Trade Liberalization, Intermediate Inputs, and the Demand for Managers: Evidence from India*

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Abstract

Recent studies indicate that globalization plays a central role in understanding how a firm is organized; to this point, however, empirical evidence for this focused strictly on developed economies, while nevertheless recognizing the potential importance of this to developing ones. Adopting the case of India, this paper presents a first attempt to examine this link in a developing economy, focusing on one key aspect of it: the effect of changes in tariffs on the demand for managers relative to non-managers. Using detailed firm-level data across Indian manufacturing sectors spanning over two decades, and exploiting the exogenous nature of India's trade reform, we investigate the potential causal link between the two, and the underlying mechanism. We find that a decrease in input tariffs increases the relative demand for managers, primarily due to managers-biased pay structures and firms' vertical expansion that operate through a quality upgrading channel. Specifically, a 10% drop in input tariffs induces, on average, a 1-2.3% increase in the compensation share of managers. These patterns are observed uniformly across the firms' size distribution, and are most acute in domestic, private, firms that use the imported inputs to produce and export final goods.

JEL classifications: F1, F14, F61

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1 Introduction

Economists have long been interested in understanding the economic implications of globalization on the labor market. One aspect of this relates to firm organization. Recent research suggest that trade liberalization affects firm managerial practices, quality, and hierarchical structure,[1] which in turn affect productivity and performance,[2] thereby placing this emerging issue at the center of economic debates. Despite acknowledging the potential prominence of this trade-organization nexus in developing economies, most notably India,[3] previous empirical studies addressing this topic were all strictly based on case studies of developed economies.[4] Adopting the case of India, we make a first attempt to empirically study this nexus in a developing economy, through which we unravel new dynamics that emphasize the distinctive features of such an economy in this context.

Our primary focus is on one key aspect of this: the effect of trade liberalization, vis-à-vis changes in tariffs, on the demand for managers relative to non-managers.[5] While previous studies examined components related exclusively to the managerial side, such as wages and bonuses (e.g. Cunat and Guadalupe (2009)), very little attention, if any, has been given to the inclusion of the non-managers' side to consider relative terms and within-firm inequality.[6] We study the causal link, look into its sources, and identify the underlying mechanism through which it operates. Through examination of the latter we additionally present results on a wide array of related issues ranging from organizational design to pay structure, shedding light on the more general aspects of organizational culture adjustments to liberalization shocks. Our main findings are that decreases in input tariffs increase the compensation share of managers via an imports-triggered quality upgrading mechanism that increases both managers' income, primarily through incentive-based payments, as well as their number, through vertical expansion of the firm.

[1] See Caliendo and Rossi-Hansberg (2012), Chen (2014), Marin and Verdier (2008) and Marin and Verdier (2014).

[2] Studies that link firm organization and managerial practices to firm performance and productivity include Bloom, Brynjolfsson, Foster, Jarmin, Saporta-Eksten, and Van Reenen (2013), Bloom, Lemos, Sadun, Scur, and Van Reenen (2014), Bloom and Van Reenen (2007), Bloom and Van Reenen (2010), Caliendo and Rossi-Hansberg (2012), Garicano and Rossi-Hansberg (2004), and Garicano and Rossi-Hansberg (2006) among others.

[3] Through a field experiment involving Indian textile firms, Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013) find that better management practices can increase productivity by 17% in the first year, and lead to firm expansions within three years.

[4] Empirical evidence has been based on data from: Austria and Germany (Marin (2009), and Marin and Verdier (2014)), France (Caliendo and Rossi-Hansberg (2012)), Portugal (Fernandes, Ferreira, and Winters (2014)), Norway and Sweden (Oxelheim and Randy (2005)), U.K. (Acemoglu, Aghion, Lelarge, and Van Reenen (2007)), and the U.S. (Carpenter and Sanders (1998), Cunat and Guadalupe (2009), Guadalupe and Wulf (2010), Ma (2015), and Marin and Verdier (2008)) – all of which belong to the group of highly developed countries.

[5] We define managers as any workers who manage at least one other worker (or who is the sole worker in the firm), with non-managers accounting for the remaining balance. We discuss this in further detail in the empirical part.

[6] An exception is Ma (2015) who studies the impact of globalization on executives' income shares in U.S. firms using conditional correlations; in contrast, we establish a causal link and empirically identify the underlying channel, while examining a more general definition of managers.

We start by presenting the link between trade and the relative demand for managers in our sample of Indian firms, outlined below, for the period of 1990-2006; this is plotted in **Figure 1**.[7] Both measures have been increasing steadily throughout the period, exhibiting a correlation of 0.85. The surge in trade is a consequence of the Indian 1990s trade reform which we discuss further below; the increase in the compensation share of managers is what we aim to investigate. We seek to understand, therefore, whether there is indeed a systematic association between the two; **Figure 2** points at a possible direction: dividing the relative demand measure to importing and non-importing firms indicates the surge is almost an exclusive feature of the former types – motivating our focus on tariffs. To test whether, and how, the latter creates a causal effect, we exploit the exogenous nature of India's 1990s trade reform in conjunction with a rich data set on Indian manufacturing firms that uniquely disaggregates labor compensation to managers' and non-managers' over a period of two decades.[8]

Our analysis begins with establishing an analytical framework, following the setting of Berman, Bound, and Griliches (1994), applied to our case. This yields a reduced form equation that links between imports and the relative demand for managers, which we then take to the data. In a preliminary analysis, testing trade measures directly via conditional correlations, we find that consistent with **Figure 2**, it is only imports, and more specifically those of intermediate inputs, that are positively associated with the relative demand for managers. This then refutes the possibility of observing a simple administrative reclassification (an option we elaborate on later), paving the way to turn the discussion to tariffs and provide causal inference.

Hence, we exploit a quasi-natural experiment, India's Eight-Plan trade reform, to establish a causal link. The details of this reform, and its merits in the context of our case, are outlined separately in the following section. The key point is that this reform provides arguably exogenous changes in industry-level input and output tariffs, with ample cross-industry variation, which we use as the basis of our identification strategy and which enables us to pinpoint the underlying mechanism. We find a remarkably robust, persistent, and economically meaningful negative effect that, consistent with the findings in the initial analysis, is entirely driven by input tariffs; specifically, our benchmark estimations indicate that a 10% decrease in input tariffs increases the relative demand for managers by approximately 1-2.3%.

This effect is robust to considering various controls, specifications, estimation techniques, and time periods. In addition, testing various possible channels, we note that it is not an out-

[7] The figure presents yearly average (over all firms), 1990-2006, of the share of total trade in gross value added and the share of managerial compensation in total labor compensation; we proxy for the relative demand for managers using the latter. We discuss both measures in more detail in the empirical part.

