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

Joel Stiebale Dev Vencappa [1]

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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.

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

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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 international and domestic M&As are a central topic both in economic policy and within the international trade, industrial organization, and finance literature. 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 and lower prices.[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.

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 as well as detailed data on firms' inputs. This 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 which mainly relies on revenue-based measures of labour or total factor productivity as indicators of firm performance.

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). However, other scholars have argued that the effects of cross-border M&As are not that different from other ownership changes (e.g. Gugler et al., 2003; Fons-Rosen et al., 2013; Wang and Wang, 2015).[3] 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. Revenue-based productivity could vary across firms due to cost-based efficiency, but it might also reflect heterogeneity in markups as well as differences in

[1] See, for instance, `http://www.wsj.com/articles/2015-becomes-the-biggest-m-a-year-ever-1449187101`, accessed Feb 11, 2016.

[2] See section 2 for a detailed discussion.

[3] There is a large literature on the effects of M&As on efficiency-related outcomes which either analyses domestic transactions or does not explicitly distinguish between domestic and international M&As (e.g. Maksimovic and Phillips, 2001; David, 2013; Blonigen and Pierce, 2015).

demand and product quality (e.g. Braguinsky et al., 2015; Forlani et al., 2016; De Loecker et al., 2016).[4] Particularly, increases in market power upon acquisition which lead to higher prices and markups would show up as higher values in common measures of productivity (Syverson, 2011).

A growing literature estimating the effects of 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, evidence on the effects of cross-border acquisitions on outcomes at the product level such as prices and marginal costs is absent. Evidence on the effects of M&As on product-level 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 since a multitude of economic reforms, including a lifting of ownership caps for foreign investors, has opened the way to a large potential for reallocation via ownership changes. In addition, in contrast to most countries, Indian firms are required by law to report sales and quantities at the product level. This information is essential for our empirical aprroach.

For the empirical analysis, we apply recent methodological advances in the estimation of production functions suggested 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 from a sample of single-product firms make it possible to recover input allocations, total factor productivity and markups across all products of single and multiple product firms. 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.

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.

[4]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., Hallak and Schott, 2011; Kugler and Verhoogen, 2012; Hallak and Sivadasan, 2013; Eckel et al., 2015).

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

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 a small increase 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 quality upgrading. We also document an increase in the average unit values of material inputs post acquisition, 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.

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. Maksimovic et al., 2011; Jovanovic and Rousseau, 2008; Breinlich, 2008; Braguinsky et al., 2015). 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., Nocke and Yeaple, 2008; Norbäck and Persson, 2007; Bertrand et al., 2012). 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 physical productivity, i.e. higher ability of producing higher quantities for a given amount of inputs. However, 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. We would then 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) quantity-based productivity, markups, and marginal costs, but also allows 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, 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 and 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 analyse 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. Kamien and Zang, 1990; Neary, 2007; Horn and Persson, 2001). 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 managers (Shleifer and Vishny, 1988).

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.[6] Most 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

[6]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.

back to superior demand management by acquiring firms which leads to higher capacity utilization and lower inventories in target firm post-acquisition. Blonigen and Pierce (2015) analyze 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. It is noteworthy that this study relies on revenue-based production function due to the absence of price and quantity measures in the data set used. Also, the analysis does not make a distinction between between domestic and international M&As. Besides changes in prices of existing products, M&As may affect product variety and the incentives for product repositioning (Berry and Waldfogel, 2001; Gandhi et al., 2008; Argentesi et al., 2016). In this paper, we analyze product repositioning in the form of quality upgrading. Although not the focus of this paper, we also provide evidence on the effects of M&As on the number of products produced.

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). 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.[7] 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.

[7] Branstetter and Drev (2014) analyse effects of foreign ownership on prices, scale and the number of products, but their analysis is limited to export markets and does not study markups and marginal costs.

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

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

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 and accounting for missing values, our product level analysis was carried out on 2782 clean and unique CMIE product codes. 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).

Data on M&A deals were sourced from the Thomson Reuters Securities Data Company (SDC) database and Bureau Van Djik Zephyr database.[11] 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 acquirer and target names from these two databases for the most part differed substantially from the names in Prowess, we manually matched names across these databases.[12]

Some of our measures of product quality (see section 4.2) use information from various external sources. For our measure of 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).[13] 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

[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.

[11] While Prowess also records domestic M&A transactions, the information provided is limited and we decided to use the Zephyr and Thomson databases as common sources of M&As information on domestic and foreign acquirers.

[12] Prowess contains ownership information but this is incomplete and does not contain information about the origin and type of foreign investors.

[13] For details on and access to the Rauch classification, see `http://econweb.ucsd.edu/~jrauch/rauch_classification.html`, accessed on April 30, 2016.

and Weinstein (2006).[14]

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 1700 products, distributed across 14 two-digits manufacturing industries. 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 mainly follow the methodology introduced by De Loecker et al. (2016), henceforth LGKP.[16] This method accounts for endogeneity of productions 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.

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

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

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

[15]The case where Indian firms acquire non-Indian firms overseas is not of interest to us

[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.

