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Acquisitions, Markups, Efficiency, and Product Quality: Evidence from India

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Abstract

This paper uses a rich panel data set of Indian manufacturing firms to analyze the effects of domestic and international acquisitions on various outcomes at target firm and product level. We apply recent methodological advances in the estimation of production functions together with information on prices and quantities to estimate physical productivity, markups, marginal costs and proxies for product quality. Using a propensity score reweighting estimator, we find that acquisitions are associated with increases in quantities and markups and lower marginal costs on average. These changes are most pronounced if acquirers are located in technologically advanced countries. We also provide evidence that the quality of products increases while quality-adjusted prices fall upon acquisitions. Our results indicate that knowledge transfer from foreign acquirers to domestic firms, predicted by theories of multinational firms, can materialize in both cost- and quality-based gains and benefit both firms and consumers.

JEL codes: *F61, F23, G34, L25, D22, D24*
Keywords: *Foreign Ownership, Mergers and Acquisitions, Multi-Product Firms, Productivity, Markups, Product Quality*

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1 Introduction

Mergers and acquisitions (M&As) play an important role in the world economy. The combined value of worldwide M&A deals exceeded \$4 trillion in 2015 and major deals often make news headlines.[1] A large share of M&A activity and global foreign direct investment (FDI) flows are cross-border acquisitions which have been increasingly targeted towards developing and emerging markets that liberalized investment and lifted ownership restrictions. The effects of acquisitions are subject to a controversial debate among researchers, practitioners, and policy makers.

Economic theory offers opposing predictions regarding the impact of M&As. On the one hand, M&As can increase market power and prices at the expense of consumers. On the other hand, they may induce productivity gains through knowledge transfer and complementary assets or the reallocation of resources to more efficient uses which may benefit consumers in the form of improved products or lower prices (e.g., Farrell and Shapiro, 1990; Neary, 2007).[2] Potential efficiency gains can be substantial in cross-border M&As which transfer superior technology or management practices across borders towards less advanced economies. Measuring these gains is, however, a challenging task. Commonly used proxies of revenue-based productivity could vary across firms due to cost-based efficiency, but they might also reflect heterogeneity in markups as well as differences in demand and product quality (e.g., Braguinsky et al., 2015; De Loecker et al., 2016; Forlani et al., 2016).[3] In particular, increases in market power upon acquisition which lead to higher prices and markups would show up as higher values in common measures of productivity even in the absence of efficiency gains (Syverson, 2011).

This paper provides evidence on the effects of international and domestic M&As using a rich data set of Indian manufacturing firms. A unique feature of this data set is that it contains information on prices and quantities at the firm-product level next to standard measures of firms' input expenditures. This information, together with recent methodological advances in the estimation of production functions, allows us to estimate markups, marginal costs, physical productivity, and proxies for product quality, and to analyze how these variables change as a result of M&As.

The lack of reliable information on these variables across a broad set of industries has been a major constraint for the previous literature on international M&As. Using revenue-based measures, a number of empirical studies have documented significant performance gains in target firms after international acquisitions (e.g., Arnold and Javorcik, 2009; Chen, 2011; Guadalupe et al., 2012).

[1] See, for instance, http://www.wsj.com/articles/2015-becomes-the-biggest-m-a-year-ever-1449187101, accessed Dec 28, 2017.

[2] See section 2 for a detailed discussion.

[3] Variation in prices and product quality have indeed been found to be of similar importance as cost based advantages in explaining the performance of firms in international markets (e.g., Eckel et al., 2015; Hallak and Schott, 2011; Hallak and Sivadasan, 2013; Kugler and Verhoogen, 2012).

However, other scholars have argued that the effects of cross-border M&As are not that different from other ownership changes (e.g. Fons-Rosen et al., 2013; Gugler et al., 2003; Wang and Wang, 2015).[4] While it seems plausible that the effects of foreign acquisitions can be quite heterogeneous across countries and target firms, the inconclusiveness of previous results might be partly due to data limitations.

A growing literature estimating the effects of (domestic) M&As on prices and efficiency has to date produced mixed results.[5] Yet, these studies are limited to very specific industries and merger cases for which prices or variables to measure efficiency are readily available. Furthermore, we know little about the effects of *cross-border* acquisitions on outcomes at the product level such as prices, marginal costs, markups, and product quality. Evidence on the effects of M&As on these outcomes across a large set of industries is, however, essential to obtain deeper insights into the effects of domestic and international acquisitions.

This paper addresses this gap and studies how M&As affect the performance of Indian manufacturing firms in various dimensions. The case of India is particularly interesting for several reasons. First, previous research has found that the Indian economy has been characterized by substantial misallocation of inputs across firms (Hsieh and Klenow, 2009) and high within-industry dispersion of productivity compared to other countries (see, for instance, Syverson, 2011). This implies a high potential for efficiency gains from reallocation via ownership changes. Furthermore, various economic reforms, including deregulation of foreign investment, have intensified competition and potentially induced M&As. Finally, in contrast to most other countries, Indian firms are required by law to report sales and quantities at the product level. This unusually rich information is essential for our empirical approach.

For the empirical analysis, we apply recent methodological advances in the estimation of production functions proposed by De Loecker et al. (2016). A unique feature of this estimation technique is the explicit treatment of a quantity-based production function and unobserved input allocation across products of multi-product firms. The methodology also accounts for endogeneity of inputs and controls for variation in unobserved input prices. Estimates of production function parameters make it possible to estimate markups at the firm-product level and a measure of physical productivity at the firm level. Estimated markups and observed prices can then be used to recover marginal costs. The availability of product-level data also allows us to construct proxies of product quality, such as variations in quantities conditional on price within product categories.

[4]There is a large literature on the effects of M&As on efficiency-related outcomes which either analyzes domestic transactions or does not explicitly distinguish between domestic and international M&As (e.g. Blonigen and Pierce, 2016; David, 2013; Maksimovic and Phillips, 2001).

[5]For recent empirical studies see Braguinsky et al. (2015) and the overview of related literature in Ashenfelter et al. (2014).

We use these estimated values along with other outcomes to study the pre- and post- acquisition performance of target firms. Since acquisition targets might not be selected randomly, we apply propensity score matching and reweighting to construct an adequate control group of non-acquired firms with similar characteristics. We compare changes in outcome variables around the time of acquisition events between acquired firms and the control group using a difference-in-differences (DiD) estimator.

To preview our results, our estimates suggest that on average, there is a large increase in post-acquisition sales in firms targeted by domestic and foreign investors, which is mainly driven by an increase in quantities of existing products. Acquisitions lead to significant decreases in marginal costs which are fully offset by higher markups, resulting in only small changes in prices on average. We find that foreign acquisitions from technologically advanced countries have the largest effect on markups and marginal costs. The growth of prices and markups does seem to be driven by enhanced quality rather than market power. For instance, quantities increase upon acquisition both in absolute terms and conditional on prices which is in line with theories of quality upgrading. We also document a post-acquisition increase in the average unit values of material inputs, suggesting that quality of inputs is reflected in both input prices and output quality. Furthermore, we find that increases in prices and markups are concentrated among product groups and industries with a high scope for product differentiation. Based on these measures, we find that quality-adjusted prices fall significantly after foreign acquisitions. To the best of our knowledge, this paper is the first to document these patterns.

As discussed in more detail in the next section, the results of this paper are consistent with the predictions of the theoretical literature on multinational firms. This literature suggests that only the most productive firms invest into foreign markets (e.g., Helpman et al., 2004) and that the knowledge underlying this productivity advantage can be transferred to foreign subsidiaries (e.g., Markusen, 1997, 2002). Our results imply that this knowledge transfer leads to lower marginal costs in target firms and also enables them to upgrade the quality of their existing products and charge higher markups.

The rest of the paper is organized as follows. Section 2 discusses the related theoretical and empirical literature, followed by a description of the data in section 3. The empirical strategy is detailed in section 4, with results discussed in section 5. Section 6 concludes.

2 Related Literature

The literature suggests various channels through which M&As can affect outcomes of targets firms. To begin with, M&As are a means of reallocating the control of resources towards more efficient usage and better management (e.g., Breinlich, 2008; Braguinsky et al., 2015; Jovanovic and Rousseau, 2008; Maksimovic et al., 2011). Efficiency can also increase upon acquisition due to economies of scale and scope or the combination of complementary firm-specific assets of acquirer and target (e.g., Bertrand et al., 2012; Nocke and Yeaple, 2008; Norbäck and Persson, 2007). These efficiency gains imply lower production costs which can lead to lower prices and in turn higher quantities sold.

International acquisitions can have quite different effects from domestic ones. The FDI literature argues that due to large sunk costs of entering a foreign market, only firms with superior productivity can operate abroad profitably (Helpman et al., 2004). This productivity advantage has, for instance, been related to management practices (e.g. Bloom and Van Reenen, 2010) and differences in innovation and knowledge (e.g., García-Vega et al., 2015; Guadalupe et al., 2012; Stiebale, 2016). The knowledge capital model (Markusen, 2002) and related theories of multinational firms (e.g., Arkolakis et al., 2013; Ekholm and Hakkala, 2007) posit that the superior productivity of multinationals stems from knowledge generated in firms' headquarters and can be transferred across borders at relatively low costs to foreign affiliates. This can benefit acquisition targets in the form of higher productivity or lower marginal costs.

In recent trade theoretical models, firms are not only heterogeneous in terms of productivity but are also differentiated in terms of product quality (e.g., Antoniades, 2015; Hallak and Sivadasan, 2013). Knowledge transfer can also translate into superior product quality and reputation of foreign affiliates as opposed to a cost-based advantage (e.g. Eckel et al., 2015; Harding and Javorcik, 2012). If foreign acquisitions lead to increased quality of products, target firms should be able to charge higher prices and markups and to sell higher quantities conditional on price upon acquisition (e.g., Amiti and Khandelwal, 2013; Khandelwal et al., 2013). We would then also expect the increase in prices and markups to be concentrated in industries with high scope for product differentiation. Our empirical framework not only allows estimating (changes in) markups, and marginal costs, but also allows us to construct proxies for product quality as we discuss in section 4. One might intuitively expect that the superior performance characteristics of foreign investors are particularly pronounced for acquirers from technologically advanced countries (see, for instance, Branstetter and Drev, 2014; Chen, 2011; García-Vega et al., 2015). Hence, in the empirical analysis, we differentiate between foreign acquisitions from different regions.

An alternative channel that benefits target firms, which is independent of technology transfer, is the provision of market access. Improved market access via cross-border M&As can induce firms to introduce new products, upgrade the quality of existing products or invest in cost reducing innovations since the fixed costs of these can then be spread over a larger production output post-acquisition (Guadalupe et al., 2012). Further, benefits of foreign acquisitions could also arise due to lower financing costs (Erel et al., 2015; Wang and Wang, 2015). To investigate the importance of these channels, we also analyze how export shares and financial indicators change upon acquisition.

M&As might alternatively be undertaken to eliminate competitors and to increase market power (e.g. Horn and Persson, 2001; Kamien and Zang, 1990; Neary, 2007). In this case, acquisitions would lead to higher prices and lower quantities and would yield at best unchanged efficiency levels. Acquisitions might even be detrimental to firm performance if they arise only out of utility maximization by empire-building managers (Shleifer and Vishny, 1988).

