs	-0.0001
	(0.0002)		(0.0013)
		Single-product status	0.0001
			(0.0007)
Pseudo-R squared	0.14		
Observations	49,167		

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% level, respectively.

Table A.5: **Balancing Test of the Nearest-Neighbour Matching Exercise**

		(1)	(2)	(3)	(4)
		Acquisitions	Controls	t-test	p-value
TFPQ	*Unmatched*	8.19	8.56	-1.26	0.21
	Matched	8.19	8.32	-0.27	0.79
Price	*Unmatched*	-2.72	-3.16	2.06	0.04
	Matched	-2.72	-2.89	0.50	0.62
Markup	*Unmatched*	0.32	0.16	6.06	0.00
	Matched	0.32	0.29	0.63	0.53
Age	*Unmatched*	2.44	2.48	-0.61	0.55
	Matched	2.44	2.49	-0.52	0.60
Employment	*Unmatched*	4.85	4.04	10.09	0.00
	Matched	4.85	4.78	0.54	0.59
Capital intensity	*Unmatched*	5.01	4.04	8.06	0.00
	Matched	5.01	4.93	0.46	0.65
Average wage	*Unmatched*	4.28	3.62	13.80	0.00
	Matched	4.28	4.21	0.92	0.36
Skill intensity	*Unmatched*	0.30	0.20	9.32	0.00
	Matched	0.30	0.29	0.58	0.56
Share of exports	*Unmatched*	0.13	0.09	2.56	0.01
	Matched	0.13	0.12	0.45	0.66
Share of imported inputs	*Unmatched*	0.15	0.07	5.64	0.00
	Matched	0.15	0.14	0.10	0.92
Single-product status	*Unmatched*	0.38	0.44	-1.95	0.05
	Matched	0.38	0.39	-0.28	0.78

Notes: This table reports means and t-tests of equality of means for variables used in the logit estimation for predicting acquisitions (see Table A.4) after constructing our nearest-neighbour control group. Column (1) reports means for foreign acquisitions; column (2) reports means for their matched controls in the row labelled *Matched* and means in the overall sample before matching is carried out in the row labelled *Unmatched*. Columns (3)-(4) report the results of a t-test between the two groups in (1) and (2) for each row. 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.4).

Table A.6: Impact of Ownership Structure on Efficiency using Alternative Matching Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPT	TFPQ_U	TFPQ_I
Minority-owned×Post-acquisition	0.0912**	0.0535	0.0377	0.0108	0.0621***	0.0660	0.0839*
	(0.0441)	(0.0523)	(0.0469)	(0.0217)	(0.0216)	(0.0555)	(0.0502)
Majority-owned×Post-acquisition	-0.0100	0.1428**	-0.1528***	0.0079	0.0007	0.1561**	0.1431**
	(0.0631)	(0.0643)	(0.0586)	(0.0303)	(0.0284)	(0.0667)	(0.0688)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry, age, size trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.13	0.12	0.07	0.04	0.14	0.12	0.14
Observations	6,822	6,822	6,822	7,999	7,981	6,822	6,822

Notes: This table reports results of (5) when $Acq_i \times postAcq_t$ is split by minority vs. majority foreign ownership 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 (the variable list includes those in Table A.4, but replaces TFPQ and price with TFPR). 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% level, respectively.

Table A.7: Horizontal Spillovers to Domestic Plants - Single-product Plants Only

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	TFPR	TFPQ	Price	Markup	TFPQ_U	TFPQ_I	Wages
Multinational presence	0.1690	0.4098***	-0.2408*	0.0873	0.4534***	0.4470***	-0.3414***
	(0.1150)	(0.1419)	(0.1441)	(0.0996)	(0.1457)	(0.1590)	(0.1102)
Industry HHI	0.3016	-0.0641	0.3657	-0.0083	-0.0893	-0.0094	0.4882**
	(0.3217)	(0.3349)	(0.3539)	(0.2347)	(0.3438)	(0.3515)	(0.2377)
Market share	0.1370	0.0648	0.0722	-0.1038	0.0456	-0.1693	-0.6949**
	(0.3588)	(0.3900)	(0.4314)	(0.2838)	(0.3880)	(0.4235)	(0.3015)
Markup	0.4108***	0.3096***	0.1013***		0.3030***	0.2820***	0.0413***
	(0.0104)	(0.0111)	(0.0096)		(0.0113)	(0.0119)	(0.0064)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.16	0.11	0.06	0.02	0.13	0.10	0.38
Observations	35,326	35,326	35,326	35,837	35,326	35,326	35,837

Notes: This table reports results from estimating (7) on a sample of single-product domestic plants. Multinational presence is measured as in (6). HHI stands for the Herfindahl-Hirschman Index. Markup is measured in logs. Market share is a plant's share of employment in a 4-digit industry. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, and exporter and importer status. Column (6) excludes markup and column (7) excludes average real wage from controls. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A.8: Domestic Plant Exit, Productivity, and Prices in the Presence of Multinationals - Single-product Plants Only

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	$y = 1$ if plant exits next period, 0 otherwise					
TFPR	-0.0180***					
	(0.0032)					
TFPR × Multinational presence	0.0138					
	(0.0336)					
TFPT		-0.0102***				
		(0.0029)				
TFPT × Multinational presence		0.0020				
		(0.0317)				
TFPQ			0.0000		-0.0175***	
			(0.0010)		(0.0033)	
TFPQ × Multinational presence			-0.0076		0.0090	
			(0.0068)		(0.0337)	
Price				-0.0020**	-0.0189***	
				(0.0010)	(0.0033)	
Price × Multinational presence				0.0136**	0.0209	
				(0.0069)	(0.0341)	
Markup						0.0043
						(0.0043)
Markup × Multinational presence						-0.0480
						(0.0467)
Industry × year effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.08	0.08	0.08	0.08	0.08	0.08
Observations	33,549	33,535	33,549	33,549	33,549	33,535

Notes: This table reports linear probability estimation results of (8) on a sample of single-product domestic plants. Multinational presence is measured as in (6). All variables are measured in logs. Plant-level controls include age, employment, capital intensity, average real wage (all in logs), skill intensity, and exporter and importer status. Standard errors are clustered at the plant level and given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.