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 error and differences in products and units within markets:

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

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. Physical inputs can be expressed as $v_{ijt} = \rho_{ijt} + \tilde{v}_{ijt} - w_{ijt}$ where $\tilde{v}_{ijt}$ denotes input expenditures, 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). For our application, we use a translog production function, hence:

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

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]:

$$q_{ijt} = f_j(\tilde{\boldsymbol{v}}_{ijt}; \boldsymbol{\beta}) + A(\rho_{ijt}, \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta}) + B(w_{ijt}, \rho_{ijt}, \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta}) + \omega_{it} + \epsilon_{ijt} \tag{6}$$

The first step in estimation is based on a sample of single product firms for which $A(.)$ can be ignored and the subscript j can be omitted. Unobserved input prices w_{it} in $B(.)$ are approximated by output prices (p_{it}), market shares (s_{it}), product dummies ($\boldsymbol{D_j}$), location dummies ($\boldsymbol{G_i}$), 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: $\tilde{m}_{it} = m(\omega_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, \boldsymbol{D}_j, \boldsymbol{G_i}, s_{it}, ex_{it}, \boldsymbol{acq}_{it})$. Inverting the material demand function yields and 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:

$$\omega_{it} = g(\omega_{i,t-1}, ex_{it}, \boldsymbol{acq}_{i,t-1}, SP_{it}) + \varsigma_{it} \tag{7}$$

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.

One can combine $f(.)$ and $B(.)$ into a function $\theta(\tilde{\boldsymbol{v}}_{ijt}, \boldsymbol{c}_{it})$ such that output can be expressed as a function of observable variables and measurement errors: $q_{it} = \theta(\tilde{\boldsymbol{v}}_{it}, \boldsymbol{c}_{it}) + \epsilon_{it}$.

$\theta(.)$ is approximated by a linear combination of all its elements and a polynomial in all continuous variables. While this expression does not identify any parameters of the production and input price

[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.

functions, it identifies output net of measurement error ϵ_{it} which is denoted by $\hat{\phi}_{it}$. Productivity can then be expressed as:

$$\omega_{it} = \hat{\phi}_{it} - f(\tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta}) - B(\boldsymbol{c}_{it}, \boldsymbol{c}_{it} \times \tilde{\boldsymbol{v}}_{it}, \boldsymbol{\beta}, \boldsymbol{\delta}) \tag{8}$$

where $\boldsymbol{\delta}$ are the parameters of the input price function to be estimated.[20] For identification of parameters, equation (7) can be used to construct moment conditions:

$$E[\varsigma_{it}(\boldsymbol{\beta}, \boldsymbol{\delta})\boldsymbol{Z}_{it}] = 0 \tag{9}$$

$\boldsymbol{Z}_{it}$ is a vector which includes current values of labour and capital, lagged values of materials and their higher order and interaction terms as they appear in the production function. It further includes lagged values of market shares and prices as well as interactions of lagged prices with lags of production factors and market share.[21] Estimation is undertaken using the GMM procedure suggested by Wooldridge (2009) which is based on moment conditions on the combined error term $\varsigma_{it} + \epsilon_{it}$.

This estimation procedure yields estimates of $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$, hence, it identifies all parameters from the production and input price functions. We estimate $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ separately for each industry to allow for industry-specific production technologies and input prices. Under the assumption that $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ are the same for multi- and single-product firms within industries[22], input allocations across products within multi-product firms can be recovered which allows estimation of markups and marginal costs for each firm-product-year. For this purpose, one can express predicted output as: $\hat{q}_{ijt} = f(\tilde{\boldsymbol{v}}_{ijt}, \boldsymbol{\beta}, \hat{w}_{ijt}, \rho_{ijt}) + \omega_{it}$ and divide the production function into two parts, f_1 and f_2, such that only f_2 depends on input allocations across products. This yields a system of equation for each firm-year which allows identifying productivity ω_{it} for each firm-year and the input share allocation ρ_{ijt} for each firm-product-year:

[20] LGKP suggests that the function $B(.)$ can additionally be allowed to depend on interactions between input prices and input expenditures. We also followed this alternative modeling procedure, which led to similar estimated production function coefficients. However, it led to collinearity problems in some industries, and we settled on the more parsimonious specification.

[21] We treat labor as a dynamic input that is characterized by adjustment costs due to the rather rigid Indian labor market.

[22] Note that as discussed by LGKP, this assumption does not rule out differences in productivity levels between single- and multi-product. Since productivity is modeled to be factor-neutral, differences in TFP do not imply differences in $\boldsymbol{\beta}$ or output elasticities. The approach also allows for TFP to depend on the number of products which can imply (dis)economies of scope.

$$\hat{q}_{ijt} - f_1(\tilde{\boldsymbol{v}}_{ijt}, \boldsymbol{\beta}, \hat{w}_{ijt}) = f_2(\tilde{\boldsymbol{v}}_{ijt}, \hat{w}_{ijt}, \rho_{ijt}) + \omega_{it} \quad (10)$$
$$\sum_j \exp(\rho_{ijt}) = 1$$

For multi-product firms, we predict $\hat{q}_{ijt}$ from a first stage regression and use parameters $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ from the sample of single product firms to construct f_1 and f_2. The equation system (10) is then solved numerically for each firm-year.[23]

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 objective 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 is based on Forlani et al. (2016). Their approach is mainly based on two 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 can be approximated by:

$$\gamma_{ijt} \approx \mu_{ijt} p_{ijt} + (\mu_{ijt} - 1) q_{ijt} \quad (11)$$

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.[24]

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

[23] We used Matlab to solve the system of equations. All other estimations were carried out in Stata, version 14.1.