Firms may change other strategic variables besides prices after M&As. For instance, they might drop products or add new ones to their portfolio and reposition their existing products to differentiate themselves from their competitors (Argentesi et al., 2016; Bernard et al., 2010; Berry and Waldfogel, 2001; Gandhi et al., 2008). An important element of product repositioning, which we study in the empirical analysis, is a change in product quality. We also provide evidence on the effects of M&As on the number of products produced.[6]

Due to the various different channels, the net impact of domestic and international M&As on product-level outcomes is ultimately an empirical matter. In a survey of the empirical literature on industry case studies of M&As, Ashenfelter et al. (2014) report that the evidence on changes in prices and efficiency is mixed and seems to depend on the characteristics of markets analyzed.[7] More recently, Braguinsky et al. (2015) find that quantity-based productivity of Japanese targets in the cotton spinning industry increased upon acquisition about a century ago. They trace this back to superior demand management by acquiring firms which leads to higher capacity utilization and lower inventories in target firms post-acquisition. Blonigen and Pierce (2016) analyze the effects on productivity and markups for acquired US plants across several industries. Their estimates indicate that post-acquisition, there is a large increase in markups but no significant change in the efficiency of acquired plants. Due to the absence of price and quantity measures in their data set, Blonigen and Pierce (2016) rely on a revenue-based production function. In contrast to our paper, they do not distinguish between between domestic and international M&As.

[6]Bernard et al. (2010) find that more than 50% of US firms that have been taken over in M&As change their product mix.

[7]For instance, while the results are ambiguous for the petroleum industry, most studies found significant price increases for banking, hospitals and other markets. Overall, price increases have been found in 36 out of 49 studies. More recent evidence by Ashenfelter et al. (2015) shows price declines after a merger in the US beer industry which are more pronounced in markets where efficiency gains are more likely to be important. In contrast, Kulick (2015) estimates substantial post-acquisition price increases among plants in the ready-to-mix concrete industry despite an increase in total factor productivity.

As mentioned earlier, the literature on foreign ownership and efficiency-related outcomes has mainly relied on revenue-based measures of productivity (e.g., Arnold and Javorcik, 2009; Chen, 2011; Fons-Rosen et al., 2013; Guadalupe et al., 2012; Wang and Wang, 2015) or studied innovation outcomes such as investment in R&D or the introduction of new products and processes (e.g., Bandick et al., 2014; Guadalupe et al., 2012). Branstetter and Drev (2014) find that foreign acquisitions, especially those with acquirers from developed countries are associated with lower prices, and higher scale and scope of target firms in Slovenia. However, their analysis focuses on export markets and does not study markups, marginal costs or measures of product quality. To the best of our knowledge, there is no evidence on how international acquisitions affect product-level outcomes such as marginal costs, quantities, and quality in target firms. We believe that analyzing these measures is of particular importance to better understand the sources behind performance changes after domestic and international acquisitions.

3 Data

Our primary data source is the Centre for Monitoring of the Indian Economy (CMIE) Prowess database, which collects company balance sheets and income statements for both publicly listed and unlisted firms from a wide cross-section of industries in manufacturing, services, utilities and financial sectors.[8] These firms cover more than 70% of industrial output from the organised sector and 75% of corporate taxes and 95% of excise taxes collected by the government. Prowess also records these firms' product-level data on quantities and values of sales and production.[9] We extracted data spanning the period 1988 (the first year firms appear in the database) until 2011 and focus on the manufacturing sector.

Firms report names of each product alongside information on their production, sales and capacities. Each product is allocated a twenty-digits code from CMIEs own internal classification of 5908 sub-industries and products. Of these, 4833 products fall under the manufactured sector.[10] We had to carry out a number of checks and make adjustments to the CMIE product codes. For instance, there were a number of cases where the same product code was attributed to different products, or where different product codes were allocated to the same product. In addition, we noticed a number of cases where product names varied in spelling and also noted frequent differences in levels of aggregation for what constitutes a product. After cleaning the data, accounting for missing values, and

[8] This database has been used in a number of recent papers, e.g. De Loecker et al. (2016); Goldberg et al. (2009, 2010a,b).

[9] The 1956 Companies Act requires Indian firms to disclose data at this level of detail.

[10] CMIE's own classification is largely based on the Indian National Industrial Classification (NIC) and the HS schedule. Example of products across different industries include shrimps, corned meat, pig iron, sponge iron, pipe fittings, rail coaches. See Goldberg et al. (2010b) for a detailed description of the product-level data in Prowess.

aggregating products to a common 12-digit level, there are 2286 clean and unique CMIE product categories in our estimation sample. Following LGKP, we choose to aggregate products because the number of observations for some narrowly defined products is very small and the degree of disaggregation varies across product categories but is quite comparable at the 12-digit level. These product codes were duly mapped onto India's 2008 revised National Industrial Classification (NIC). We augment the primary data source with a number of additional data sets from external sources which use international industrial classifications such as HS and SITC. We mapped these classifications onto NIC following the concordance tables published by Debroy and Santhanam (1993). Prowess also contains information at the firm-level such as sales, material costs, wage bill and capital stock, which we measure by gross fixed assets. Unfortunately, the data base does not contain information about the skill level of employees or the quality of capital and materials.

Data on M&A deals were sourced from the Thomson Reuters Securities Data Company (SDC) database and Bureau Van Djik Zephyr database. These provide information on M&A deal characteristics including country of origin for acquirers and targets, stakes in the acquisition (initial, acquired, and final), economic activity of acquirer and targets, etc. While there was a large overlap of M&A deals across these two databases, we pooled from both sources to ensure a wide coverage of unique M&A transactions. As the spelling of many acquirer and target names from these two databases differed from the names in Prowess, we manually matched names across these databases.[11]

Some of our measures of product quality (see section 4.2) use information from various external sources. To measure the scope of product differentiation, we classify each of the products in our database as a differentiated product or a homogenous product based on the approach proposed in Rauch (1999).[12] Our measure of quality-adjusted prices requires estimates for elasticity of substitution between varieties within a market. Such elasticities are not readily available and we proxy for these using industry-specific levels of elasticities for imports into India as estimated in Broda and Weinstein (2006).[13]

Table 1 reports the coverage of firms, products and acquisitions in our sample. Hence, for our empirical analysis, we use data on more than 9,000 firms covering over 2,200 products, distributed across 14 two-digits manufacturing industries. About 62% of the firms in our estimation sample

[11]Prowess records domestic but not international M&A transactions. Further, the information provided on M&As is limited, so we decided to use the Zephyr and Thomson databases as common sources of M&As information on domestic and foreign acquirers. While Prowess contains ownership information, it does not contain information about the origin and type of foreign investors. Further, ownership information is incomplete and missing for some types of firms and years.

[12]For details on the Rauch classification, see `http://econweb.ucsd.edu/~jrauch/rauch_classification.html`, accessed on April 30, 2016. We defined differentiated product according to the liberal classification in Rauch (1999) for our empirical analysis.

[13]For details on these trade elasticities, see `http://www.columbia.edu/~dew35/TradeElasticities/TradeElasticities.html`, accessed on July 15, 2016.

are single product firms.[14] The largest number of firms operate in the food, chemical and metals industries, with chemicals recording the largest number of products. Our sample includes 971 domestic and 367 foreign acquisitions. Domestic acquisitions refer to Indian firms that acquire other Indian firms. Foreign acquisitions refer to non-Indian firms with overseas headquarters that acquire Indian firms.[15] Among foreign acquirers, 77 are located in North America, 96 in Europe (mainly Germany, Netherlands, and the UK) and 39 in high income countries in Asia (Hong Kong, Japan, Singapore). Other countries with a high share of acquirers include Mauritius and Australia, the remaining acquirers are dispersed around the world. The largest share of acquisitions took place in the food, chemicals, pharmaceuticals, and metal sectors.

4 Empirical strategy

4.1 Estimating productivity, markups and marginal costs

To estimate productivity, markups, and marginal costs, we follow the methodology introduced by De Loecker et al. (2016), henceforth LGKP.[16] This method accounts for endogeneity of production inputs similar to standard techniques in the productivity literature (Ackerberg et al., 2015; Levinsohn and Petrin, 2003; Olley and Pakes, 1996). In addition, it relies on the availability of quantities and prices at the product level to separate true efficiency from revenue based productivity. As most (if not all) firm-product-level data sets, Prowess does not include complete information on prices of all inputs and has no information about how inputs are allocated across products for multi-product firms.[17] The main innovations of the LGKP approach are the introduction of a control function for unobserved input prices and a method to recover the allocation of inputs across products. We briefly describe the methodology below.

[14] The share of single-product firms is very similar to Bernard et al. (2010) who report a share of single-product firms of 61% in the US for the year 1997. The share of single-product firms in our sample is slightly higher than in a previous study for India by Goldberg et al. (2010b) who report a share of 53%. This difference emerges partly because coverage of relatively small firms is higher in our more recent version of Prowess and partly because we aggregate some similar product into common categories for our estimation approach. Note that in line with other studies on multi-product firms, our definition of a product refers to a category such as motorcycles or sponge iron, not a unique variety within these categories. The share of single-product firms among foreign acquisitions targets is 26%.

[15] The case where Indian firms acquire non-Indian firms overseas is beyond the scope of this paper.

[16] These authors investigate the effect of trade reforms on prices, markups and marginal costs in India using the same main data source as our paper, but covering an earlier time period.

[17] While Prowess contains data about the prices of some material inputs, it does not contain information about the price of capital. Furthermore, for a large proportion of firms, data exists only on total wage bill but not on number of employees.

Consider a production function for firm i producing a product j at time t:

$$Q_{ijt} = F_j(M_{ijt}, K_{ijt}, L_{ijt})\Omega_{it} \tag{1}$$

where Q_{ijt} denotes physical output, M_{ijt} denotes a freely adjustable input (materials in our case), K_{ijt} and L_{ijt} are capital stock and labor input respectively and Ω_{it} denotes total factor productivity (TFP). All production inputs are defined in physical units. A firm minimizes costs product-by-product subject to the production function and input costs.

As shown by De Loecker and Warzynski (2012) and LGKP, this cost minimization yields an expression for the firm-product specific markup as:

$$\mu_{ijt} = \left(\frac{P_{ijt}Q_{ijt}}{W^M_{ijt}M_{ijt}}\right)\frac{\partial Q_{ijt}(.)}{\partial M_{ijt}}\frac{M_{ijt}}{Q_{ijt}} = \frac{\theta^M_{ijt}}{\alpha^M_{ijt}} \tag{2}$$

where P_{ijt} denotes the output price, W^M_{ijt} is the input price of materials, α^M_{ijt} is the ratio of expenditures on input M_{ijt} to a product's revenue and θ^M_{ijt} is the elasticity of output with respect to this input. Intuitively, the output elasticity equals the input's revenue share only in the case of perfect competition. Under imperfect competition, the output elasticity will exceed the revenue share. As we describe below, θ^M_{ijt} can be estimated from a production function and α^M_{ijt} can be calculated, once the allocation of inputs across a firms' product has been estimated. Marginal costs (mc_{ijt}) can then be calculated as the ratio of observed prices to estimated markups:

$$mc_{ijt} = \frac{P_{ijt}}{\mu_{ijt}} \tag{3}$$

The basis for productivity estimation is the logarithmic version of equation (1) with an additive error term, ϵ_{ijt} which captures measurement errors:

$$q_{ijt} = f_j(\boldsymbol{v}_{ijt}; \boldsymbol{\beta}) + \omega_{it} + \epsilon_{ijt} \tag{4}$$

where $\boldsymbol{v}_{ijt}$ denotes a vector of logarithmic physical inputs (capital k_{ijt}, labor l_{ijt} and materials m_{ijt}) allocated to product j and ω_{it} is the log of TFP. For our application, we use a translog production function, hence:

$$\begin{aligned} f_j(\boldsymbol{v}_{ijt}; \boldsymbol{\beta}) =& \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \beta_{lm} l_{ijt} m_{ijt} + \beta_{lk} l_{ijt} k_{ijt} + \beta_{mk} m_{ijt} k_{ijt} \\ &+ \beta_{ll} l^2_{ijt} + \beta_{mm} m^2_{ijt} + \beta_{kk} k^2_{ijt} + \beta_{lmk} l_{ijt} m_{ijt} k_{ijt} \end{aligned} \tag{5}$$

The translog production function yields a physical output-material elasticity:

$$\theta_{ijt}^{M} = \beta_m + \beta_{lm} l_{ijt} + \beta_{mk} k_{ijt} + 2\beta_{mm} m_{ijt} + \beta_{lmk} l_{ijt} k_{ijt} \tag{6}$$

which varies across firms within industries and nests a Cobb-Douglas production function as a special case.