[8] We discuss the sources, characteristics, and details of these two main features (namely, the firm-level data, and the Indian trade reform) separately, in the following sections.

come of industry-specific trends or potential associations between managers and: skill, capital-complementarity, productivity, and management technology. Digging deeper, we identify the subset of firms that drive this as those that import intermediate inputs to produce and export final goods, irrespective of their size. Put together, these results point at a quality upgrading mechanism reminiscent of Caliendo and Rossi-Hansberg (2012),[9] adjusted to an importing-based economy: firms import intermediate inputs of higher quality and variety; these together with the products they produce are embedded with new knowledge that in turn increase the relative demand for workers with skills to manage that.[10]

This is the first contribution of this paper. Next, we investigate how this potential mechanism operates to increase the compensation share of managers in practice. Since the observed change is compensation-based, it can be made either via income directly, or through a change in the number of managers; we look into both aspects. Starting with the first, we decompose the compensation ratio of managers and non-managers to its different components, including the separate incomes, and further to their portions of salary and bonuses. We find that decreases in input tariffs (do not affect) increase (non-)managers' compensation, indicating the main result is not an outcome of outsourcing or other schemes that may lead to major layoffs of non-managers, but rather through increases coming from the managers' side. Consistent with patterns observed in developed countries (e.g. Cunat and Guadalupe (2009)), the more detailed components indicate that both managers' salaries and bonuses increase, suggesting pay structures are managers-biased when interacted with trade liberalization.

Moving to the second aspect, we find that decreases in input tariffs increase the number of managers. Realizing this is an outcome of a change in organizational design, we consider both horizontal and vertical changes in firms' structure, following trade liberalization. We proxy the former through the variety of products produced,[11] whereas for the latter we exploit features in our compensation data to create a dummy for the number of organizational layers, based on the notion of hierarchical layers laid out by Garicano (2000). We build on Goldberg, Khandelwal, Pavcnik, and Topalova (2010) who find a robust negative link between input tariffs and product variety in Indian manufacturing firms, indirectly pointing at a horizontal expansion; hence, our initial focus is on the vertical side. We find that an input liberalization shock creates vertical expansion. In

[9] Studying a model of heterogeneous firms with knowledge-based hierarchies, they show that trade liberalization increases the number of management layers in exporting firms, as managers can solve more efficiently problems arising from increasing output than workers for whom costly knowledge needs to be acquired.

[10] Interestingly, this is in contrast to previous studies that examined developed economies, pointing at a product market competition mechanism (e.g. Cunat and Guadalupe (2009), Bloom, Draca, and Van Reenen (2015), and Bloom, Sadun, and Van Reenen (2010)), and hence emphasizing the extent to which the case of a developing economy may present different dynamics and provide new insights.

[11] Assuming more products imply more same-level divisions within a firm, hence measuring horizontal size.

addition, we note that a horizontal (vertical) expansion decreases (increases) the relative demand for managers, thus tracing the organizational design's component of the overall effect in the expanding number of organizational layers – again, consistent with theoretical predictions of Caliendo and Rossi-Hansberg (2012).

The paper in addition contributes to the more specific literature on globalization and organizational structure. Using a sample of U.S. firms, Guadalupe and Wulf (2010) find that greater competition causes firms to flatten their hierarchies. A similar finding is derived by Marin and Verdier (2008) examining also U.S. firms, as well as by Marin and Verdier (2014) using Austrian and German firms. More generally, Caliendo, Monte, and Rossi-Hansberg (2014) and Rajan and Wulf (2006) find that firms tend to flatten over time in France and the U.S., respectively. In contrast, we find that trade liberalization vertically expand Indian firms, which also follow a more general vertical expanding trend irrespective of the former, hence emphasizing the different dynamics that may be present in a developing economy in this regard. Conversely, our result is supportive of Caliendo and Rossi-Hansberg (2012); however, we find this is triggered by imports rather than by exports (as they emphasize), again highlighting the different perspective of an emerging economy.

Also related is the literature on trade liberalization and the demand for skill in developing economies. Neoclassical trade theory, via the Stolper-Samuelson theorem, predicts that trade liberalization increases demand in the abundant factor, which is expected to translate to increased relative demand for low-skill labor in developing economies. Several studies, however, document an increase in the skill premium in some developing economies, especially during the 1980s and 1990s (Goldberg and Pavcnik (2007)). Various explanations have been offered, including trade-induced skill-biased technical change (Acemoglu (2003), and Zeira (2007)), credit constraints (Bonfatti and Ghatak (2013)), improved exports (Zhu and Trefler (2005)), import composition (Raveh and Reshef (2015)), and quality upgrading (Verhoogen (2008)). We show that our main result is not an outcome of an increase in the demand for skill; nonetheless, since our analysis focuses on relative terms, and managers are included in the standard definition of the skilled group,[12] this paper points at a new potential contributing factor: organizational change that increases the relative demand for managers.

The paper is structured as follows. Section 2 describes the analytical framework. Section 3 outlines the details of the firm-level data. Section 4 undertakes the main exercise, examining the effects of trade liberalization on the relative demand for managers. Section 5 traces the sources of the main effect, looking into pay structures and organizational design. Section 6 concludes.

[12] Most of the said papers adopt a skill division of production and non-production workers, where the managers group is included in the latter.

2 Analytical Framework

This section lays out a simple analytical framework to help organize the discussion. As mentioned, our main focus is on trade liberalization vis-à-vis changes in tariffs; realizing, however, that by definition tariffs affect imports directly, and for tractability purposes, we link the latter directly to imports within our setting.[13] We follow the framework set by Berman, Bound, and Griliches (1994), applied to our case.

Suppose a representative firm uses three inputs: managers (m), non-managers (n), and imports (M). The price of imports is determined in international markets, taken as given by local firms; M is, therefore, assumed to be a quasi-fixed factor. Conversely, m and n are variable inputs. Hence, variable costs are given by $c = w_m \cdot m + w_n \cdot n$; w_m and w_n being the wage rates of managers and non-managers, respectively. If m and n are the argmin of costs, then c is the cost function. The logarithm of c can be approximated by a translog cost function:

$$\begin{aligned}\ln(c) \;=\; & \alpha_m \ln(w_m) + \alpha_n \ln(w_n) + \alpha_M \ln(M) + \alpha_y \ln(y) + \\ & \frac{1}{2}[\beta_{mm} \ln(w_m)^2 + \beta_{mn} \ln(w_m)\ln(w_n) + \beta_{nm} \ln(w_n)\ln(w_m) + \beta_{nn} \ln(w_n)^2 + \\ & \beta_{MM} \ln(M)^2 + \beta_{yy} \ln(y)^2] + \gamma_{mk} \ln(w_m)\ln(M) + \gamma_{my} \ln(w_m)\ln(y) + \\ & \gamma_{nM} \ln(w_n)\ln(M) + \gamma_{ny} \ln(w_n)\ln(y) + \gamma_{My} \ln(M)\ln(y) \;\;,\end{aligned}$$

where y is output. Symmetry implies $\beta_{mn} = \beta_{nm}$. By Shephard's lemma, $\partial c/\partial w_m = m$, so that the cost share of managers is:

$$S \equiv \frac{w_m m}{c} = \frac{\partial \ln(c)}{\partial \ln(w_m)} = \frac{\partial c}{\partial w_m}\frac{w_m}{c} \;\;.$$