[24] 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 $\frac{\partial p_{ijt}}{\partial q_{ijt}} \equiv -\frac{1}{\eta_{jt}}$.

the assumption that consumers maximize a CES utility function, one can write:

$$q_{ijt} + \sigma p_{ijt} = \alpha_j + \alpha_t + \epsilon_{ijt} \tag{12}$$

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.[25] Quality can be inferred from this specification as $\gamma_{ijt} = \epsilon_{ijt}/(\sigma - 1)$. 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: $p_{ijt} - \hat{\gamma}$.

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.[26]

We first estimate the predicted probability of being acquired, $\hat{Pr}(acq_t = 1|\boldsymbol{x}_{t-1})$ (propensity score), 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 the selection into the group of acquired firms to be based on the expected impact on our outcome variables (Heckman et al., 1997). Furthermore,

[25] 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.

[26] 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.

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 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:

$$y_{it} = \alpha_i + \varphi Acq_{it} + d_{kt} + u_{it} \tag{13}$$

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.[27] This representation makes the analysis of heterogeneous effects across firms straight forward using the following estimating equation:

$$y_{it} = \alpha_i + \varphi_0 Acq_{it} + \varphi_1 Acq1_{it} + d_{kt} + u_{it} \tag{14}$$

where $Acq1$ is a particular characteristic of an acquisition, e.g. the origin of the acquirer.

For outcomes that vary at the firm-product level such as prices, markups, quantities and marginal costs, equation (13) becomes:

$$y_{ijt} = \alpha_{ij} + \gamma Acq_{it} + d_{jt} + u_{ijt} \tag{15}$$

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.[28] We

[27] 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.

[28] 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).

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.

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).[29] The model also controls for time, industry (2-digit NIC level) and region (2-digit pin code area) dummies. We conduct a separate matching exercise for domestic and international acquisitions to allow the determinants of being acquired to vary between these two groups. In our baseline specifications, we only match on firm characteristics to avoid using different weights for product- and firm-level regression. However, as we discuss in the next section, our results are robust towards matching at the firm-product level and controlling for pre-acquisition levels and trends of several firm-product-level outcome variables.

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, raw 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 enjoy higher sales, face higher wage bills, higher levels of expenditure on materials, larger capital stocks and generally 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. Despite facing higher capital stocks, acquired firms are generally found to be less capital intensive.[30]

The lower panel reports variables constructed at the product level. Markups and marginal costs are computed as per equations (2) and (3). All the variables reported under product level are demeaned logged values, i.e. they are purged of product-unit-year fixed effects. This allows us to

[29] 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 $t-1$ only to increase our sample size.

[30] Our measure of capital intensity uses data on wage bills rather than number of employees. The lower capital intensity through higher wage bills of the acquired firms could possibly reflect the increased use of skilled employees, who generally command higher wages.

compare quantities, prices, and costs relative to other firms producing the same product across the different groups.[31] On average, we find that acquired firms produce higher relative quantities and charge higher prices for their product compared to non-acquired firms. These difference are more pronounced for targets of foreign acquirers. On the cost side, we observe that firms acquired by domestic or foreign investors face higher marginal costs. We also find that targets of foreign acquirers enjoy 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 Appendix. In Table A1, columns (1) and (2) show a positive association between quantities and markups and a negative correlation between marginal costs and quantities, suggesting increasing returns to scale; though we should note that these correlations do not necessarily reflect causal relationships between 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) confirming that this is indeed the case within our sample. From Table A2, column (1) shows that within-firm increases in the number of products are associated with increased TFP. This result is in line with

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

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 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 average rates of about 0.3 to 0.4 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. 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 1, particularly in terms of sales, sales growth, 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 not statistically significant. However, this does not necessarily imply that foreign acquisitions have no effects on the efficiency of production. First, TFP is not affected by economies of scale from increased production since these are captured by output elasticities of our translog production function. Second, a drawback of the TFP measure is that it does not vary across products within firm-years. Hence, this physical TFP measure is not directly comparable across time if firms change their product mix upon acquisition. In column (3), we replicate the analysis from column (2) on a subsample of single-product firms. The estimates from these suggest that these firms experience a large and significant increase in TFP.[32] As we discuss below, we find more robust evidence for efficiency gains once our analysis moves to the product level. There is also a small but significant effect on the number of products a firm produces (column 4), indicating an approximate increase of 3%. Estimated effects on the share of exports (column 5) and imports (column 6) in total sales are rather small and not statistically significant. In contrast to previous studies (e.g., Guadalupe et al., 2012; Javorcik and Poelhekke, forthcoming), this indicates that market access is not the main channel that boosts output in acquired firms. A possible explanation is that the majority of acquisition targets already have relatively high export shares before acquisition (see Table 1) as well as access to a large domestic market.