Physical inputs can be expressed as $v_{ijt} = \rho_{ijt} + \tilde{v}_{it} - w_{ijt}$ where $\tilde{v}_{it}$ denotes observed input expenditures at the firm-level, ρ_{ijt} is the log of the input share allocated to product j and w_{ijt} denotes the log of an input price index (defined as deviations from industry-specific deflators). When the log of input allocations, ρ_{ijt}, is captured by a function $A(\rho_{ijt}, \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta})$ and the log of the unobserved input price index, w_{ijt}, are captured by a function $B(w_{ijt}, \rho_{ijt}, \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta})$, output can be rewritten as a function of firm-specific input expenditures instead of unobserved product-specific input quantities:[18]

$$q_{ijt} = f_j(\tilde{\boldsymbol{v}}_{ijt}; \boldsymbol{\beta}) + A(\rho_{ijt}, \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta}) + B(w_{ijt}, \rho_{ijt}, \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta}) + \omega_{it} + \epsilon_{ijt} \tag{7}$$

Estimation of the parameters of the production function is based on a sample of single product firms for which $A(.)$ can be ignored. Unobserved input prices w_{it} in $B(.)$ are approximated by output prices (p_{it}), market shares (s_{it}), product dummies ($\boldsymbol{D_j}$),and export status (ex_{it}) to account for differences in product quality and local input markets. We also include acquisition dummies ($\boldsymbol{acq}_{it}$), as we want to allow for the possibility that acquisitions are correlated with input prices.

Material demand is assumed to be a function of productivity, other inputs, output prices, market share, product, export and acquisition dummies, hence: $\tilde{m}_{it} = m(\omega_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, \boldsymbol{D}_j, s_{it}, ex_{it}, \boldsymbol{acq}_{it})$. Inverting the material demand function yields an expression for productivity: $\omega_{it} = h(\tilde{\boldsymbol{v}}_{it}, \boldsymbol{c}_{it})$ where $\boldsymbol{c}_{it}$ includes all variables from the input demand function except input expenditures.

The use of single product firms induces a further complication of endogenous sample selection since single-product firms might be less productive compared to multi-product firms. Analogous to the exit correction proposed by Olley and Pakes (1996), the probability of remaining a single product firm (SP_{it}) is a function of previous year's productivity and an unobserved productivity cutoff.[19]

For the evolution of productivity, the following law of motion is assumed:

$$\omega_{it} = g(\omega_{i,t-1}, ex_{it}, \boldsymbol{acq}_{i,t-1}, SP_{it}) + \varsigma_{it} \tag{8}$$

[18] See LGKP for the exact functional form of $A(.)$ and $B(.)$ for the translog case.

[19] SP_{it} is estimated by a Probit regression of a dummy variable for remaining a single-product firm on $\tilde{\boldsymbol{v}}_{i,t-1}$ $\boldsymbol{c}_{i,t-1}$, investment, year and industry dummies.

In addition to export status and the probability of remaining a single product firm, we follow Braguinsky et al. (2015) and allow the evolution of productivity to depend on a vector of acquisition dummies, indicating previous domestic and foreign acquisitions. We discuss how we estimate the production functions and recover unobserved input allocation across products of multi-product firms in section B of the online appendix.

4.2 Heterogeneity in quality

As a first indicator for the importance of quality upgrading, we estimate separate effects across industries using a measure for the scope of product differentiation suggested by Rauch (1999). If firms increase the quality of their products upon acquisition, we would expect increases in markups and prices to be concentrated in industries with differentiated products. In contrast, if acquisitions increase market power, markups and prices are more likely to increase in homogenous product categories. However, we also consider more formal alternatives. Since we study a broad set of manufacturing products and industries, it is difficult to define a common measure of quality from product and firm characteristics. Hence, to measure (perceived) quality, we need to impose some additional assumptions on the demand side.

Our first direct measure of quality follows the approach of Forlani et al. (2016), which is based on two main assumptions. First, a representative consumer maximizes a utility function which is multiplicative in quality (Γ) and quantity, $U(\Gamma_{ijt}Q_{ijt})$, under a budget constraints. Second, a firm's markup over marginal costs is a function of η, the elasticity of demand: $\mu_{ijt} = \frac{\eta_{ijt}}{\eta_{ijt}-1}$. Under this condition, an expression for quality within product categories can be approximated by:

$$\gamma_{ijt} \approx \mu_{ijt}p_{ijt} + (\mu_{ijt} - 1)q_{ijt} \tag{9}$$

where $\gamma = \ln \Gamma$ and $q = \ln Q$. This measure of quality can be calculated using estimated firm-product specific markups from the production function and observed values of quantities and revenues.[20]

An alternative approach to measure quality follows recent empirical contributions (e.g., Amiti and Khandelwal, 2013; Khandelwal et al., 2013) and is based on the intuition that, within product categories, varieties with higher quality should generate higher demand conditional on price. Under the assumption that consumers maximize a CES utility function, one can write:

$$q_{ijt} + \sigma p_{ijt} = \alpha_j + \alpha_t + \zeta_{ijt} \tag{10}$$

[20]Forlani et al. (2016) show that the approach is also valid under the more general conditions $\frac{\partial p_{ijt}}{\partial \gamma_{ijt}} = \frac{\partial p_{ijt}}{\partial q_{ijt}} + 1$ and $\frac{\partial p_{ijt}}{\partial q_{ijt}} \equiv -\frac{1}{\eta_{jt}}$.

where q_{ijt} and p_{ijt} denote logarithmic quantities and prices, α_j and α_t are product and year fixed effects and σ is the elasticity of substitution between varieties within a market.[21] Quality can be inferred from this specification as $\gamma_{ijt} = \zeta_{ijt}/(\sigma - 1)$. Through the assumption of a CES utility function, this approach ignores heterogeneity of markups within product categories. Hence, this measure does not rely on our estimated production function elasticities, and we can check the robustness of our finding across alternative measures that are based on different assumptions. We use industry-specific levels of σ estimated for imports into India by Broda and Weinstein (2006) to avoid having to estimate demand for each product category. However, as a robustness check, we also follow Fan et al. (2015) and restrict σ to equal 5 or 10 across all industries. Once quality has been estimated, quality-adjusted log prices can be measured as: $p_{ijt} - \hat{\gamma}_{ijt}$.

4.3 Evaluating the effects of acquisitions

Our empirical strategy aims to identify the causal effect of domestic and foreign acquisitions. Particularly, we are interested in the average treatment effect on the treated (ATT) which involves a comparison between the actual post-acquisition outcome of a target firm and the situation had the firm not been acquired. For this purpose, we employ propensity score reweighting (to construct the counterfactual) and combine it with a difference-in-differences estimator in order to evaluate the impact of an acquisition.[22]

We first estimate the propensity score, $\hat{Pr}(acq_t = 1|\boldsymbol{x}_{t-1})$, the predicted probability of being acquired, from a Probit model which allows us to control for observable characteristics affecting acquisitions and our outcome variables of interest. The vector $\boldsymbol{x}_{t-1}$ contains only pre-acquisition characteristics in order to avoid reverse causality problems (Caliendo and Kopeinig, 2008). As we exploit a panel data set, we can relax the assumption of selection on observables. Instead of comparing differences in the levels of outcome variables between the two groups, we focus on within-firm (and within firm-product) changes of outcome variables (e.g., Arnold and Javorcik, 2009; Chen, 2011; Guadalupe et al., 2012). This procedure allows selection into the group of acquired firms to be based on the expected impact on our outcome variables (Heckman et al., 1997). Furthermore, we can control for time-invariant unobservables through the DiD estimator, while time-varying observables are controlled through the propensity score. Nevertheless, unobserved time-varying factors that influence both acquisition probability and our outcomes, as well as heterogeneous responses to macroeconomic shocks across treatment and control groups, would lead to biased estimates. Another

[21] See, for instance, Khandelwal et al. (2013) for details on the derivation. A similar specification has, for instance, also been applied by Breinlich et al. (2016) recently. Note that equation (10) is a special case of equation (9) when consumers have CES preferences and firms charge a constant markup over marginal costs within product categories.

[22] Propensity score reweighting methods are widely applied in the context of evaluating foreign acquisitions. See, for instance, Branstetter and Drev (2014) or Guadalupe et al. (2012) for recent applications.

concern is that we have to assume that our comparison group is independent of acquisitions, which could be violated in the case of spillovers or strategic interaction. As part of our robustness checks, we experiment with alternative control groups and matching estimators to show that a violation of this assumption is unlikely to drive our results.

As in Guadalupe et al. (2012), we implement the DiD estimator in a weighted regression of a fixed effects model:

$$y_{it} = \alpha_i + \varphi Acq_{it} + d_{kt} + u_{it} \tag{11}$$

where Acq_{it} takes on a value of one in all post-acquisition periods, d_{kt} represents industry-specific time dummies, α_i denotes unobserved time-invariant firm heterogeneity and u_{it} is an error term.[23] This representation makes the analysis of heterogeneous effects across firms straight forward using the following estimating equation:

$$y_{it} = \alpha_i + \varphi_0 Acq_{it} + \varphi_1 Acq1_{it} + d_{kt} + u_{it} \tag{12}$$

where $Acq1$ is an acquisition with a particular characteristic, e.g. the initial size of the target firm or the origin of the acquirer.

For outcomes that vary at the firm-product level such as prices, markups, quantities and marginal costs, equation (11) becomes:

$$y_{ijt} = \alpha_{ij} + \phi Acq_{it} + d_{jt} + u_{ijt} \tag{13}$$

where α_{ij} represents a firm-product fixed effect and d_{jt} denotes product-specific time dummies.

Different estimators are proposed in the matching literature. In our main specification, we follow Guadalupe et al. (2012) and estimate a propensity score reweighting estimator (e.g. Imbens, 2004) where we assign a weight equal to $\frac{\hat{Pr}(acq_t=1|\boldsymbol{x}_{t-1})}{1-\hat{Pr}(acq_t=1|\boldsymbol{x}_{t-1})}$ for all non-acquired firms. However, we also experiment with nearest neighbor matching, which means that each target firm has one comparison firm, implying each target firm and each matched non-acquired firm is given a weight of one.[24] We compute block-bootstrapped standard errors for all equations, based on draws of firms' time series. This accounts for some variables used in matching and DiD regressions being estimated in a previous step and allows for dependence of error terms at the firm-level across products and time periods.