Using this in the translog we get:

$$S = \alpha_m + \beta_{mm} \ln(w_m) + \beta_{mn} \ln(w_n) + \gamma_{mM} \ln(M) + \gamma_{my} \ln(y) \;\;.$$

By linear homogeneity of cost with respect to prices, cost shares are homogenous of degree zero. Therefore $\beta_{mm} + \beta_{mn} = 0$. By linear homogeneity of the production function we have $\gamma_{mM} + \gamma_{mM} = 0$; increasing all inputs by same factor increases output by same factor, but this should not affect the cost share. Using these two properties gives:

$$S = \alpha + \beta \ln\left(\frac{w_m}{w_n}\right) + \gamma \ln\left(\frac{M}{y}\right) \;\;. \tag{1}$$

[13] This follows Cunat and Guadalupe (2009) and Guadalupe and Wulf (2010), for instance, who also maintain a focus on import penetration for investigating related issues.

The compensation share of managers ($w_m m$) in total labor compensation (c), S, is affected by the managers to non-managers wage ratio, and the output share of imports. We follow Berman, Bound, and Griliches (1994) and assume that the quality-adjusted price ratio of managers to non-managers does not vary across industries, thus only affecting the constant term in case dropped, which will be done due to data limitations. Nonetheless, as in Michaels, Natraj, and Van Reenen (2014) we will add year by industry fixed effects that will absorb the relative wage term in case the above assumption is relaxed (which will not affect results, as will be evident). We are therefore left with the following outcome:

$$S = \alpha + \gamma \ln\left(\frac{M}{y}\right). \tag{2}$$

Relaxing the assumption of constant returns to scale in technology, as is done in the empirical part, requires controlling for output, yielding the following:

$$S = \alpha + \gamma \ln\left(\frac{M}{y}\right) + \delta \ln(y). \tag{3}$$

This empirically testable association links between the output share of imports, and the share of managers' compensation in total labor compensation, regarded as the relative demand for managers in the empirical part. Note that this framework can be extended further, in the same manner, to various types of M – a feature that we exploit in the empirical section, where we take this framework to the data.

3 Firm-Level Data

We examine firms in the Indian manufacturing sector. The firm-level analysis is primarily based on the Prowess database, constructed by the Centre for Monitoring the Indian Economy (CMIE), an Indian government sponsored agency. We outline the features of this dataset in detail in this section.

The Prowess database contains information on approximately 27,400 publicly listed companies, all within the organized sector, of which almost 11,500 are in the manufacturing sector.[14] It reports direct measures on a vast array of firm-level characteristics including sales, disaggregated trade components, R&D expenditures, technology transfers, production factors employed, gross value added, assets, ownership, and others which we outline further within the empirical analysis. In addition, it covers both large and small enterprises; data for the former types is collected from balance sheets, whereas that for the latter ones is based on CMIE's periodic surveys of smaller

[14] While placed according to the 4-digit 2008 National Industrial Classification (NIC) level, firms are reclassified to the 2004 level to facilitate matching with the industry-level tariffs.

companies.

Prowess presents several features that make it particularly appealing for the purposes of our study, and puts it in an advantage compared to other available sources, such as the Indian Annual Survey of Industries (ASI), for instance. First, unlike other sources, the Prowess data is in effect a panel of firms, enabling us to study their behavior over time; specifically, the (unbalanced) sample covers up to 8,000 firms, across 108 (4-digit NIC) manufacturing industries that belong to 22 (2-digit NIC) larger ones,[15] over the period of 1990-2006,[16] hence covering the 1990s trade reform, being an essential part of our analysis that we discuss later.

Second, the unique feature of the data set, upon which our study is mainly based, is that it disaggregates compensation data to those received by managers and non-managers, with a further disaggregation of compensation to wages and bonuses. Specifically, the division is done to three layers: non-managers, directors, and executives; the latter two comprise the managers' group. While the definition of the former is that they do not manage other employees, directors are defined as managers without executive powers, as opposed to executives which do possess such responsibilities. Executives include, for instance, the CEO, CFO, and Chairman, whereas Directors cover positions such as Divisional Managers. In effect, directors are considered to be middle management, whereas executives are the top management. These features enable us to study a wide array of management-related firm-level characteristics, over a relatively large period of time, ranging from the relative demand for managers to organizational design and pay structures, and by that trace down the underlying channel that affects the former.

Importantly, the data set provides much variation across firms and industries in the compensation characteristics of managers compared to non-managers, which enables us to better understand how they react to trade shocks. For instance, in **Figure 3** we plot the average share of managerial compensation in total labor compensation across 2-digit industries for the period of 1990-2006;[17] going from a low of approximately 1.5% to a high of around 9%, the difference across industries is clearly observed. This is also seen when measuring changes over time; averaging annual changes over the same period, we observe that while in some industries the average annual rate of change is around 10%, in others it can get higher than 200%, hence providing quite large differences that we examine in the empirical part. This translates to the firm level, where such variation is even more prominent. One key related characteristic is that close to 25% of firms report having no managerial

[15] In terms of composition, approximately 20% of the firms in the dataset are registered under the Chemical and Pharmaceutical industries, followed by Food Products and Beverages (13.74%), Textiles (10.99%) and Basic Metals (10.46%).

[16] While our data covers the period of 1990-2011, we limit the main analysis to 2006 to avoid potential biases caused by the 2008 financial crisis. We do, however, extend our analysis to 2011 in the robustness section.

[17] Note that all industry-level categorization made throughout the paper are based on the 2004 NIC classification.

layer (in the form of reporting zero, or otherwise sufficiently low, managerial compensation). This is consistent with the family-oriented Indian firm culture (Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013)).

Last, it has a relatively wide coverage, accounting for more than 70% of the economic activity in the organized industrial sector, and 75% (95%) of corporate (excise duty) taxes collected by the Indian Government (Goldberg, Khandelwal, Pavcnik, and Topalova (2010)). In terms of trade, it covers approximately 30-35% of India's total exports and imports activity, presenting a reasonably good aggregate picture on India's trade position. In addition, it has been used in various previous similar studies, providing some reassurance for its relevance and applicability to the particular issues studied.[18]

All variables are measured in Millions of Indian Rupees (INR), deflated to 2005 using the industry-specific Wholesale Price Index,[19] and are outlined in the Appendix. **Table 1** presents descriptive statistics for all variables.[20]

4 Trade Liberalization and the Relative Demand for Managers

In this section we test the general empirical association derived by the analytical framework, through a firm-level analysis, using the data described above. Specifically, we investigate the link between changes in tariffs and the relative demand for managers, yet also motivate our focus on the former through a preliminary analysis that examines trade measures directly.