Panel B shows heterogeneous effects of international acquisitions by investor origin. In particular, we analyze whether effects are different if the acquirer is located in one of the most technologically advanced countries.[33] We identify this group if the acquirer is from the US, Europe, Japan, Canada, Singapore or Hong Kong, which applies to just under 60% of all foreign acquisitions. In this specification, *Foreign acquirer* measures the estimated effect of acquisitions from foreign acquirers that are not located in these countries, while *Foreign acquirer high* measures the difference between the effects of acquirers from technologically advanced countries compared to others. Our results suggest that acquirers from these advanced economies have, on average, quite similar effects on sales and TFP of target firms. In contrast to other investors, they do not affect the number of products by much, but they increase the share of exports significantly. As we describe below, there are, however, 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 no, however, no evidence for significant changes in TFP, exports or imports.

To analyze the source of output expansion, we turn to regressions results at the firm-product level based on the sample of matched firms.[34] 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

[32] 95 out of 367 foreign acquisition targets produce a single product at the time of acquisition.

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

[34] The estimates show results on a sample that is matched on firm characteristics only to avoid using a different set of firms or weights from Table 7 and to ease comparability between firm- and product-level outcomes. However, as we discuss in the next subsection and document in Table A7 in the Appendix, our results are very similar if we perform a matching at the firm-product level.

that are produced by a firm during at least one year pre- and post-acquisition.[35] 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.[36] While acquired firms are able to substantially lower their marginal costs by more than 12%, 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).[37]

If technology transfer is important, we should see larger decreases in marginal costs if acquirers are located in technologically advanced countries. As Panel B 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. These acquisitions also lead to somewhat higher markups compared to other foreign acquisitions but this difference is smaller than the difference in cost changes and is not statistically significant.

Results for domestic acquisitions are shown in Panel C. Firms acquired by domestic investors display 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 low-tech foreign acquirers. Despite the cost reduction, prices increase

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

[36]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.

[37]Table A3 in the Appendix shows results for specifications in differences for up to three years after foreign 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.

by a small but weakly significant amount since markups increase by almost 7%. 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) 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.[38]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 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 different types of acquisitions and differ 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 Panels A and B of Table 9 show, increases in prices and markups after foreign

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

acquisitions are indeed concentrated among products classified as differentiated according to Rauch's liberal classification. For non-differentiated goods, we even observe falling prices for acquisitions from technologically advanced countries. There are also substantial differences across product categories for targets acquired by domestic investors. As displayed in Panel C, markups only increase significantly in differentiated product categories upon domestic acquisitions.

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 (12) and the industry-specific import elasticities from Broda and Weinstein (2006). For foreign and domestic acquisitions, we estimate quality increases of 11% and 8%, respectively. Quality-adjusted prices, the difference between changes in log prices and log quality, falls significantly after acquisitions as depicted in column (2). 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) and defined in equation (11) which is based on markups, prices and quantities. The estimated effects are substantially higher, possibly because the firm-product specific markups generate more within-industry variation than the 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; Wang and Wang, 2015; Stiebale, 2016; Javorcik and Poelhekke, forthcoming). 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 that quality improvements are concentrated among foreign acquisitions that lead to an increase in exports. However, we measure similar improvements in quality for acquisitions from low-technology countries for which we found no significant effects on export shares, 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.[39] However, 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 tab:maquality, 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.[40] 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, there seem to be no substantial differences between the different types of acquisitions.

5.4 Extensions and robustness checks

In this subsection, we discuss 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 tables of results, we mainly present estimates for the average effect of foreign acquisitions only.

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

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

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

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 A4 shows results for post-acquisition outcomes for these variables using DiD estimates. As column (1) indicates, payments for outsourced jobs do not increase upon foreign acquisitions. The same is true for financial factors displayed in columns (2) and (3); if anything, these measures decline post-acquisitions. We therefore believe that financial factors and outsourcing are not among the main channels that affect our target firms after acquisition.

Our next set of robustness checks refers to the matching procedure. 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 A5 confirm our main results, both at the firm and at the firm-product level. 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 A6, 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.

To have a common sample of firms for the firm-level and the firm-product-level regressions, our baseline specification uses a matched sample based on firm-level characteristics only. To check whether the omission of product attributes affects our results, we conduct an additional matching exercise at the firm-product level. For this purpose, we match each product of acquisition targets with a similar product of non-acquired firms. We include all the firm-level variables from the previous specification but additionally control for product groups at the three digit level. We also control for levels and trends in product-level sales, prices and markups. We demean each of these variable by product-year, to make them comparable across firms, product categories, and time.[41] Our estimation sample contains 1,000 firm-products affected by foreign acquisitions. The results of the DiD reweighting estimator based on the firm-product matched sample depicted in Table A7 are very similar to our previous findings.