[23] In the next section, we also discuss results of alternative specification in differences which estimate separate effects for each post-acquisition period up to 3 years after acquisition.

[24] Several recent contributions in the context of foreign acquisitions are based on nearest neighbour matching, e.g. Chen (2011); Javorcik and Poelhekke (forthcoming); Wang and Wang (2015).

To estimate the propensity score, we use pre-acquisition values of sales, sales growth, (quantity-based) productivity, number of products produced, export share, imports divided by sales, capital stock (gross fixed assets), and capital intensity (capital stock divided by costs of employees).[25] The model also controls for time, industry (2-digit NIC level) and region (2-digit pin code area) dummies. We conduct separate matching exercises for domestic and international acquisitions from high and low-income countries to allow the determinants of being acquired to vary between these groups. In all specifications, the control group consists of non-acquired domestic firms. We conduct a separate matching procedure for product-level outcomes and in order to control for pre-acquisition levels and trends of our product characteristics. However, as we discuss in the next section, our results are robust towards a common matching procedure at the firm-level which assigns the same weights to product-and firm-level regressions.

5 Results

5.1 Characteristics of firm- and product-level variables

In this subsection, we discuss some characteristics of our variables estimated from production functions. These are potentially important to understand the gains from acquisitions.

Table 2 reports means and standard deviations on our measures of revenue, labour, capital, materials and other variables comparing firms acquired by domestic and foreign investors in the year before acquisitions to non-acquired firms. The upper panel reports firm-level variables only. From these, we note that acquired firms generally have higher sales, face higher wage bills, higher levels of expenditure on materials, larger capital stocks and import and export more compared to non-acquired firms. They also produce more products than their non-acquired counterparts but face lower levels of physical productivity. The lower pre-acquisition productivity of acquired firms is in contrast to previous empirical evidence using revenue-based measures of TFP (e.g., Guadalupe et al., 2012). However, as discussed by Blonigen et al. (2014), acquirers might prefer either low or high productivity targets from a theoretical point of view. Further, the distinction between revenue and physical measures of TFP might matter for characterizing acquired firms (Braguinsky et al., 2015). Despite facing higher capital stocks, acquired firms are generally found to be less capital intensive.[26]

[25] As we discuss in the results section, our results are robust to including pre-acquisition trends of all regressors and controlling for a longer pre-acquisition time period. For the main specification, we prefer to control only for trends in sales between $t-2$ and $t-1$ to increase our sample size.

[26] Acquired firms are, on average, larger and characterized by higher export shares but lower TFP. Nonetheless, there is a positive association between revenue TFP on the one hand and export status and size on the other hand as commonly found in the literature. In our estimation sample, a regression of log revenue TFP on export status yields a coefficient of 0.04 and a regression on log sales yields a coefficient of 0.11, both statistically significant at the 1% level. Our measure of capital intensity uses data on wage bills rather than number of employees. The lower capital

The lower panel reports variables constructed at the product level. Markups and marginal costs are computed as per equations (2) and (3). All product-level variables are reported as demeaned logged values, i.e. they are purged of product-year fixed effects. This allows us to compare quantities, prices, and costs relative to other firms producing the same product across the different groups.[27] On average, we find that acquired firms produce higher relative quantities and charge higher prices for their product compared to non-acquired firms. These differences are more pronounced for targets of foreign acquirers. On the cost side, we observe that firms acquired by domestic or foreign investors produce with slightly higher marginal costs. We also find that targets of foreign acquirers have higher markups compared to domestic acquired and non-acquired firms.

Table 3 depicts median and mean elasticities of output with respect to all inputs estimated from separate production functions for each industry. Since we use a translog, rather than a Cobb-Douglas production function, elasticities and return to scale parameters vary not only across industries but also across firms and firm-products within industries. This is important for our analysis because it does not constrain the markups to depend on a firm's material share only. The estimates indicate increasing returns to scale with an average measure of 1.1 across all industries. Returns to scale for the median firm within each industry are above 1 in 12 out of 14 cases and range between 0.94 and 1.44.

Table 4 shows average and median markups of products across industries. While the average markup of 2.82 seems quite high, the median markup is 1.33 for the whole sample and ranges from 1.16 to 1.65 for the median firm within each industry. These figures are similar to those obtained by LGKP who estimate a markup distribution for Indian manufacturing firms over an earlier time period, reporting an average of 2.70 and a median of 1.34.

Following LGKP, we ran some regressions to investigate the plausibility of these estimates of returns to scale. In a first set of analysis, we correlate logarithmic values of markups and marginal costs with quantities. We demean all these variables by product-unit-year fixed effects to make them comparable across firms, products and time periods. These results are reported in Tables A1 and A2 in the online appendix. We find a positive association between quantities and markups and a negative correlation between marginal costs and quantities, which are consistent with increasing returns to scale; although these correlations do not necessarily reflect causal relationships between

intensity through higher wage bills of the acquired firms could possibly reflect a high share of skilled employees who receive relatively high wages.

[27]As an example, ln(quantity residual) is equivalent to $ln(quantity)_{ijt}$-$\frac{\sum(ln(quantity)_{ijt}}{N_{jt}}$ where N_{jt} denotes the number of firms producing product j at time t.

variables.

Next, we examine the role of multi-product firms. Recent theoretical contributions (e.g. Eckel and Neary, 2010; Mayer et al., 2014) posit that multi-product firms have core competencies, which implies that products with higher sales shares within firm-years are associated with higher markups and lower marginal costs, with columns (3) and (4) of Table A1 confirming that this is indeed the case within our sample. We also found that within-firm increases in the number of products are associated with increased TFP (see table A2, column (1) in the online appendix). This result is in line with economies of scope at the firm level. However, an alternative explanation stems from theories of multi-product firms which predict that productivity shocks may induce firms to add or drop products (e.g. Bernard et al., 2010).

Table A2 in the online appendix also reports correlations for estimates of TFP, markups, and marginal costs. We find a positive correlation between productivity and markups in column (3) and a negative correlation between productivity and marginal cost in column (2) which seems plausible. Column (4) suggests evidence of incomplete pass-through of marginal costs to prices with a rate slightly below 0.3 which is comparable to LGKP. All in all, these statistics suggest that our estimated measures display plausible correlations and indicate the possible presence of economies of scale, which is potentially an important gain from acquisitions.

5.2 Results from difference-in-differences estimates

We now analyze how our outcome variables change around the time of acquisition compared to non-acquired firms. As described in the previous section, our analysis is based on propensity score matching and reweighting combined with a DiD estimator.

Table 5 shows results of Probit models used for the estimation of propensity scores. The coefficients indicate that the selection profile of domestic and foreign acquisitions is quite similar. Within industries, exporters as well as firms with a large value of sales and capital are more likely to be acquired. Conditional on these variables, productivity and pre-acquisition growth do not affect the probability of being acquired significantly. Import intensity is a significant predictor of foreign but not domestic acquisitions. Export and import intensity are associated with higher propensity of foreign acquisitions with investors from high income countries but not from low income countries. Table 6 shows, for both types of acquisitions, differences between acquisition targets and the control group after matching. While the unmatched groups look very different as documented in Table 2, particularly in terms of sales, sales growth, TFP, and capital stock, there are no statistically significant differences in any of the variables employed in the matched sample.

Table 7 depicts results of the reweighting DiD estimation on various dimensions of firm-level outcomes conducted on the matched sample. Each outcome variable is regressed on a dummy variable that takes on value one in all years after a firm has been acquired, firm fixed effects and industry-specific time dummies. Results for foreign acquisitions are reported in Panel A. In column (1), we find that post-acquisition, target firms significantly increase the total value of sales by more than 10%. The average impact on physical TFP (column 2) is positive but not statistically significant. However, this average effect hides a lot of heterogeneity. In column (3), we add an interaction term between foreign acquisitions and an indicator variable for small target firms – which takes a value of one for all target firms with sales below the median of acquired firms, measured in the pre-acquisition year. The estimates suggest that these firms experience a large and significant increase in TFP. A possible explanation for these heterogeneous effects is that smaller firms are likely to operate relatively far away from the technological frontier and thus can learn relatively more from their acquirers.[28] As we discuss below, we find more robust evidence for efficiency gains once our analysis moves to the product level.[29]

Panels B and C shows heterogeneous effects of international acquisitions by investor origin. In particular, we analyze whether effects are different if acquirers are located in a high income (HI) country.[30] We identify this group if the acquirer is from the US, Europe, Australia, Japan, Canada, Singapore or Hong Kong, which applies to 60% of all foreign acquisitions. Arguably, these countries, are technologically more advanced than India, which implies a high potential for knowledge transfer to target firms. The remaining countries are classfied as countries with relatively low income (LI).[31] Our results suggest that acquirers from more advanced economies have, on average, quite similar effects on sales of target firms as acquirers from LI countries. They seem to have somewhat larger effects on TFP, although this result is only weakly statistically significant. In contrast to other

[28]Unfortunately, we do not have detailed data for most of our foreign acquirers which prevents us from analyzing this channel in more detail. In a previous version of this paper, we estimated heterogeneous effects for a sample of single product firms. We discuss these results in the online appendix where we also show that higher TFP growth in single product firms upon acquisition can be explained by smaller average size rather than producing a single product per se.

[29]The absence of significant average TFP effects does not necessarily imply that foreign acquisitions have no average effects on the efficiency of production. First, changes in TFP do not capture economies of scale. Second, increases in fixed costs might imply lower TFP but do not affect marginal costs. Third, measurement error might play a more important role for TFP compared to marginal cost estimates. We discuss these issues in more detail in section C of the online appendix.

[30]Amongst others, Branstetter and Drev (2014), Chen (2011) and García-Vega et al. (2015) provide evidence that the origin of foreign investors matters.

[31]We conducted a common matching and DiD approach for foreign acquirers from different regions in which *Foreign acquirer HI* measured the difference between the effects of acquirers from HI regions compared to LI countries. We discuss these estimates in the robustness section. In the specifications depicted in Table 7, *Foreign acquirer HI* measures the total effect of foreign acquisitions with acquirers from HI countries compared to the counterfactual of no acquisition.

investors, they do not affect the number of products by much, but they increase the share of exports and imports significantly. As we describe below, there are, however, more substantial differences between acquirers from different countries at the product level. Panel C depicts results for domestic acquisitions. These acquisitions seem to cause a similar increase in sales and the number of products compared to foreign acquisitions on average. There is, however, no evidence for significant changes in TFP, exports or imports.

To analyze the source of output expansion, we turn to regression results at the firm-product level based on the sample of matched firm-products. Estimates of the propensity score estimation for firm-products are documented in Table A3 in the online appendix. Conditional on firm-level variables, most product-level variables are insignificant predictors of acquisitions with the exception of changes in prices and quality for foreign acquisitions, mainly due to acquirers from LI countries.[32] Table 8 shows DiD results of various product-level outcomes: sales, quantities, prices, markups and marginal costs. Since we employ firm-product fixed effects in all estimations, this specification solely identifies the effect of acquisitions on products that are produced by a firm during at least one year pre- and post-acquisition.[33] We also include product-year fixed effects to capture changes in demand and production costs common to all firms that produce a particular product.