4.1 Preliminary analysis: Trade measures

Our analysis begins by studying the direct effects of trade, via import and export penetration. We consider the empirical counterpart of Equation (3), yielding the following managers' share equation, for firm i, at time t:

$$\frac{Mcomp}{Tcomp}_{i,t} = \alpha + \beta \ln(\frac{T}{GVA})_{i,t} + \gamma \mathbf{X}_{i,t} + \delta_i + \eta_t + \epsilon_{i,t} \ , \tag{4}$$

where $Mcomp$ is the managers' total compensation, $Tcomp$ is total labor compensation, T is total imports or exports, GVA is gross value added, $\mathbf{X}$ is a vector of controls which depends on the

[18] See e.g. Ahsan (2013), Ahsan and Mitra (2014), De Loecker, Goldberg, Khandelwal, and Pavcnik (2014), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), and Topalova and Khandelwal (2011).

[19] We thank Hunt Allcott for sharing this data with us, used in Allcott, Collard-Wexler, and O'Connell (2014).

[20] One pattern described in Table 1 deserves further comment. As reported, maximum figures of various GVA-normalized measures can reach relatively high values; this is a feature of the definition of GVA (see Appendix), and occurs in cases of high purchases and low sales, such as in initial investments, for instance. All results are robust to omitting observations with GVA-normalized figures higher than one; nonetheless, we maintain the full sample in the main analyses for the purposes of exploiting its full extent.

specifiacation tested as we specify below, and δ and η are firm and time fixed effects, respectively. In effect, this model examines the determinants of the relative demand for managers, measured through the compensation share of managers. Specifically, we are interested in understanding the characteristics of β; i.e. the empirical association between normalized imports, or exports, and the relative demand for managers.

Our benchmark setting includes several points. First, we start by testing the full sample; as mentioned, this means examining the annual-based, unbalanced, panel over the period of 1990-2006. Second, standard errors are clustered at the firm-level in all cases. Third, while the vector $\mathbf{X}$ is continuously modified, we follow insights from Acemoglu, Aghion, Lelarge, and Van Reenen (2007) and Garicano and Rossi-Hansberg (2012), and hence begin with including four basic controls (henceforth, firm controls) in it: the age, extent of technology adoption, assets, and output of a firm. Realizing that older firms might have a more established structure and culture, the first measure hence controls for potential differences in the flexibility of undertaking organizational reforms; addressing potential related U-shaped effects, we also include the square term of age. The second variable, measured as the share of R&D expenditure and royalty payments for technical knowhow in GVA, captures technology differences which can affect the dependent variable to the extent that managers relate to skill intensity. The third controls for firm size, given that larger firms may have greater management needs. The last controls for firm's output, following the analytical framework and Equation (3). All four are, therefore, potentially highly related to the demand for managers, which is why we consider them as being the essential *firm controls*;[21] later we discuss separately further controls and potential channels.

We begin by closely following Equation (3), estimating a version of Equation (4) where the relevant independent variables are in their natural logarithm form. Specifically, these include the normalized trade-related measures. Since, however, some firms do not import or export, these were increased by one prior to conversion, to be able to exploit the sample to its fullest; for consistency we repeat this modification for all logarithmic conversions done throughout the analysis.[22]

Results appear in **Table 2**. Starting with imports, denoted by T in the empirical specification, Column (1) presents the benchmark setting. As can be seen, our coefficient of interest is positive and significant. The two are, thus, positively related as conjectured; following exercises, focusing on tariffs, will reveal this association is highly persistent and robust. In addition, the magnitude is economically meaningful: a 1% increase in the GVA share of total imports increases the compensation

[21] Nonetheless, we note that all results are robust to their exclusion.

[22] We note that all results hold, both qualitatively and quantitatively, without this manual addition in any of the logarithmic variables used in the estimations. We prefer it as the alternative would result in testing smaller samples and raising further sample-selection related concerns.

share of managers by approximately 0.1%.

In Column (2) we estimate a variant of the former, having industry by year fixed effects; these control for various within-year industry trends, such as the industry-year specific '*delicensing*' or FDI-liberalizing phenomena,[23] the managers to non-managers wage ratios in case the assumption that they lack inter-industry variation is relaxed, or various industry-specific labor laws and federal subsidies initiatives. Here as well, β is positive and significant, with similar magnitude. Last, realizing that the demand for managers may be a persistent phenomenon, in the third case we test a dynamic version with a lagged dependent variable included, noticing that the main result remains to hold, albeit with some drop in magnitude.

An initial implication of these observations, together with the patterns outlined in **Figure 2**, is that this refutes the possibility that a simple administrative reclassification of workers is driving the increasing trend observed on our outcome variable in **Figure 1**, so long as such reclassification would not be a specific feature of importing firms, and to the extent that it may be an outcome of the abovementioned '*delicensing*' process, given it is a phenomenon we control for.

Turning to exports, Columns (4)-(6) replicate Columns (1)-(3), only in these cases T denotes exports. As can be seen, unlike imports these cases yield statistically insignificant results with lower magnitudes. To better observe the distinction between the two, in Column (7) we include both, only under a first-difference setting to address potential multicollinearity. The result clearly points at imports as being the triggering factor, hence motivating our focus on changes in tariffs. Interestingly, this depicts different dynamics than those presented in previous studies that emphasize the role of exports in developed economies (e.g. Caliendo and Rossi-Hansberg (2012)), implying how the case of a developing economy may provide a new perspective on this. We, hence, dig deeper into this in what follows.

4.1.1 Disaggregating imports: The role of imported capital goods

Following the above, and as an initial step to better understand the underlying channel, we next disaggregate imports to various groups, to investigate their separate effects on the relative demand for managers. All results in this sub-section appear in **Table 3**, and all estimations follow the benchmark specification as in Column (1) of **Table 2**, only with the respective import type in lieu of T, as specified.

[23] Until the 1980s large firms were required to obtain an operating license, and FDI was capped at 40% in most industries. Starting in 1985, and continuing in the 1990s, industries went through both a 'delicensing' reform, where the abovementioned requirement was dropped, and a FDI-liberalization process (see e.g. Nataraj (2011)). Chamarbagwala and Sharma (2011) note that the 'delicensing' process helped upgrading firms' skill intensity, emphasizing further the relevance of controlling for this in our context.