We also check the robustness of the matching procedure with respect to the control group. First, we match foreign acquisition targets with firms that will or have been targeted by domestic acquirers during the sample period. This procedure might 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. Results using this alternative control group are presented in Table A8 and are consistent with our previous estimates.

In our main specification, heterogeneous effects for foreign acquisitions with respect to acquirer origin have been based on a common matching procedure of all foreign acquisitions. While this eases the presentation and statistical significance testing, it may lead to biased effects if acquirers from technologically advanced countries have a significantly different selection profile which is correlated with the outcome variables. To investigate this possibility, we conduct a separate matching procedure for these acquisitions. Estimated effects based on a sample reweighted according to the probability of being acquired by an investor from a technologically advanced country are displayed in Table A9. The results are quite similar to the estimated effects from the common 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 more often been applied in the analysis of foreign acquisitions. Therefore, as an additional robustness check, we preform one-to-one nearest neighbour matching without replacement and perform a DiD regression based on the matched sample in a second step. Results which are depicted in Table A10 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., Javorcik, 2004; Haskel et al., 2007; Girma et al., 2015, among others) and that these spillovers are most likely to occur within the same

[41] Note that we do not include quantities and marginal costs in the estimation of the propensity since these variables do not provide any independent variation conditional on sales, prices and markups

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 displayed in Table A11 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.

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 alongside no reduction in prices. 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 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 quality-adjusted prices fall as a result of both domestic and foreign acquisitions.

The results also 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. From an economic policy point of view, our results indicate that acquisitions can enhance both cost efficiency and quality and therefore reallocation and growth in emerging markets. For future research it would be interesting to analyse 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 increased availability of firm-product level data sets, it will also be interesting to see if our results hold in different countries.

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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	163	138	49
13	Textiles	936	636	108	72	21
14,15	Wearing Apparel and Leather	311	225	41	33	7
16,7,18	Wood, Paper Products and Printing	396	280	65	42	5
19	Coke	128	56	23	19	10
20	Chemicals	1255	736	393	136	44
21	Pharmaceuticals	528	291	64	89	53
22	Rubber and Plastic	566	398	93	51	17
23	Non-metallic Mineral Product	400	297	82	60	25
24,25	Basic Metal and Fabricated Metal	1372	869	162	153	47
26	Computers and Electronics	370	249	169	23	13
27	Electricals	411	246	128	51	19
28	Machinery and Equipment	612	357	178	63	37
29,30	Motor Vehicles and Transport Equipment	424	322	113	41	20
10-30	All Manufacturing	9192	5722	1782	971	367

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

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

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
ln(Sales)	0.0901***	0.2005***
	(0.0186)	(0.0297)
TFP	-0.0004	-0.0141
	(0.0105)	(0.0150)
Δln(Sales)	0.0555	0.0533
	(0.0406)	(0.0659)
Capital stock	0.2485***	0.1546***
	(0.0186)	(0.0285)
Capital intensity	0.0004	-0.0156
	(0.0068)	(0.0101)
Export share	0.1543*	0.2223*
	(0.0805)	(0.1162)
Import ratio	0.0107	0.2104**
	(0.0694)	(0.0961)
No. of products	-0.0166*	0.0011
	(0.0095)	(0.0126)
Observations	23431	22827

Notes: Table reports coefficients from Probit estimation
Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Balancing property - domestic and foreign acquisitions

Variable	Domestic acquisitions					Foreign acquisitions				
	Mean			t-test		Mean			t-test	
	Treated	Control	%diff	t	$p > \|t\|$	Treated	Control	%diff	t	$p > \|t\|$
Propensity score	0.123	0.124	-0.5	-0.09	0.930	0.081	0.081	0.2	0.02	0.982
ln(Sales)	7.638	7.646	-0.4	-0.10	0.924	8.110	8.107	0.2	0.02	0.981
Δln(Sales)	0.151	0.149	0.6	0.14	0.886	0.167	0.169	-0.5	-0.08	0.935
TFP	-0.289	-0.290	0.1	0.01	0.991	-0.410	-0.455	2.7	0.35	0.723
Capital stock	7.103	7.070	2.0	0.43	0.667	7.352	7.402	-3.2	-0.44	0.663
Capital intensity	1.755	1.744	0.3	0.17	0.865	1.541	1.580	-1.2	-1.03	0.306
Export share	0.138	0.139	-0.4	-0.09	0.932	0.155	0.153	1.2	0.16	0.876
Import share	0.238	0.250	-4.8	-1.00	0.317	0.292	0.285	2.6	0.33	0.740
No. of Products	2.587	2.539	2.5	0.49	0.622	2.916	2.788	6.7	0.75	0.455

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

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

Δln(sales) is logarithmic sales growth.

Capital stock measured as log of tangible fixed assets.

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

Export share is the ratio of exports to sales.

Import ratio is the ratio of imports to sales.

Products denotes the number of products produced.