Table 8 reports our estimates at the firm-product level. To begin with, Panel A depicts product-level results for foreign acquisitions. It is not surprising that the finding of an increase in revenue at the firm-level is also reflected at the product-level (column 1). Columns (2) and (3) indicate that this increase is mainly driven by a rise in quantities while the growth of prices is positively but only weakly significantly affected. In columns (4) and (5), we decompose the change in price into changes in markups and marginal costs.[34] While acquired firms are able to substantially lower their marginal costs by more than 10%, this effect is fully offset by higher markups. Decreases in marginal costs might partly result from economies of scale which is line with the expansion of quantities produced and the evidence of increasing returns to scale in Table 3. The decrease in marginal costs might also stem from technology transfer from foreign acquirers, as predicted by the literature on international trade and FDI (e.g., Guadalupe et al., 2012; Nocke and Yeaple, 2007).[35]

[32] We match on both firm and product characteristics to control for pre-acquisition differences in product-level outcomes. This implies a different set of weights compared to Table 7. However, as we discuss in the next subsection and document in Table A7 in the online appendix, our results are very similar if we conduct our DiD regressions for product-level outcomes based on a sample matched on firm-characteristics only, i.e. the same sample and weights used in Table 7.

[33] We found that products added and dropped account for only a small share of firms' sales in the first years after acquisitions. Therefore, our analysis focuses on changes in existing products.

[34] Note that the coefficient for the log of sales at the product level exactly equals the sum of the coefficient for log quantities and log prices. The coefficient for log price equals the sum of the coefficients for log markups and log marginal costs.

[35] Table A5 in the online appendix shows results for specifications in differences for up to three years after foreign

If technology transfer is important, we should see larger decreases in marginal costs if acquirers are located in technologically advanced countries. As Panel B and C of Table 8 shows, there is indeed substantial heterogeneity with respect to investor origin. Similar to the firm-level regressions, the average change in revenues is not very different for acquisitions from technologically advanced countries. But these acquisitions are responsible for most of the increase in quantities, while only acquisitions from low-technology countries seem to cause prices to grow substantially. In particular, column (5) of Panel B suggests that differences in price changes among the two groups arise mainly from differences in costs since most of the average reduction in marginal costs stems from acquisitions with acquirers from technologically advanced countries. Both types of acquisitions lead to significantly higher markups.

Results for domestic acquisitions are shown in Panel D. Firms acquired by domestic investors display, on average, quite similar changes in revenues and quantities as foreign acquisition target. They are also able to reduce their marginal costs, but by an amount of less than 5%, which is similar to those observed for firms targeted by foreign acquirers which are located in LI countries, and this effect is only weakly statistically significant. Despite the cost reduction, prices increase by a small (but statistically insignificant) amount since markups increase by more than 6%. Hence, incomplete pass-through can only explain part of the increase in markups upon acquisition. While firms might increase their market power to some extent, this is unlikely to be the main explanation for the estimated change in markups since we observe a substantial increase in quantities.

A potential explanation for the rise in quantity and markups is an increase in (perceived) product quality. The interpretation of higher quantities with no fall in prices as potential evidence of higher quality is in line with recent literature that uses variation in demand or market shares conditional on price as a measure of quality (e.g. Amiti and Khandelwal, 2013). We investigate this possibility more formally below based on the measures discussed in the previous section.

5.3 Quality upgrading

While one would typically associate quality upgrading with higher per-unit production costs, it is possible that marginal costs would have declined to an even larger extent and prices would have fallen without quality upgrading.[36]As we discuss below, there is indeed evidence that quality adjusted prices have fallen as a result of acquisitions. Furthermore, quality upgrading may also be associated with higher fixed costs of product development as opposed to marginal costs.

Eckel et al. (2015) argue and provide evidence that foreign-owned firms have higher quality-based

acquisitions. The results show that changes in sales, quantities, markups and costs occur already in the year following acquisitions while the effects are increasing over time.

[36]LGKP make a similar argument regarding the effects of trade liberalization on markups and marginal costs.

competence due to superior brands compared to domestic firms. Since they analyze these differences in a cross-section, their results might stem from greenfield investments or foreign acquirers choosing target firms with high quality products. However, our results indicate that the quality-based competence of foreign-owned firms might result from a causal effect of foreign acquisitions. If one interprets technology transfer in a broad way to include superior brands, quality, and reputation, technology transfer is also in line with our observation of no reduction in prices alongside higher markups and quantities post-acquisition. Note that higher quality would not be picked up by the physical measure of productivity used in Table 7. Our results also indicate that revenue-based measures of productivity might hide a lot of the adjustments that take place upon acquisitions since they might pick up changes in costs, prices, markups and quality. This is particularly the case if these variables change differently after heterogeneous types of acquisitions and vary across industries.

As a further indicator of the importance of quality upgrading, we investigate heterogeneous effects across products classified using a measure of product differentiation proposed by Rauch (1999). Arguably, heterogeneity in quality plays a more important role in differentiated as opposed to homogenous goods. As Table 9 shows, increases in prices and markups after foreign acquisitions are indeed concentrated among products classified as differentiated according to Rauch's liberal classification. The average increase in price after foreign acquisitions, documented in Table 8, seems to be mainly due to differentiated goods in firms acquired by investors from LI countries. For non-differentiated goods, we do not observe statistically significant increases in prices for any group of acquisitions. Similarly, increases in revenues and quantities mainly stem from differentiated goods as well. The picture is less clear for reductions in marginal costs. While the observation of declining marginal costs besides quality upgrading in differentiated goods might seem counterintuitive, it is well possible that acquirers have a competitive advantage in producing high-quality goods at relatively low costs.

The effect of acquisitions on more formal measures of product quality are documented in Table 10. Column (1) reports results for our first measures of quality based on equation (10) and the industry-specific import elasticities from Broda and Weinstein (2006). For foreign and domestic acquisitions, we estimate quality increases of between approximately 6% and 10%, respectively. Quality-adjusted prices, the difference between changes in log prices and log quality, fall significantly after acquisitions as depicted in column (2). This result is a likely explanation for the estimated increases in quantities besides no fall in unadjusted prices. It indicates that consumers, and not only firms, can benefit from acquisitions. In columns (3) and (4), we follow Fan et al. (2015) and set σ to 5 and 10 respectively for all industries. The effects are smaller compared to the measure based on industry-specific values of σ, possibly because this measure is less precise but the sign and significance are confirmed. In column (5), we use the quality measure suggested by Forlani et al. (2016) which is defined in equation (9) and is based on markups, prices and quantities. The estimated effects are substantially higher, because the firm-product specific markups generate more within-industry variation than measures based on common or industry-specific elasticities of substitution. Nonetheless, results using this alternative measure confirm the positive association between acquisitions and quality. Overall, there is evidence that all types of acquisitions studied lead to improved quality but no robust evidence of heterogeneity according to acquirers' origin. In our sample, differences among acquirers from different regions seem to materialize in the form of differences in costs rather than product quality.

Our main indicator of quality assigns all variations in demand besides price to differences in quality. If this assumption fails, there might be alternative explanations besides quality upgrading for the patterns we observe. For instance, recent research argues that the gains from acquisitions may stem to a significant extent from improved market access (e.g. Guadalupe et al., 2012; Javorcik and Poelhekke, forthcoming; Stiebale, 2016; Wang and Wang, 2015). If targets have access to a larger market or redirect their sales towards markets with higher demand and lower price elasticity of demand, we might observe higher quantities conditional on price even in the absence of quality upgrading. The market access hypothesis and quality upgrading are not mutually exclusive, however. Access to a larger market has been found to increase incentives to innovate (e.g. Guadalupe et al., 2012) and investment in product quality can be interpreted as a form of innovation. The fixed costs of product upgrading can be applied to a larger production output if acquisitions provide access to new markets.

If market access was the main mechanism behind our result, we should see an increase in exports upon all types of acquisitions. As shown in Table 7, we did not find strong effect on export shares, except for acquirers from HI countries, suggesting that market access is unlikely to be the main explanation for our results. However, due to data limitations, we cannot completely rule out the possibility that firms export indirectly through other firms or enter new regional markets within India - especially in the case of domestic acquisitions. Another potential explanation for the increase in quantity conditional on price would be horizontal instead of quality differentiation. For instance, Di Comite et al. (2014) distinguish horizontal from vertical differentiation by analyzing differences in consumer tastes across markets. Since our data does not include information about firms' destination markets, we are again unable to pursue this potential explanation.[37] However,

[37] We leave this formal distinction for future research.

we conduct an alternative test based on input prices which is not directly related to assumptions about demand for final goods. As argued by Kugler and Verhoogen (2012) and others, high quality products require high quality inputs which arguably have relatively high input prices. This implies a positive association between output quality and input prices. Hence, in column (6) of Table 10, we analyze how unit values of materials used in firms' production processes change upon acquisition. These regressions are conducted at the firm-input level rather than the firm-product level which explains the higher number of observations.[38] The estimated coefficients imply a positive and statistically significant increase in material unit values of more than 10% which is consistent with the quality upgrading hypothesis. Again, the results are qualitatively similar across the different types of acquisitions.

5.4 Extensions and robustness checks

In this subsection, we present the results of various robustness checks which are mainly related to the conditioning variables, the matching procedure and the choice of the control group. To avoid overcrowding the paper with additional results, we mainly discuss estimates for the average effect of foreign acquisitions and document these results in the online appendix.

We start, however, by discussing results on some alternative outcomes to test whether mechanisms other than cost reductions and quality upgrading are likely explanations for our results. For instance, lower production costs after acquisitions might stem from a restructuring process that involves outsourcing of certain activities. Further, as argued by Erel et al. (2015) and Wang and Wang (2015), acquirers might induce growth in target firms by relaxing financial constraints. If the growth of targets has been constrained by financial factors pre-acquisition, this may partly explain the observed post-acquisition growth. To test the importance of these factors, we conduct a separate matching analysis to ensure that there are no significant pre-acquisition differences in these variables between treatment and control group. For outsourcing, we use information from Prowess on payments for outsourced jobs which we scale by firms' sales. To measure the importance of financial factors, we follow Greenaway et al. (2007) and Wang and Wang (2015) and measure a firm's (short term) liquidity as the ratio of current assets less current liabilities relative to total assets. We also assess whether acquisitions provide access to long-term finance by utilizing information on loans received from the corporate group, which we divide by sales. Table A6 shows results for post-acquisition outcomes for these variables using DiD estimates. We find that payments for outsourced jobs do not increase upon foreign acquisitions. The same is true for financial factors; if anything, these measures decline post-acquisitions. We therefore believe that financial factors and outsourcing

[38] On average, we have information about unit values for about three different raw materials used per firm.

are not amongst the main channels that affect our target firms after acquisition.

Our next set of robustness checks refers to the matching procedure. The baseline results in Table 7 and Table 8 are based on separate matching procedures at the firm and firm-product level and therefore use different weights. To analyze whether a common sample of firms for firm-level and firm-product-level regressions leads to different results, we rerun our product-level regressions using a sample matched on firm-level characteristics only. Table A7 in the online appendix shows that there are only minor differences in estimated coefficients based on this sample. While our main specification estimates the propensity score based on lagged levels of all firm-level outcomes and lagged changes in sales, acquired firms might still have different long-run growth trends. Hence, in an alternative specification, we control for longer pre-acquisition trends and include one to three year lags of sales growth in the estimation of the propensity score. This reduces our sample to 297 foreign acquisitions. Results for the effects of foreign acquisitions displayed in Table A8 of the online appendix confirm our main results, both at the firm and at the firm-product level. The main difference is that the effect on export shares becomes statistically significant in this specification. We also checked whether different trends in other outcome variables affect our results. For this purpose, we included pre-acquisition lagged changes and level of all our conditioning variables at the firm-level (sales, TFP, capital, capital intensity, number of products, exports and imports) in the estimation of the propensity score. As documented in Table A9, this does not change our main conclusions either. Foreign acquisitions increase sales and quantities and are accompanied by enhanced quality, higher markups and lower marginal costs. While there is weak evidence for an increase in prices, quality-adjusted prices fall upon acquisition.