The data enables us to disaggregate imports to four groups: raw materials, capital goods, stores and spares, and finished goods. The aggregation of the first two represents the group of intermediate inputs, with the other two being non-inputs. In Columns (1) and (2) we estimate Equation (4) for imports of inputs and non-inputs separately; Column (3) then estimates the two together, addressing potential omitted variable bias. Through the positive and significant result on inputs, in conjunction with the opposite one on non-inputs, these estimations indicate it is specifically imported inputs that are associated with increases in the compensation share of managers; question is, therefore, which inputs are dominant?

To address that, we estimate each of the groups separately. Results appear in Columns (4)-(7) for the separate cases, and in Columns (8) for the specification that includes all the four. The pattern observed is clear. The overall effect outlined previously is apparently driven in its entirely by imports of capital goods, given its precisely estimated positive β, in contrast to those of the other types which appear imprecise and with small magnitudes.

Although not further disaggregated, given that ICT is a component of capital goods and since during most of these years a large portion of India's ICT capital formation was done through imports (Raveh and Reshef (2015)), these patterns are consistent with Bloom, Garicano, Sadun, and Van Reenen (2014) who find that ICT capital increases managers' span of control (and hence indirectly, also their demand). Importantly, this also gives a more detailed indication of the potential underlying mechanism. Having the main effect being driven by imported inputs implies a quality upgrading mechanism is at work. We describe and consider this option in more detail in the sections to follow, where we turn the focus to changes in tariffs.

4.2 Main analysis: Changes in tariffs

To this point our analysis evolved around trade measures, motivating a focus on imports and capital inputs. In this sub-section, however, we turn the focus to trade liberalization directly; motivated by the initial trade-related results, we examine changes in tariffs – a major liberalization tool. In addition, this modification enables us to address various econometric issues that may have plagued the initial analysis, the most notable one being the potential endogeneity of imports to the relative demand for managers. We address this concern, among others, in this sub-section. To do so, we exploit a quasi-natural experiment: The 1990s India's trade reform. We describe it next.

4.2.1 India's trade reform: A quasi-natural experiment

Prior to 1990 India was one of the most trade-restrictive economies in Asia, having high tariff and non-tariff barriers. In 1991, India turned to the IMF, following a balance-of-payments crisis,

for assistance; the latter conditioned such assistance on an implementation of a major adjustment program that was to include also liberalization steps that would abandon the restrictive trade policies. As a result, average tariffs fell by more than half between 1990 and 1996 (Topalova and Khandelwal (2011)); non-tariff barriers made a similar drop between the late 1980s and the mid 1990s (Goldberg, Khandelwal, Pavcnik, and Topalova (2010)). To better illustrate the change in our period of interest, in **Figure 4** we plot the average annual tariff level in the manufacturing sector during 1990-2006; starting at around 150 in 1990, the average tariff level dropped to approximately tenth of that by 2006. These major tariff changes form the key policy measure we exploit.

This trade reform presents several advantages that make it appealing for the purposes of this study. First, the crisis that led to the adjustment program was triggered by external events, such as the sudden increases in oil prices, drop in remittances from Indian workers abroad, and major political occurrences (the murder of Rajiv Gandhi, for instance) that damaged foreign investment. This, in turn, in conjunction with the fact that reforms were passed quickly, led to sudden changes that were unanticipated by Indian firms, establishing the reform as being a quasi-natural experiment.

Second, the liberalization reform did not seem to have targeted industries within the manufacturing sector in a way that was related to pre-reform conditions; indeed, Topalova and Khandelwal (2011) show that changes in industry-level tariffs during these years (1991-1997) were not correlated with pre-reform industry characteristics. In the empirical analysis we follow this finding by restricting the causal analysis to the said period; we discuss this further in the estimations. Importantly, this further establishes the plausibly exogenous nature of the reform and the shocks we study.

Third, there is much variation in the tariff changes across industries, as has been reported in previous studies (e.g. Topalova and Khandelwal (2011)); this feature is also observed in our sample, where the 3-digit industry-level annual tariff drops range from as low as 25% to as high as 2%, with a mean of 6% and standard deviation of approximately 2.5%. Last, the usage of this quasi-natural experiment as a tool to identify the effects of trade liberalization on firm-level behavior has been done in several previous studies,[24] thus establishing its familiarity and reliability; we exploit this feature next, as we outline our empirical strategy.

Data and empirical strategy Industry-level tariff data are categorized according to 1987 NIC code, yet are reclassified to 2004 NIC to match with our firm-level dataset. We use tariff data from Ahsan and Mitra (2014) for the period of 1990-2003, updating post-2003 years using HS 6-digit level tariff data from the TRAINS-WITS tariff database. We match the HS 6-digit level tariff data with our firm-level data by using the Debroy and Santhanam (1993) concordance table for matching

[24] See e.g. Ahsan (2013), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), and Topalova and Khandelwal (2011).

trade codes with industrial codes.

Hence, similar to Ahsan (2013) and Ahsan and Mitra (2014), we investigate industry-level tariffs. Importantly, at the industry level it is possible to distinguish between input and output tariffs, which as will be evident enables us to better identify the underlying mechanism at work – a central feature in the analysis. One alternative could have been following Goldberg, Khandelwal, Pavcnik, and Topalova (2010), for instance, who construct firm-level tariff measures through a combination of industry-level input and output tariffs coupled with firm-level input-output tables; this setting, however, would put a constraint on the option to detect the triggering channel, hence supporting our preference for the former.

As for the empirical strategy, we build upon the exogeneity feature discussed above to undertake the main analysis using OLS. Realizing tariff changes may have a lagging effect, and to better address further endogeneity concerns we consider liberalization shocks in the previous period. In effect, we follow the empirical strategy of previous studies investigating the effects of trade liberalization using the same reform (e.g. Topalova and Khandelwal (2011)).

4.2.2 Input vs. Output tariffs: Causal Inference

We estimate the tariff-based version of Equation (4), for firm i, in industry j, at time t using the following reduced-form equation:

$$\frac{Mcomp}{Tcomp}_{i,t,j} = \alpha + \beta \ln(Tariff)_{t-1,j} + \gamma \mathbf{X}_{i,t,j} + \delta_j + \eta_t + \epsilon_{i,t} \ , \tag{5}$$

where $Tariff$ refers to either input or output tariffs. The remaining notation follows that described in (4), with the primary exception of the industry fixed effect, δ_j. Given our main explanatory variable, tariffs, is at the industry level, we follow Moulton (1990) and maintain a fixed effect, and an error clusterting, framework that corresponds to that level.[25] In addition, given the industry level framework, we now add an ownership dummy to $\mathbf{X}$;[26] motivated by Conconi, Legros, and Newman (2012), this variable controls for whether firms are domestic or foreign owned.

Results appear in **Table 4**. Columns (1)-(4) examine input tariffs. Specifically, the first three cases follow the specifications of Columns (1)-(3) of **Table 2**, only with the input tariff in lieu of imports; the first denotes the benchmark scenario, the second includes an interaction of the industry fixed effects with a time trend,[27] and the third estimates a dynamic version – all of them

[25] Nonetheless, we note that results are maintained, with high stability, when using fixed effects and clustering at the firm level.