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
Firms	all	all	1-product	all	all	all
Panel A						
Foreign acquirer	0.1023***	0.0471	0.0969***	0.0312***	0.0044	0.0061
	(0.0250)	(0.0450)	(0.0210)	(0.0115)	(0.0061)	(0.0088)
Observations	34666	34666	18442	34666	34666	34666
Panel B						
Foreign acquirer	0.1087***	0.0257	0.1050***	0.0587***	-0.0025	0.0028
	(0.0139)	(0.0637)	(0.0055)	(0.0055)	(0.0031)	(0.0045)
Foreign acquirer high	-0.0111	0.0344	-0.0132	-0.0477***	0.0119***	0.0057
	(0.0170)	(0.0322)	(0.0382)	(0.0067)	(0.0038)	(0.0055)
Observations	34666	34666	18442	34666	34666	34666
Panel C						
Domestic acquirer	0.0842***	-0.0392	-0.0273	0.0301***	-0.0033	-0.0068
	(0.0189)	(0.0246)	(0.0320)	(0.0071)	(0.0039)	(0.0056)
Observations	38670	38670	20417	38670	38670	38670

Notes: Table shows estimates of the ATT based on reweighted regressions at the firm level.
Foreign acquirers takes a value of one in all periods after foreign acquisitions.
Foreign acquirers high takes a value of one for acquirers from the US, Canada, Europe, Japan, Singapore, Hong Kong.
Domestic acquirers takes a value of one in all periods after acquisitions with Indian acquirers.
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	0.1145***	0.0781**	0.0364*	0.1637***	-0.1273***
	(0.0278)	(0.0313)	(0.0199)	(0.0343)	(0.0391)
Observations	69970	69970	69970	69970	69970
Panel B					
Foreign acquirer	0.1008**	0.0197	0.0811***	0.1326***	-0.0515
	(0.0399)	(0.0423)	(0.0271)	(0.0427)	(0.0525)
Foreign acquirer high	0.0225	0.0960**	-0.0735**	0.0512	-0.1246**
	(0.0415)	(0.0455)	(0.0309)	(0.0439)	(0.0575)
Observations	69970	69970	69970	69970	69970
Panel C					
Domestic acquirer	0.1204***	0.0994***	0.0210	0.0697***	-0.0487**
	(0.0210)	(0.0215)	(0.0128)	(0.0214)	(0.0248)
Observations	78892	78892	78892	78892	78892

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 high denotes acquirers from the US, Canada, Europe, Japan, Singapore, Hong Kong.
Domestic acquirer takes a value of one in all periods after acquisitions with Indian acquirers.
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: markups and prices across product groups

	(1)	(2)	(3)	(4)
Dependent variable	ln(markups)	ln(price)	ln(markups)	ln(price)
Products	differentiated	differentiated	homogenous	homogenous
Panel A				
Foreign acquirer	0.1823***	0.0603**	0.1215**	0.0040
	(0.0388)	(0.0272)	(0.0513)	(0.0288)
Observations	39907	39907	30063	30063
Panel B				
Foreign acquirer	0.1468**	0.1174***	0.0998	0.0386
	(0.0578)	(0.0359)	(0.0637)	(0.0398)
Foreign acquirer high	0.0531	-0.0855**	0.0421	-0.0671*
	(0.0615)	(0.0429)	(0.0660)	(0.0404)
Observations	39907	39907	30063	30063
Panel C				
Domestic acquirer	0.0969***	0.0284	0.0344	0.0104
	(0.0279)	(0.0188)	(0.0332)	(0.0145)
Observations	44546	44546	34346	34346

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 high denotes acquirers from the US, Canada, Europe, Japan, Singapore, Hong Kong.
Domestic acquirer takes a value of one in all periods after acquisitions with Indian acquirers.
All regressions include firm-product fixed effects and product-specific time dummies.
Differentiated and homogenous are defined according to Rauch (1999)'s liberal classification.
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

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Quality 1	Ln(price $/\gamma$)	Quality 1	Quality 1	Quality 2	ln(material prices)
	$\sigma = \sigma_j$	$\sigma = \sigma_j$	$\sigma = 5$	$\sigma = 10$	Forlani et al.	
Panel A						
Foreign acquirer	0.1134***	-0.0623***	0.0835***	0.0682***	0.6188***	0.1089***
	(0.0251)	(0.0169)	(0.0212)	(0.0194)	(0.1188)	(0.0116)
Observations	64586	64586	64586	64586	64586	101114
Panel B						
Foreign acquirer	0.1380***	-0.0516**	0.1124***	0.0960***	0.8614***	0.0847***
	(0.0337)	(0.0228)	(0.0326)	(0.0256)	(0.1693)	(0.0165)
Foreign acquirer high	-0.0410	-0.0178	-0.0482	-0.0463	-0.4072**	0.0420**
	(0.0396)	(0.0239)	(0.0344)	(0.0295)	(0.2026)	(0.0204)
Observations	64586	64586	64586	64586	64586	101114
Panel C						
Domestic acquirer	0.0827***	-0.0559***	0.0552***	0.0384***	0.4954***	0.1014***
	(0.0170)	(0.0105)	(0.0147)	(0.0127)	(0.1030)	(0.0108)
Observations	72876	72876	72876	72876	72876	114775