We conducted further robustness tests of the matching estimates with respect to the control group. First, we matched foreign acquisition targets with firms that will or have been targeted by domestic acquirers during the sample period. This procedure can control for unobservables which make acquisitions more likely to occur, particularly when these characteristics persist over some time and the exact timing of acquisitions is rather random (Blonigen and Pierce, 2016). Results using this alternative control group are presented in Table A10 in the online appendix and are consistent with the conclusions from our previous estimates.

We conducted further robustness tests of the matching estimates with respect to the control group. First, we matched foreign acquisition targets with firms that will or have been targeted by domestic acquirers during the sample period. This procedure can control for unobservables which make acquisitions more likely to occur, particularly when these characteristics persist over some time and the exact timing of acquisitions is rather random (Blonigen and Pierce, 2016). Results using this alternative control group are presented in Table A10 in the online appendix and are consistent

with the conclusions from our previous estimates.

In our main specification, heterogeneous effects for foreign acquisitions with respect to acquirer origin have been based on a separate matching procedure for foreign acquisitions from high and low income countries to control for different selection profiles across the two groups. As a robustness check, we report results based on a common propensity score estimation which also eases testing for statistically significant differences across the two groups. For this purpose, we estimate a variant of equation (12) in which we regress our outcome variables on two indicator variables for foreign acquisitions and foreign acquisitions with acquirers from high-income countries. Estimated effects based on the reweighted sample are displayed in Table A11 in the online appendix. Note that in these specifications, *Foreign acquirer* estimates the effect of acquirers from low-income countries, while *Foreign acquirer HI* measures the *difference* between the effects of acquisitions from HI compared to those from LI countries. There are few statistically significant differences between the effects of acquirers from HI and LI countries for firm-level outcomes of target firms with the exception of the product count. In contrast, for product-level outcomes, there is significant heterogeneity between the two groups. Increases in quantity and decreases in marginal costs are mainly driven by acquirers from HI countries, while only acquisitions from LI countries are associated with higher prices. Again, there are only minor differences in quality outcomes between the two groups. All in all, the conclusions are very similar to the estimated effects from the separate matching procedure.

All our results discussed so far are based on propensity score reweighting. We also experimented with nearest neighbour matching based on the propensity score implying each acquired firm and each matched non-acquired firm is given a weight of one. While recent research argues that propensity score reweighting is more efficient compared to nearest neighbour matching (Busso et al., 2014), nearest neighbour matching has been more popular in the analysis of foreign acquisitions. Therefore, as an additional robustness check, we implemented one-to-one nearest neighbour matching without replacement and performed a DiD regression based on the matched sample in a second step. Results which are depicted in Table A12 in the online appendix confirm our main findings.

Finally, we assess whether our results might be affected by spillovers from acquired to non-acquired firms which would violate the stable unit treatment value assumption. Previous literature has shown that there is evidence that domestic firms can be affected by the presence of foreign investors due to technology spillovers or competitive effects (e.g., Girma et al., 2015; Haskel et al., 2007; Javorcik, 2004) and that these spillovers are most likely to occur within the same region. To assess whether spillovers bias our estimated effects of acquisitions, we follow Javorcik and Poelhekke (forthcoming) and construct an alternative control group based on nearest neighbour matching such that each acquired firm is located in a different region (2-digit pin code area) from its matched control. This procedure reduces the probability that treated and control firms compete in the same local product and input markets. Although imposing this constraint reduces our sample size to some 300 foreign acquisitions, results documented in Table A13 in the online appendix again confirm our conclusions. There is a substantial increase in post-acquisition sales which is mainly driven by quantities and accompanied by higher markups and lower marginal costs, higher quality and lower quality-adjusted prices. All in all, our results are very robust across different matching estimators, control groups and conditioning variables.

5.5 Discussion

Our results indicate that acquisitions lead to higher markups, higher quantities and quality and lower marginal costs. As we discuss in more detail in section C of the online appendix, these results are consistent with arguments proposed in recent trade theoretical models with heterogeneous firms, in particular Antoniades (2015) and Hallak and Sivadasan (2013). The intuition is based on the following ideas. Acquisitions lead to a substantial increase in process productivity via technology transfer, i.e. a reduction in marginal production costs for a given level of product quality. Relatively low physical TFP pre-acquisition and the result that the highest gains from acquisitions occur when acquirers are located in technologically advanced countries seem to be consistent with the idea of technology transfer. One particular form of technology transfer is improvement in management. For instance, Bloom et al. (2012) provide evidence from a field experiment that adoption of management practices which are standard in the developed world lead to improvements in productivity, profitability and product quality in Indian textile firms.

Quality upgrading requires higher fixed costs and the incentives to invest in quality increase with process productivity. This is consistent with increases in proxies for product quality and higher demand (higher quantity produced conditional and unconditional on price) upon acquisition. Incomplete pass-through of cost savings and higher quality upon acquisition both imply higher markups. Our results of increasing average material prices are consistent with the common assumption that, ceteris paribus, high quality outputs also require more expensive inputs. If the increase in process productivity is large enough, acquisitions might lead to lower marginal costs besides higher factor prices.

Our estimated TFP effects are, across the sample of all foreign acquisitions, on average positive but statistically insignificant. On the one hand, this result can be explained by treatment effect heterogeneity as the results are large and statistically significant for smaller target firms and for acquirers from HI countries. On the other hand, one might wonder why the effects for marginal cost reductions for some treatments are not reflected in higher TFP estimates. Fixed costs related to quality production are a potential explanation for differences between our estimated marginal cost and TFP effects. If fixed costs for higher quality production require higher amounts of fixed capital or labour, increases in process productivity and reductions in marginal costs might not be fully reflected in higher TFP which is measured as output less an index of (fixed and variable) production factors.

Another potential explanation for marginal costs declines that outweigh increases in measured TFP are economies of scale which seem to be important in our sample as evidenced by production function elasticities in Table 3 and correlations between costs and quantities (see table A1 in the online appendix). Returns to scale are not captured by our measure of TFP, and hence marginal costs can fall due to an increase in quantities upon acquisition even in the absence of adjustments in TFP. We discuss fixed costs and economies of scale in more detail in an analytical framework in section C of the online appendix.

Finally, another explanation for differences between changes in measured TFP and marginal costs is measurement error (Marin and Voigtländer, 2013) which could potentially bias estimated TFP effects towards zero. TFP measures are affected by estimates of all parameters of the production function. In contrast, marginal costs rely on observed unit values and estimated markups, where the latter are constructed from material-revenue shares and material-output elasticities. While material-output elasticities might be mismeasured, as we discuss below, changes in markups upon acquisition are mainly due to changes in the material-sales ratio.[39]

It is important to understand whether traditional revenue-based measures of TFP yield different results from physical TFP estimates. For this purpose, we compute firm-level revenue-based productivity using the procedure proposed by Levinsohn and Petrin (2003). Estimates documented in columns (1) of Table A14 in the online appendix indicate that the average foreign acquisition has a small and statistically insignificant effect on revenue TFP. However, the estimates imply very different results regarding the origin of foreign acquirers compared to physical TFP estimates. Particularly, the results indicate that revenue-based TFP increases after acquisitions from LI countries, but not upon acquisitions from HI countries. This is consistent with our results for other outcome variables. Revenue-based productivity can increase due to higher physical TFP or higher output prices. Results from our product-level regressions in Tables 8 and 9 show that prices increase after foreign acquisitions with acquirers from LI countries but not from HI countries and after domestic acquisitions. Revenue-based measures of TFP can thus lead to misleading conclusions regarding the effects of acquisitions on technical efficiency. This is particularly the case when some types of

[39]Note that when estimating a commonly used Cobb-Douglas production function, which is a special case of our more flexible translog production function, all variation in markups within industries would be due to variation in the material-sales share by assumption since material-output elasticities are constant across firms.

acquisitions lead to declines in costs which are ceteris paribus reflected in falling prices and other types of acquisitions lead to higher output prices in the absence of efficiency gains. Similarly, we do not find more pronounced effects on revenue TFP for small acquisition targets, possibly because quantities and prices are negatively correlated in our data within product categories. We discuss the relationship between revenue TFP, prices, and markups in more detail in section C of the online appendix.

We checked the robustness of our results for physical TFP towards an alternative approach to estimate productivity. A crucial aspect of the LGKP approach are the assumptions to recover input allocations across multi-product firms. Therefore, to construct an alternative measure of firm-level TFP, we construct a quantity-index at the firm level by using sales shares as weights within firm-years. Results documented in column (2) of Table A14 in the online appendix show that this measure yields qualitatively similar results as the LGKP measure. There is a statistically insignificant effect of foreign acquisitions on TFP on average which is, again, smaller than the estimated marginal cost declines in Table 8.

Another related potential concern of our TFP estimates is that our production function approach might not be very well suited if a firm's product portfolio changes. To investigate this possibility, we additionally estimated our DiD regressions for TFP outcomes for a sample of single-product firm-years and for a sub-sample of firms which do not change their product portfolio during our sample period. The effect for single-product firms is indeed substantially larger. However, this can potentially be explained by heterogeneous effects for smaller target firms (which are more likely to be single-product firms), as indicated by our estimates in Table 7. Higher effects for single-product firms are completely driven by relatively small acquisitions targets. Further, there is no evidence that TFP effects are higher for the subsample of firms with a constant product portfolio as indicated by column (5). These results are documented in Table A14 of the online appendix.

To check the plausibility of estimated marginal cost declines, we computed alternative measures of costs efficiency based on material expenditures and the sum of labour and material costs per unit of output. These measures do not rely on consistently estimated markups. We discuss the relationship between average and marginal costs in section C of the online appendix as well. Table A15 in the online appendix shows that measures of average costs decline by a similar magnitude as marginal cost measures in Table 8 and that these changes are more pronounced for acquirers from HI countries. Material costs per unit of physical output decrease besides higher material unit values. This is consistent with an upgrading of the production process that uses less physical units of materials per unit of output but materials of higher quality. As indicated by equation (2), estimated markups can increase upon acquisition due to a decline in the materials to sales ratio or due to an increase in the material-output elasticity. As documented in columns (3) and (4) of Table A15 in the online appendix, increases in estimated markups, and therefore reductions in estimated marginal costs, stem from a reduction in the material cost share in sales, not a change in the material-output elasticity. Since only material-output elasticities are estimated from our production function, this indicates that violation of our assumptions to estimate productivity are not the main driver of the estimated decline in marginal costs.