[26] Given it presents no within-firm variation, this measure was implicitly controlled for in the previous exercises, through the firm fixed effects.

[27] Unlike the previous trade-based cases, in this case our variable of interest is at the industry-level; hence, the interaction is with a time trend as an alternative one with year fixed effects would have absorbed it.

pertaining to the full period of 1990-2006. Following the previously discussed finding of Topalova and Khandelwal (2011) regarding the exogeneity of tariff changes to industry characteristics during the period of 1990-1997, Column (4) hence estimates the benchmark specification while restricting the sample to that period. Thereafter, Columns (5)-(8) follow the same specifications as (1)-(4), respectively, only using output tariffs instead of the input ones.

Results indicate that when tested separately, both input and output tariffs negatively affect the relative demand for managers. The lower-bound benchmark estimations show that a 10% decrease in either input or output tariffs increases the compensation share of managers by about 1%. Nonetheless, the initial disaggregated imports analysis revealed the effect is triggered by imported capital inputs. Translating this to the current exercise, we conjecture that the effect observed on output tariffs works through the input side, contributing to the latter's relative domination. To test this we estimate a specification with both included; as before, we follow a first-difference setting to mitigate multicollinearity. Result appears in Column (8), which indeed supports the input side. The coefficient on output tariffs drops in both magnitude and significance, while that on input tariffs remains stable and precisely estimated. Importantly, this points at a potential underlying mechanism which we elaborate on next.

A quality upgrading mechanism The distinction between input and output tariffs relates to a key question: what is the underlying mechanism? Previous studies on developed economies pointed at an export-based quality upgrading channel (Caliendo and Rossi-Hansberg (2012)) or product market competition (e.g. Cunat and Guadalupe (2009), Bloom, Draca, and Van Reenen (2015), and Bloom, Sadun, and Van Reenen (2010)). We show how a developing economy can present different dynamics regarding this.

Input (output) tariffs relate to imported inputs (final goods). Imported inputs, which in the case of a developing country are of higher quality (Acemoglu and Zilibotti (2001), and Eaton and Kortum (1996)) given that the vast majority of them are imported from the OECD (Eaton and Kortum (2001), and Raveh and Reshef (2015)), are used to produce higher quality products (Verhoogen (2008), and Zhu and Trefler (2005)); final goods, on the other hand, are sold in domestic or foreign markets. Thus, an increase in the former (latter) upgrades quality (stiffens product competition). Realizing the main effect is completely driven by the inputs side hence indicates a quality upgrading channel is at work, operating via input liberalization.

This lends complementary support to the dynamics proposed by Caliendo and Rossi-Hansberg (2012), taken from a developing, equipment importing, economy's perspective, rather than an exports-based one. Imported inputs of higher quality, together with the more technology sophisti-

cated products they produce, require managers to cope with the new knowledge, hence increasing their relative demand. Thus, while in a developed country exports of equipment are central in this, as in Caliendo and Rossi-Hansberg (2012), in a developing economy imports may take the focus.

We elaborate on an additional observation. In all specifications firms' payments to technical knowhow are controlled for. Related to the above, this in turn suggests that upgraded knowledge is handled by new managers, rather than through training of non-managers.[28] In Section 5 we lend support to this, and look into further aspects of how this quality upgrading channel operates to increase the relative demand for managers.

4.3 Potential channels

After establishing the basic result, we next turn to test some additional controls and further potential channels. All specifications in this sub-section follow the stricter specification of Equation (5), with industry and year fixed effects and an interaction of the former with a time trend; given our previous results, we focus strictly on input tariffs. Results are presented in **Table 5**.[29] Our starting point is with the the potential connection between managers and skilled labor.[30] We measure the latter through the 3-digit industry level ratio of non-production workers to all workers, obtained from Ghosh (2014) (1990-2000),[31] and the Indian Annual Survey of Industries (2001-2006) – being the standard skill intensity measure used in the literature. It is reassuring to note that our proxies for the relative demand for managers and skill intensity do not appear to have significant correlation ($\rho = -0.13$) at the industry level, being the outcome of examining one occupation in a larger set of non-production ones; realizing, however, that the effect we capture might nevertheless be a result of previously studied related phenomena we next test two aspects of this.

Starting with the connection between liberalization and skill, previous studies found that the former increases demand for the latter in developing economies (Goldberg and Pavcnik (2007)). Therefore, our main result may simply be a consequence of an increase in the relative demand for skill. To test this, in Column (1) we add the skill intensity variable; the main result remains to

[28] This is consistent with Caliendo and Rossi-Hansberg (2012) who emphasized the trade-off involved in costly knowledge, rationalizing why new managers would be hired.

[29] Note that the number of observations may change between cases, due to data availability of the various additional controls.

[30] At first glance it may be susceptible that skill and managers might be correlated through the standard definition of skill in the literature which considers non-production workers or otherwise those in white collar occupations. Note however that this definition, while covering also managers, includes various additional occupations that do not necessarily hold managerial positions. For instance, in the cases of Berman, Bound, and Griliches (1994) and Zhu and Trefler (2005), skilled workers are defined to hold the following positions within the manufacturing sector: manager, professional, technician, and clerical worker; indeed managers represent a subset of that, though the other professions can fall under the non-managers classification.

[31] We thank Sangeeta Ghosh for sharing this data with us.

hold, suggesting it is not driven by increases in the demand for skill. The second aspect relates to the capital-skill complementarity hypothesis.[32] To the extent that trade liberalization increases firms' capital stocks and that managers are considered skilled labor, then the effect we capture might simply be evidence of having a capital-skill complementarity technology. This is all the more relevant given our previous observation on the input-related source of the main effect. Hence, in Column (2) we add firms' GVA share of capital employed; while this increases the compensation share of managers, consistent with Bloom, Garicano, Sadun, and Van Reenen (2014), our main result holds suggesting it is not an outcome of the above.

Next, we refer to the literature on trade liberalization and productivity, which suggest that firm productivity increases in liberalized industries (e.g. Topalova and Khandelwal (2011)). To the extent that quality and quantity of management is associated with improved productivity, the effect we observe might in fact be a result of that. This may be especially prominent in the Indian economy; Hsieh and Klenow (2009) estimated that the 90th to the 10th percentiles of firms' TFP in India is 5.0, whereas Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013) found that better managed Indian firms are significantly more productive. To address that, we control directly for productivity, by following Ahsan (2013) and Topalova and Khandelwal (2011) and hence using the Levinsohn and Petrin (2003) methodology to control for firm-level TFP. The latter controls for the potential simultaneity in the production function by using a firm's raw material inputs as a proxy for the unobservable productivity shocks.[33] Results are presented in Column (3); as can be seen, β remains stable in sign, significance, and magnitude, providing some support that the underlying mechanism works through a different channel.