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 high denotes acquirers from the US, Canada, Europe, Japan, Singapore, Hong Kong.
Domestic acquirer takes a value of one in all periods after acquisitions with Indian acquirers.
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.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix

Table A1: Correlations between quantities, markups and costs

	(1) ln(marginal cost)	(2) ln(markup)	(3) ln(marginal cost)	(4) ln(markup)
ln(quantity)	-0.7709***	0.4455***		
	(0.0060)	(0.0064)		
Sales share			-2.1152***	2.4250***
			(0.0538)	(0.0445)
Observations	73184	73184	73184	73184

Regressions include firm-year and product-year fixed effects
Bootstrapped standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Correlations between TFP, marginal costs, products, and prices

	(1) TFP	(2) ln(marginal costs)	(3) ln(markup)	(4) ln(price)
ln(No. of Products)	0.5817***			
	(0.0186)			
TFP		-0.3442***	0.3109***	
		(0.0101)	(0.0078)	
ln(marginal Costs)				0.2841***
				(0.0064)
Observations	94504	94504	94504	94504

Regressions include firm, product and year fixed effects.
Bootstrapped standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A3: DiD reweighting estimates in differences

	(1) (t)	(2) (t+1)	(3) (t+2)	(4) (t+3)
	Panel A: ln(sales)			
Foreign acquirer	0.0481***	0.0991***	0.1304***	0.1563***
	(0.0163)	(0.0251)	(0.0296)	(0.0350)
Observations	9747	9716	9715	9747
	Panel B: ln(quantity)			
Foreign acquirer	0.0523***	0.0780***	0.1610***	0.1899***
	(0.0182)	(0.0228)	(0.0251)	(0.0311)
Observations	20643	20643	20643	20643
	Panel D: ln(markup)			
Foreign acquirer	0.0421**	0.0629**	0.0944***	0.1424***
	(0.0209)	(0.0258)	(0.0298)	(0.0332)
Observations	20643	20643	20643	20643
	Panel D: ln(marginal cost)			
Foreign acquirer	-0.0451**	-0.0765***	-0.1501***	-0.1628***
	(0.0218)	(0.0285)	(0.0325)	(0.0378)
Observations	20643	20643	20643	20643

Standard errors in parentheses

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

Table A4: DiD estimates for other outcome variables

	(1) Outsourcing ratio	(2) Liquidity ratio	(3) Group loan ratio
Foreign acquirer	-0.0009***	-0.0127***	-0.0027
	(0.0003)	(0.0021)	(0.0515)
Observations	39547	39547	39547

Standard errors in parentheses

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

Table A5: DiD reweighting estimates based on longer pre-acquisition trends

			Panel A: Firm-level regressions			
	(1)	(2)	(3)	(4)	(5)	(6)
	ln(sales)	TFP	TFP	Ln(products)	Export share	Import share
Firms	all	all	1-product	all	all	all
Foreign acquirer	0.1109***	0.0590***	0.2883***	0.0310***	0.0121***	0.0095***
	(0.0113)	(0.0194)	(0.0265)	(0.0043)	(0.0020)	(0.0031)
Observations	43059	43059	23106	43059	43059	43059
			Panel B: Product-level regressions			
	(7)	(8)	(9)	(10)	(11)	(12)
	ln(quantity)	ln(price)	ln(markup)	ln(marginal cost)	Quality (σ_j)	ln(p/γ)
Foreign acquirer	0.0798***	0.0275***	0.1508***	-0.1233***	0.1052***	-0.0737***
	(0.0157)	(0.0099)	(0.0153)	(0.0188)	(0.0129)	(0.0082)
Observations	60005	60005	60005	60005	56037	56037

Firm-level regressions include firm fixed effects and industry-year fixed effects.
Product-level regressions include firm-product fixed effects and product-year fixed effects.
Standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A6: DiD reweighting estimates controlling for pre-acquisition trends in all firm-level variables

			Panel A: Firm-level regressions			
	(1)	(2)	(3)	(4)	(5)	(6)
	ln(sales)	TFP	TFP	ln(products)	Export share	Import share
Firms	all	all	1-product	all	all	all
Foreign acquirer	0.0968***	0.0076	0.2273***	0.0312***	0.0087***	0.0132***
	(0.0110)	(0.0183)	(0.0256)	(0.0041)	(0.0020)	(0.0030)
Observations	47831	47831	25778	47831	47831	47831
			Panel B: Product-level regressions			
	(7)	(8)	(9)	(10)	(11)	(12)
	ln(quantity)	ln(price)	ln(markup)	ln(marg.cost)	Quality (σ_j)	ln(p/γ)
Foreign acquirer	0.0714***	0.0359***	0.1511***	-0.1153***	0.1074***	-0.0638***
	(0.0146)	(0.0093)	(0.0141)	(0.0173)	(0.0119)	(0.0075)
Observations	68177	68177	68177	68177	63745	63745