6 Conclusion

This paper analyzes the effects of domestic and foreign acquisitions on various firm- and product-level outcomes of target firms in India. We use propensity score reweighting, combined with a DiD estimator, and find that acquisition targets sell higher quantities of output post-acquisition although they do not reduce their prices on average. Based on recent methodological advances in the estimation of quantity-based production functions, we find that target firms achieve significant reductions in marginal costs and raise their markups substantially after acquisitions. These effects are most significant when acquirers are located in technologically advanced countries. The estimated increase in markups as well as higher quantities conditional on price indicate that acquisitions can not only increase efficiency but also contribute to higher product quality. Consistent with quality upgrading, we find that increases in prices and markups are concentrated among product groups with high scope for quality differentiation. We also observe higher unit values of material inputs used in production after acquisition. This result is in line with recent theories of multi-product firms which stress the importance of quality-based competence next to cost-based efficiencies for firms active in international markets. Our results indicate that knowledge transfer to foreign affiliates, predicted by theories of multinational firms, can benefit targets of foreign acquisitions in the form of both cost reductions and upgrading of product quality.

We also find that quality-adjusted prices fall as a result of both domestic and foreign acquisitions. From an economic policy point of view, this suggests that, on average, acquisitions in an emerging market like India can benefit both firms and consumers. Since these benefits seem to be larger for international M&As, especially if acquirers are located in technologically advanced countries, restrictions on foreign acquisitions, which are common in many developing and emerging markets, may hurt both firms and consumers.

Our results further imply that commonly used measures of revenue-based productivity at the firm-level hide a lot of the adjustments that take place after ownership changes. These measures may pick up changes in physical productivity but also adjustments in input and output prices due to changes in market power or quality. A broad set of product-level variables including prices, quantities, markups and costs seems to be necessary to fully understand the effects of acquisitions. An interesting extension to this area of research is to analyze whether acquisitions generate spillovers in terms of quality improvements or cost reductions to other firms in the same market and in vertically related industries. Given the increasing availability of firm-product level data sets, it will also be interesting to see if our results hold in different countries. We leave these questions for future research.

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Tables

Table 1: Firms, products and acquisitions across industries

NIC codes	Sector	All firms	Single product firms	No. of products	Domestic acquisitions	Foreign acquisitions
10,11,12	Food, Beverages and Tobacco	1318	760	208	138	49
13	Textiles	936	636	120	72	21
14,15	Wearing Apparel and Leather	311	225	48	33	7
16,7,18	Wood, Paper Products and Printing	396	280	75	42	5
19	Coke	128	56	34	19	10
20	Chemicals	1255	736	541	136	44
21	Pharmaceuticals	528	291	92	89	53
22	Rubber and Plastic	566	398	108	51	17
23	Non-metallic Mineral Product	400	297	90	60	25
24,25	Basic Metal and Fabricated Metal	1372	869	197	153	47
26	Computers and Electronics	370	249	232	23	13
27	Electricals	411	246	169	51	19
28	Machinery and Equipment	612	357	215	63	37
29,30	Motor Vehicles and Transport Equipment	424	322	139	41	20
10-30	All Manufacturing	9192	5722	2268	971	367

Table 2: Firm Characteristics: Means, (standard deviation)

Variables	Definition	Non-acquired firms	Domestic acquisitions	Foreign acquisitions
	Firm level	$N = 22460$	$N = 971$	$N = 367$
Sales	income from sales (Rs. million)	2029.6 (25647.4)	8271.7 (25837.0)	10982.1 (31197.6)
Labour	salaries and wages (Rs. million)	79.76 (735.5)	375.4 (1415.4)	403.0 (994.3)
Materials	expenditure on raw materials (Rs. million)	909.7 (9683.4)	3457.6 (12138.9)	5012.4 (17345.8)
Capital stock	gross fixed assets (Rs. million)	926.4 (7181.4)	5222.2 (15411.0)	5592.1 (18073.0)
Capital intensity	capital stock / labour	27.85 (203.5)	20.27 (25.01)	18.60 (22.47)
Export share	foreign exchange earnings / sales	0.109 (0.223)	0.140 (0.215)	0.155 (0.212)
Import share	foreign exchange expenditure / sales	0.157 (0.251)	0.234 (0.260)	0.292 (0.280)
TFP	total factor productivity	0.106 (1.699)	-0.280 (1.621)	-0.410 (1.657)
RTFP	revenue-based TFP	0.082 (0.070)	-0.042 (0.607)	0.014 (0.675)
No. of products	product count	1.886 (1.469)	2.536 (2.213)	2.916 (2.281)
	Product level	$N = 37143$	$N = 2486$	$N = 1000$
Sales	ln(product sales residual)	-0.375 (1.762)	0.305 (1.571)	0.599 (1.471)
Quantity	ln(quantity residual)	-0.347 (1.984)	0.265 (1.739)	0.535 (1.783)
Price	ln(price residual)	-0.0279 (1.220)	0.0394 (0.999)	0.0638 (1.098)
Marginal cost	ln(marginal cost residual)	-0.0252 (1.956)	0.0446 (1.800)	0.0283 (1.837)
Markup	ln(markup residual)	-0.00265 (1.442)	-0.00514 (1.407)	0.0355 (1.349)

Notes: Summary statistics for acquired firms are from the year before acquisition.
TFP is estimated as described in section 4.1.
Variables presented at product level are demeaned by product-unit of measurement-year.
Observations and average values of acquired firms based on the year before acquisition.

Table 3: Elasticities from production function: Means, *Medians*, (Standard deviations)

Sector	SP observations	Labour	Materials	Capital	RTS
Food, Beverages and Tobacco	2903	0.31	0.61	0.19	1.12
		0.28	*0.59*	*0.16*	*1.02*
		(0.21)	(0.29)	(0.5)	(0.71)
Textiles	2622	0.16	0.76	0.12	1.04
		0.15	*0.77*	*0.12*	*1.04*
		(0.07)	(0.09)	(0.05)	(0.06)
Wearing Apparel and Leather	864	0.27	0.63	0.26	1.16
		0.26	*0.62*	*0.3*	*1.19*
		(0.23)	(0.13)	(0.19)	(0.16)
Wood, Paper Products and Printing	1413	0.12	0.84	0.04	1.00
		0.12	*0.82*	*0.04*	*0.98*
		(0.06)	(0.08)	(0.06)	(0.08)
Coke	248	0.07	0.91	0.12	1.09
		0.08	*0.92*	*0.09*	*1.08*
		(0.1)	(0.08)	(0.26)	(0.26)
Chemicals	2995	0.25	0.71	0.12	1.08
		0.25	*0.71*	*0.14*	*1.10*
		(0.1)	(0.07)	(0.06)	(0.1)
Pharmaceuticals	1262	0.3	0.6	0.07	0.97
		0.31	*0.65*	*0.14*	*1.12*
		(0.58)	(0.39)	(0.36)	(1.06)
Rubber and Plastics	1840	0.19	0.7	0.37	1.25
		0.16	*0.71*	*0.38*	*1.26*
		(0.15)	(0.13)	(0.26)	(0.21)
Non-metallic Mineral Products	1238	0.15	0.46	0.45	1.06
		0.18	*0.51*	*0.46*	*1.11*
		(0.19)	(0.18)	(0.16)	(0.29)
Basic Metal and Fabricated Metal	3611	0.14	0.79	0.07	1.01
		0.13	*0.79*	*0.04*	*0.94*
		(0.11)	(0.09)	(0.18)	(0.27)
Computers and Electronics	998	0.43	0.61	0.51	1.55
		0.41	*0.62*	*0.45*	*1.44*
		(0.13)	(0.13)	(0.32)	(0.35)
Electricals	1102	0.24	0.68	0.03	0.95
		0.24	*0.75*	*0.06*	*1.03*
		(0.19)	(0.22)	(0.18)	(0.29)
Machinery and Equipment	1583	0.4	0.67	0.26	1.34
		0.34	*0.63*	*0.13*	*1.06*
		(0.27)	(0.27)	(0.55)	(0.93)
Motor Vehicles and Transport Equipment	1755	0.21	0.66	0.13	1.01
		0.17	*0.7*	*0.13*	*1.1*
		(0.32)	(0.32)	(0.27)	(0.32)
All Manufacturing	24434	0.23	0.69	0.18	1.10
		0.19	*0.73*	*0.14*	*1.06*
		(0.23)	(0.22)	(0.31)	(0.48)

Notes: Table shows output elasticities from physical production functions with respect to input quantities.
RTS denotes returns to scale.
SP observations denotes the number of observations for single-product firms used to identify parameters of the production functions.

Table 4: Markups across industries

Sector	No. of Observations	Mean	Median
Food, Beverages and Tobacco	13096	2.86	1.37
Textiles	7823	2.41	1.43
Wearing Apparel and Leather	2264	2.17	1.17
Wood, Paper Products and Printing	3071	3.05	1.60
Coke	1063	4.16	1.65
Chemicals	17226	2.75	1.26
Pharmaceuticals	6241	3.38	1.47
Rubber and Plastic	5508	2.25	1.28
Non-metallic Mineral Product	3142	2.81	1.61
Basic Metal and Fabricated Metal	12876	2.46	1.25
Computers and Electronics	3264	3.20	1.25
Electricals	4590	3.79	1.31
Machinery and Equipment	6501	2.99	1.16
Motor Vehicles and Transport Equipment	5967	2.96	1.32
All Manufacturing	92632	2.82	1.33

Table 5: Propensity score estimation

	Domestic acquisitions t+1	Foreign acquisitions t+1	Foreign acquisitions HI t+1	Foreign acquisitions LI t+1
ln(Sales)	0.0901***	0.2005***	0.1878***	0.1940***
	(0.0186)	(0.0297)	(0.0371)	(0.0402)
TFP	-0.0004	-0.0141	-0.0215	0.0034
	(0.0105)	(0.0150)	(0.0181)	(0.0208)
Δln(Sales)	0.0555	0.0533	0.1145	-0.0439
	(0.0406)	(0.0659)	(0.0733)	(0.0996)
Capital stock	0.2485***	0.1546***	0.1144***	0.1662***
	(0.0186)	(0.0285)	(0.0353)	(0.0387)
Capital intensity	0.0004	-0.0156	-0.0111	-0.0183
	(0.0068)	(0.0101)	(0.0137)	(0.0123)
Export share	0.1543*	0.2223*	0.2803**	0.1022
	(0.0805)	(0.1162)	(0.1397)	(0.1634)
Import share	0.0107	0.2104**	0.3439***	-0.0247
	(0.0694)	(0.0961)	(0.1139)	(0.1379)
No. of products	-0.0166*	0.0011	0.0156	-0.0198
	(0.0095)	(0.0126)	(0.0150)	(0.0171)
Observations	23431	22827	22661	22302

Notes: Table reports coefficients from Probit estimation

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

TFP denotes the logarithm of physical total factor productivity relative to the industry mean.

Δln(sales) is logarithmic sales growth.

Capital stock is measured as logarithm of tangible fixed assets.

Capital intensity is defined as the logarithm of capital stock less logarithmic employment costs.

Export share is the ratio of exports to sales.

Import share is the ratio of imports to sales.

No. of products refers to the product count of each firm.