Another potential channel relates to management technology. In a recent study Chen (2014) connects between trade liberalization and management technology. If the former indeed affects the latter, and better such technology requires a higher volume and quality of managers, it might be a viable channel. To test this we follow Chen (2014) and proxy management technology through the cross country-industry management survey done by Bloom and Van Reenen (2010). Surveying a large number of firms in various manufacturing industries in India (among other countries) throughout 2004, Bloom and Van Reenen (2010) constructed a measure for management quality in different sectors; this index is a number between 1 and 5, with 5 representing the best quality.

[32] The notion that capital is complementary to skilled labor has been studied extensively in the literature (see e.g. Griliches (1969), and Krusell, Ohanian, Rios-Rull, and Violante (2000)).

[33] For firm i, in industry j, at time t, if $\omega_{i,j,t}$ is an unobservable productivity shock that might be correlated with the firm's choice of variable inputs, yet demand function for intermediate inputs is monotonic in the firm's productivity, then Levinsohn and Petrin (2003) show that raw materials expenditure can act as a proxy for the unobservable shocks, which in turn enables to estimate the corresponding production function and TFP levels. See Levinsohn and Petrin (2003) for further details.

Given this measure is available for only one year we examine the interaction of it with tariffs, to test its affect on different industries when trade liberalization hits; given data limitations, the underlying assumption is that the Spearman correlation between management technologies in 1990 and 2006 is reasonably high. Results appear in Column (4) where we note that the main result remains to hold.

Last, despite controlling for firm assets, we follow Acemoglu, Aghion, Lelarge, and Van Reenen (2007) to dig deeper into the potentially important effect of size on demand for managers, by testing an additional related measure: the number of factories and plants at the 3-digit industry level, derived from the ASI. We add this measure in Column (5); the estimated β indicates that our main result is robust to this addition.

4.4 Firm characteristics

Having identified the effect, and tested various potential mechanisms, let us now examine the issue at hand using larger lens. Hence, in this sub-section we look into various firm characteristics, in an attempt to identify the type of firms that drive the main result. Unless specified otherwise, regressions in this exercise follow the benchmark specification of Equation (5), focusing on input tariffs, as per Column (1) of **Table 4**; all results are presented in **Table 6**.

We start with the previous section's latter point – firms' size. Although we control for it, we seek to realize whether the main effect differentiates across the firms' size distribution. To test this, in Column (1) we add interactions of the tariff measure with dummies for each of the four size-quartiles (based on our size proxy). Results on the four coefficients of interest show the main effect is apparent in each quartile, having some stronger magnitude in the two middle quartiles; hence, although there is some premium to size as expected, interestingly trade liberalization increases the relative demand for managers in firms of all sizes. To better illustrate this, in **Figure 5** we plot a version of **Figure 2** for each of the four size-quartiles, where the post-1995 hike in the compensation share of managers in the importing firms is equivalently apparent in all four cases.

We already noted our main effect is primarily a feature of importing firms. Nonetheless, following related insights of Caliendo and Rossi-Hansberg (2012) and Mion and Opromolla (2014) on exporting firms, we next investigate the subset of input importing firms that export. Hence, we divide the sample to exporting and non-exporting firms, and test each separately; results appear in Columns (2) and (3), respectively. As can be seen, the effect is observed solely in the first case, and is slightly stronger than the one in the benchmark estimation. Indeed, it is specifically those input importing firms that export that increase their relative demand for managers when liberalization occurs.

Next, we turn to test firms' end use. We follow Nouroz (2001) and use the input-output classifications to categorize firms by the end use of their products. The division is thus made to five groups: consumer non-durables, intermediates, basic, capital, and consumer durables. Here also we divide the sample to each of these groups, and estimate each separately. Results appear in Columns (4)-(8). We can see that the main result is a feature of firms that belong to the consumer non-durables and basic groups; meaning, those that produce final goods. This is consistent with the various patterns observed previously on the trade measures and the two tariff types; the subset of firms that drive the main result are those that import inputs to produce and export final goods – consistent with the quality upgrading mechanism discussed above.

Last, we examine firm ownership. As noted, the data divides firm ownership to two main categories, domestic and foreign owned; additionally, the former is divided to two further sub-categories of private and public. We divide the sample to these three groups, and again estimate each separately, with ownership dummy excluded from $\mathbf{X}$. Results appear in Columns (9)-(11). Our coefficient of interest in each of the cases indicates that the main result is entirely driven by domestic and privately owned firms. While it is expected that privately owned firms would have a more flexible and adjusting organizational structure, it is nevertheless surprising to realize domestic owned ones represent the responsive portion. This result implies that the change in managerial demand is not a feature of foreign organizational culture inflows from abroad.

4.5 Robustness tests

As a final step in the main analysis, we take a few robustness tests to examine the persistency and stability of our main result. We relegate all results in this section to **Tables 9 and 10** in the Appendix. Starting with the former table, in Columns (1)-(5) we test our benchmark estimation under various specifications: Using an industry-level and log versions of our dependent variable, estimating a first-difference and Arellno-Bond (Arellano and Bond (1991)) versions of Equation (5), and examining the unrestricted sample period of 1990-2011 (i.e. with the post-2008 financial crisis included), respectively. Although magnitude slightly fluctuates, the main result remains to hold in sign and significance in all cases.

Next, we test different trade liberalization and import penetration measures. These measures are inferior to our main one (and hence, not used in the main analysis) in terms of establishing a causal link or delivering insights regarding the underlying mechanism; nonetheless, their use is informative for robustness purposes. In each case they substitute for input tariffs in the benchmark version of Equation (5).

First, we test imports normalized by domestic sales, being the import penetration measure

used in Bloom, Sadun, and Van Reenen (2010). Second, we use a Lerner Competition Index measure (Lerner (1934)), defined as: $1-profits/sales$, at the 4-digit industry level. Third, we exploit India's 1994 addition to the WTO to undertake a standard difference-in-differences estimation, where we interact the industry-level average tariffs in 1990-1993 with a post-1994 year dummy to construct our variable of interest. Last, following Bloom, Draca, and Van Reenen (2015), we use an external, and hence plausibly exogenous, measure: Chinese exports to the World minus those to India; this proxies for more general globalization patterns and global demands that are exogenous to the Indian economy. Results appear in Columns (6)-(9), respectively, providing further support for the robustness of our key observation through the precision and sign of the coefficients of interest.

Given the relative importance of the period of 1990-1997 to our analysis, due to the exogeneity-related reasons outlined previously, in **Table 10** we present re-estimations of some of the key results and robustness tests when restricted to the abovementioned period. In order of appearance, we re-examine: Column (2) of **Table 2**, Column (3) of **Table 3**, Column (3) of **Table 4**, and Columns (2)-(4) and (6)-(8) of **Table 9**, respectively. As can be seen, all the previously observed results remain to hold, some with increased precision, when estimated under the limited sample period.