Firm-level regressions include firm fixed effects and industry-year fixed effects.
Product-level regressions include firm-product fixed effects and product-year fixed effects.
Standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A7: DiD regressions from firm-product matched sample

	(1)	(2)	(3)	(4)	(5)	(6)
	ln(sales)	ln(quantity)	ln(price)	ln(markup)	ln(marginal cost)	Quality (σ_j)
Foreign acquirer	0.1389***	0.1083***	0.0306***	0.1477***	-0.1170***	0.1149***
	(0.0136)	(0.0151)	(0.0091)	(0.0145)	(0.0175)	(0.0118)
Observations	71765	71765	71765	71765	71765	68832

All regressions include firm-product fixed effects and product-year fixed effects.
Standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A8: DiD reweighting estimates based on domestic acquisition targets as control group

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Firm-level regressions					
	ln(sales)	TFP	TFP	ln(products)	Export share	Import share
Firms	all	all	1-product	all	all	all
Foreign acquirer	0.1084***	0.0400	0.0855*	0.0202***	0.0080**	0.0209***
	(0.0187)	(0.0295)	(0.0484)	(0.0074)	(0.0034)	(0.0049)
Observations	15105	15105	6507	15105	15105	15105
	Panel B: Product-level regressions					
	ln(quantity)	ln(price)	ln(markup)	ln(marginal cost)	Quality (σ_j)	ln(p/γ)
Foreign acquirer	0.0885***	-0.0187	0.1417***	-0.1605***	0.0380**	-0.0360***
	(0.0219)	(0.0141)	(0.0196)	(0.0251)	(0.0172)	(0.0107)
Observations	24699	24699	24699	24699	22875	22875

Firm-level regressions include firm fixed effects and industry-year fixed effects.

Product-level regressions include firm-product fixed effects and product-year fixed effects.

Standard errors in parentheses.

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

Table A9: Separate matching for acquirers from technologically advanced countries

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Firm-level regressions					
	ln(sales)	TFP	TFP	ln(products)	Export share	Import share
Firms	all	all	1-product	all	all	all
Foreign acquirer high	0.0719***	0.0975***	0.3871***	-0.0022	0.0147***	0.0240***
	(0.0097)	(0.0165)	(0.0232)	(0.0036)	(0.0018)	(0.0026)
Observations	48106	48106	26365	48106	48106	48106
	Panel B: Product-level regressions					
	ln(quantity)	ln(price)	ln(markup)	ln(marg.cost)	quality (σ_j)	ln(p/γ)
Foreign acquirer high	0.0931***	-0.0230***	0.1643***	-0.1873***	0.0359***	-0.0444***
	(0.0130)	(0.0088)	(0.0118)	(0.0153)	(0.0106)	(0.0068)
Observations	66757	66757	66757	66757	62385	62385

Firm-level regressions include firm fixed effects and industry-year fixed effects.

Product-level regressions include firm-product fixed effects and product-year fixed effects.

Standard errors in parentheses.

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

Table A10: DiD estimates based on 1-1 nearest neighbour matching

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Firm-level regressions					
	ln(sales)	TFP	TFP	ln(products)	Export share	Import share
Firms	all	all	1-product	all	all	all
Foreign acquirer	0.1566***	-0.0514	0.2091***	0.0281***	0.0073	0.0324***
	(0.0249)	(0.0415)	(0.0712)	(0.0094)	(0.0046)	(0.0067)
Observations	8501	8501	3038	8501	8501	8501
	Panel B: Product-level regressions					
	ln(quantity)	ln(price)	ln(markup)	ln(marginal cost)	Quality (σ_j)	$ln(p/\gamma)$
Foreign acquirer	0.1010***	0.0301*	0.1008***	-0.0708**	0.1006***	-0.0690***
	(0.0278)	(0.0181)	(0.0258)	(0.0327)	(0.0231)	(0.0136)
Observations	15872	15872	15872	15872	14775	14775

Firm-level regressions include firm fixed effects and industry-year fixed effects.
Product-level regressions include firm-product fixed effects and product-year fixed effects.
Standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A11: DiD based on nearest neighbour matching, control group from different regions

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Firm-level regressions					
	ln(sales)	TFP	TFP	ln(products)	Export share	Import share
Firms	all	all	1-product	all	all	all
Foreign acquirer	0.1699***	-0.0393	0.2291***	0.0263***	0.0083*	0.0311***
	(0.0250)	(0.0426)	(0.0735)	(0.0097)	(0.0048)	(0.0070)
Observations	8039	8039	2861	8039	8039	8039
	Panel B: Product-level regressions					
	ln(quantity)	ln(price)	ln(markup)	ln(marginal cost)	Quality (σ_j)	$ln(p/\gamma)$
Foreign acquirer	0.0967***	0.0320*	0.1123***	-0.0803**	0.0948***	-0.0646***
	(0.0289)	(0.0188)	(0.0268)	(0.0339)	(0.0239)	(0.0141)
Observations	14992	14992	14992	14992	13928	13928

Firm-level regressions include firm fixed effects and industry-year fixed effects.
Product-level regressions include firm-product fixed effects and product-year fixed effects.
Standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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