Table 6: Balancing property - domestic and foreign acquisitions

Variable	Domestic acquisitions ($N = 23431$)					Foreign acquisitions: All Countries ($N = 22827$)					Foreign acquisitions: High Income Countries ($N = 22661$)					Foreign acquisitions: Low Income Countries ($N = 22302$)				
	Mean			t-test		Mean			t-test		Mean			t-test		Mean			t-test	
	Treated	Control	%diff	t	$p > \|t\|$	Treated	Control	%diff	t	$p > \|t\|$	Treated	Control	%diff	t	$p > \|t\|$	Treated	Control	%diff		$p > \|t\|$
ln(Sales)	7.638	7.646	-0.4	-0.10	0.924	8.110	8.107	0.2	0.02	0.981	7.985	8.1354	-9	-0.92	0.358	8.273	8.067	12.6	1.18	0.238
Δln(Sales)	0.151	0.149	0.6	0.14	0.886	0.167	0.169	-0.5	-0.08	0.935	0.188	0.173	4.3	0.57	0.568	0.140	0.100	10.3	1.26	0.208
TFP	-0.289	-0.290	0.1	0.01	0.991	-0.410	-0.455	2.7	0.35	0.723	-0.486	-0.451	-2	-0.20	0.845	-0.311	-1.121	-11.6	-1.04	0.300
Capital stock	7.103	7.070	2.0	0.43	0.667	7.352	7.402	-3.2	-0.44	0.663	7.222	7.289	-4.1	-0.40	0.691	7.521	7.654	-8.7	-0.79	0.433
Capital intensity	1.755	1.744	0.3	0.17	0.865	1.541	1.580	-1.2	-1.03	0.306	1.555	1.612	-2.1	-1.27	0.203	1.528	1.113	12.8	1.21	0.227
Export share	0.138	0.139	-0.4	-0.09	0.932	0.155	0.153	1.2	0.16	0.876	0.171	0.149	9.9	0.97	0.335	0.135	0.101	15.8	1.60	0.110
Import share	0.238	0.250	-4.8	-1.00	0.317	0.292	0.285	2.6	0.33	0.740	0.319	0.329	-3.8	-0.35	0.726	0.258	0.246	4.6	0.38	0.705
No. of products	2.587	2.539	2.5	0.49	0.622	2.916	2.788	6.7	0.75	0.455	2.923	2.875	2.4	0.21	0.837	2.906	2.874	1.7	0.12	0.907

Notes: Table shows mean values of variables for the reweighted sample

TFP denotes the logarithm of physical total factor productivity relative to the industry mean.

Δln(sales) is logarithmic sales growth.

Capital stock measured as logarithm of tangible fixed assets.

Capital intensity is defined as the logarithm of capital stock less logarithmic employment costs.

Export share is the ratio of exports to sales.

Import share is the ratio of imports to sales.

No. of products refers to the product count of each firm.

Table 7: Propensity score reweighted DiD estimators, firm-level outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	ln(sales)	TFP	TFP	ln(products)	Export share	Import share
Panel A						
Foreign acquirer	0.1023***	0.0485	-0.0543	0.0312***	0.0044	0.0061
	(0.0247)	(0.0435)	(0.0578)	(0.0117)	(0.0058)	(0.0089)
$\cdots \times$ small target			0.1922**			
			(0.0731)			
Observations	34666	34666	34666	34666	34666	34666
Panel B						
Foreign acquirer HI	0.0941***	0.0897*	0.0340	0.0020	0.0138**	0.0238***
	(0.0317)	(0.0543)	(0.0622)	(0.0116)	(0.0059)	(0.0072)
$\cdots \times$ small target			0.1772			
			(0.1091)			
Observations	33419	33419	33419	33419	33419	33419
Panel C						
Foreign acquirer LI	0.1085***	0.0188	-0.0045	0.0688***	-0.0071	-0.0013
	(0.0385)	(0.0609)	(0.0707)	(0.0180)	(0.0086)	(0.0127)
$\cdots \times$ small target			0.0784			
			(0.1322)			
Observations	32546	32546	32546	32546	32546	32546
Panel D						
Domestic acquirer	0.0842***	-0.0392	-0.0883***	0.0301***	-0.0033	-0.0068
	(0.0189)	(0.0246)	(0.0320)	(0.0071)	(0.0039)	(0.0056)
$\cdots \times$ small target			0.0857*			
			(0.0395)			
Observations	38670	38670	38670	38670	38670	38670

Notes: Table shows estimates of the ATT based on reweighted regressions at the firm level.
Foreign acquirers takes a value of 1 in all periods after foreign acquisitions.
Foreign acquirers HI takes a value of 1 for acquirers from US, Canada, Europe, Australia, Japan, Singapore, Hong Kong.
Foreign acquirers LI takes a value of 1 for foreign acquirers from all remaining countries.
Domestic acquirers takes a value of 1 in all periods after acquisitions with Indian acquirers.
In all specifications, the control group consists of non-acquired domestic firms.
All regressions include firm fixed effects and industry-specific time dummies.
Bootstrapped standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Treatment effects of acquisitions, product-level outcomes

	(1) ln(sales)	(2) ln(quantity)	(3) ln(price)	(4) ln(markup)	(5) ln(marginal cost)
Panel A					
Foreign acquirer	0.1390***	0.1084***	0.0306*	0.1470***	-0.1164***
	(0.0281)	(0.0302)	(0.0181)	(0.0284)	(0.0365)
Observations	71765	71765	71765	71765	71765
Panel B					
Foreign acquirer HI	0.1377***	0.1368***	0.0009	0.1231***	-0.1223***
	(0.0288)	(0.0349)	(0.0221)	(0.0298)	(0.0375)
Observations	66698	66698	66698	66698	66698
Panel C					
Foreign acquirer LI	0.1262***	0.0667	0.0596**	0.1400***	-0.0804
	(0.0449)	(0.0483)	(0.0288)	(0.0467)	(0.0553)
Observations	65167	65167	65167	65167	65167
Panel D					
Domestic acquirer	0.1190***	0.1078***	0.0112	0.0601***	-0.0489*
	(0.0208)	(0.0227)	(0.0129)	(0.0222)	(0.0279)
Observations	75402	75402	75402	75402	75402

Notes: Table shows estimates of the ATT based on reweighted regressions at the firm-product level.
Foreign acquirer takes a value of one in all periods after foreign acquisitions.
Foreign acquirer HI denotes acquirers from the US, Canada, Europe, Australia, Japan, Singapore, Hong Kong.
Foreign acquirers LI takes a value of 1 for foreign acquirers from all remaining countries.
Domestic acquirer takes a value of one in all periods after acquisitions with Indian acquirers.
In all specifications, the control group consists of non-acquired domestic firms.
All regressions include firm-product fixed effects and product-specific time dummies.
Bootstrapped standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Treatment effects of acquisitions: outcomes for differentiated and homogenous goods

	(1) ln(sales)	(2) ln(quantity)	(3) ln(price)	(4) ln(markup)	(5) ln(marginal cost)
			Differentiated goods		
Panel A					
Foreign acquirer	0.1920***	0.1468***	0.0452*	0.1629***	-0.1177***
	(0.0336)	(0.0372)	(0.0242)	(0.0346)	(0.0454)
Observations	39333	39333	39333	39333	39333
Panel B					
Foreign acquirer HI	0.1911***	0.1792***	0.0119	0.1309***	-0.1190**
	(0.0390)	(0.0435)	(0.0299)	(0.0390)	(0.0515)
Observations	36542	36542	36542	36542	36542
Panel C					
Foreign acquirer LI	0.2059***	0.1049*	0.1010***	0.1686***	-0.0676
	(0.0574)	(0.0567)	(0.0363)	(0.0623)	(0.0731)
Observations	35446	35446	35446	35446	35446
Panel D					
Domestic acquirer	0.1337***	0.1210***	0.0127	0.0782***	-0.0656*
	(0.0282)	(0.0298)	(0.0180)	(0.0273)	(0.0336)
Observations	41815	41815	41815	41815	41815
			Homogenous goods		
Panel E					
Foreign acquirer	0.0735**	0.0571	0.0164	0.1154**	-0.0990*
	(0.0286)	(0.0387)	(0.0349)	(0.0561)	(0.0556)
Observations	32432	32432	32432	32432	32432
Panel F					
Foreign acquirer HI	0.0583	0.0658	-0.0076	0.0964	-0.1040
	(0.0412)	(0.0464)	(0.0257)	(0.0760)	(0.0721)
Observations	30156	30156	30156	30156	30156
Panel G					
Foreign acquirer LI	0.0482	0.0375	0.0107	0.1001	-0.0895**
	(0.0824)	(0.1393)	(0.0230)	(0.1453)	(0.0431)
Observations	29721	29721	29721	29721	29721
Panel H					
Domestic acquirer	0.0998**	0.0908***	0.0090	0.0370	-0.0280
	(0.0501)	(0.0093)	(0.0056)	(0.0352)	(0.0231)
Observations	33587	33587	33587	33587	33587

Notes: Table shows estimates of the ATT based on reweighted regressions at the firm-product level.
Differentiated and homogenous are defined according to Rauch (1999)'s liberal classification.
Foreign acquirer takes a value of one in all periods after foreign acquisitions.
Foreign acquirer HI denotes acquirers from the US, Canada, Europe, Australia, Japan, Singapore, Hong Kong.
Foreign acquirers LI takes a value of 1 for foreign acquirers from all remaining countries.
Domestic acquirer takes a value of one in all periods after acquisitions with Indian acquirers.
In all specifications, the control group consists of non-acquired domestic firms.
All regressions include firm-product fixed effects and product-specific time dummies.
Bootstrapped standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Treatment effects of acquisitions: product-level measures of quality

Dependent variable	(1) Quality 1 $\sigma = \sigma_j$	(2) ln(price $/\gamma$) $\sigma = \sigma_j$	(3) Quality 1 $\sigma = 5$	(4) Quality 1 $\sigma = 10$	(5) Quality 2 Forlani et al.	(6) ln(material prices)
Panel A						
Foreign acquirer	0.1081***	-0.0716***	0.0553***	0.0748***	0.7411***	0.1285***
	(0.0231)	(0.0152)	(0.0187)	(0.0203)	(0.2595)	(0.0258)
Observations	67450	67450	67450	67450	67450	106654
Panel B						
Foreign acquirer HI	0.0937***	-0.0702***	0.0417**	0.0602***	0.6411**	0.1047***
	(0.0268)	(0.0175)	(0.0203)	(0.0215)	(0.2776)	(0.0284)
Observations	64046	64046	64046	64046	64046	106372
Panel C						
Foreign acquirer LI	0.0937***	-0.0425*	0.0596**	0.0717**	0.6543*	0.1576***
	(0.0360)	(0.0230)	(0.0282)	(0.0320)	(0.3572)	(0.0401)
Observations	62455	62455	62455	62455	62455	98995
Panel C						
Domestic acquirer	0.0620***	-0.0479***	0.0262**	0.0441***	0.6171***	0.0967***
	(0.0164)	(0.0106)	(0.0116)	(0.0134)	(0.1639)	(0.0177)
Observations	77005	77005	77005	77005	77005	120494

Notes: (1)-(5) show estimates of the ATT based on reweighted regressions at the firm-product level.
(6) shows estimates of the ATT based on reweighted regressions at the firm-material input level.
Foreign acquirer takes a value of one in all periods after foreign acquisitions.
Foreign acquirer HI denotes acquirers from the US, Canada, Europe, Australia, Japan, Singapore, Hong Kong.
Foreign acquirers LI takes a value of 1 for foreign acquirers from all remaining countries.
Domestic acquirer takes a value of one in all periods after acquisitions with Indian acquirers.
In all specifications, the control group consists of non-acquired domestic firms.
Quality measures and other variables are defined in section 4.2.
Regressions in (1)-(5) include firm-product fixed effects and product-specific time dummies.
Regressions in (6) include firm-material input fixed effects and material input-specific time dummies.
Bootstrapped standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$