5 Tracing the Source of the Effect

Our analysis so far indicated that trade liberalization increases the relative demand for managers in input importing firms that produce and export final goods; in addition, we provided evidence that point at an imports-triggered quality upgrading mechanism a-la Caliendo and Rossi-Hansberg (2012), where additional managers are hired to handle new knowledge transmitted via the imported inputs. To better pinpoint the above, we also refuted other potential avenues such as administrative reclassification, industry-specific trends, and indirect channels that may work through managers' possible association with skill, capital-complementarity, management technology, and productivity.

The question remains, however, how does the abovementioned channel operate to increase the compensation share of managers in practice? Since the observed change is compensation-based, it can be made either via income directly, or through a change in the number of managers. In this section we, hence, address both aspects, by examining managers' pay structure and firms' organizational design.

5.1 Disaggregating compensation

The first step to understanding the changes in the compensation share of managers is to examine the changes in its separate components. Thus, in this section we disaggregate our main ratio to its smaller ingredients, exploiting the full extent of Prowess' related available data on this. All

specifications follow the benchmark one as in Column (1) of **Table 4**, with the dependent variable changing between cases; Results appear in **Table 7**.

We start with disaggregating the ratio to its two main components; namely, managers' and non-managers' compensation. In Columns (1) and (2) we test the natural logarithm form of the GVA share of either, respectively. The distinction, observed through the precision and magnitude of β, is clear; decreases in input tariffs increases managers' compensation, while not affecting that of non-managers. This, in turn, indicates that the relative demand for managers increases because the managers' bill increases rather than due to non-managers' bill decreasing or increasing by less, indicating that the main effect is not driven by outsourcing of non-managerial tasks or other specific schemes that may bring major layoffs on the non-managers' side.

Next, we disaggregate compensation itself into its two main components: wages and bonuses.[34] The former is the pre-determined salary received by the employees, whereas the latter is incentive-based, often being linked to performance. Each is examined in Columns (3) and (4), respectively, using relative terms, similar to our benchmark dependent variable in Equation (5). This means using $Managers_j/(Managers_j + Non - Managers_j)$, where $j \in (wage, bonus)$, as the dependent variable in each of the cases.

Seeing that β in both cases is negative and statistically significant indicates that input liberalization increases both relative wages and relative bonuses of managers, which when combined make a relative increase in managers' compensation. To interpret these patterns, first it is interesting to note that similar to the observations made on trade liberalization and the demand for skill in developing economies (Goldberg and Pavcnik (2007)), here also Stolper-Samuelson predictions do not appear to follow, given that the Indian workforce is abundant with non-managers, hence pointing at a new potential contributing factor to the said skill premium puzzle. Second, connecting the results on the incentive-based payments to the previous ones it becomes apparent that firms' division of profits is managers-biased; this becomes all the more relevant in our case given that our key subset of firms are those input importing ones that export, keeping in mind that those that export are also relatively more profitable (Bernard and Jensen (2004)). Third, these results are consistent with those reported by Cunat and Guadalupe (2009), who found that import penetration increases the sensitivity of pay-to-performance of US executives, hence indicating these patterns are not confined to developed economies.

[34] Since this disaggregation is not available for all firm-years, and is unbalanced between the different groups, each specification relates to a different sample size; in all cases, however, we use the maximized sample available.

5.2 Number of managers and organizational design

Following an examination of the compensation components, we next look into the number of managers. If trade liberalization changes the number of managers, the compensation share can change even without changes in wages, making this distinct, yet complementary, to the previous exercise. Realizing that the number of managers changes with organizational design, we thereafter examine the various aspects of the latter. Unless otherwise specified, all specifications again follow the benchmark one as in Column (1) of **Table 4**, with the dependent variable changing as described in each case. Results appear in **Table 8**.

Starting with the number of managers, we exploit a feature in the firm-level data that lists the top management for more than half of our firm-year observations to count their number.[35] With this measure we note two initial observations. First, the average number of managers in Indian firms has been steadily increasing over our sample period; this is plotted in **Figure 6**, where we see it is close to 0 in 1990, and increasing continuously up to almost 0.6 in 2006. Second, when dividing the sample to importing and non-importing firms, we once again note the average increase observed over the entire sample is driven almost entirely by the importing firms; this is plotted in **Figure 7**.

To test this more rigorously, in Column (1) we estimate a dynamic version of our benchmark specification, with the number of executives as the outcome variable, and its lagged value added as a control to address the potential persistence of this measure. The precisely estimated negative β confirms that input liberalization increases the number of executives. The question that then follows is why. Touching previously on the option of administrative reclassification, this leaves us with changes in organizational design.

An organization can change either horizontally or vertically, and through that change the number of managers, and ultimately their relative demand. A horizontal expansion refers to the addition of horizontal layers such as new divisions with similar managerial and non-managerial layering, whereas a vertical expansion refers to the addition of vertical hierarchical layers, following the definition of Garicano (2000), such as extra managerial roles between the CEO and the non-managed workers.

We first consider the former. Ideally, we would use the number of within-firm divisions as a direct measure, yet since this is not available we measure this indirectly through the variety of products produced. Assuming different products require distinct same-level divisions, we thus use

[35] The data set also lists middle management yet only for approximately 10% of the sampled firms; we do note that the patterns presented hold as well when middle management is included, yet due to the significant drop in sample size we focus strictly on the case of executives.

this as a proxy for horizontal size. **Figure 8** plots its average value over time, showing the general increasing trend. To understand, however, the effect of input tariffs on it, we build on Goldberg, Khandelwal, Pavcnik, and Topalova (2010) who find a robust negative effect using virtually the same data. Given their extensive study on this specific link, we hence take their result as given and abstract from deepening the discussion to avoid repetition, albeit finding similar patterns.

Next, we study the vertical change. To proxy for vertical expansion we construct a dummy that measures the number of layers in the organization. As was described earlier, we consider three types of workers: non-managers, directors, and executives (the latter two representing the aggregated managerial layer). Since executives are managers with executive powers, and hence make the top management of a firm, we consider it as being the highest layer. Thus, this dummy is assigned a number between 1 and 3. We assign a 1 when either overall managerial or non-managerial compensation is zero; this can occur when a firm lists no managers or reports sufficiently small compensation for the ones that are listed, or otherwise when the firm is a one-man operation or one which simply lists no non-managers. A 2 is assigned when there are non-managers and executives' compensation is zero while directors' is non-zero – or vice versa, or when both executives and directors are listed yet there are no non-managers. Finally, 3 is assigned when non-managers', directors', and executives' compensation is non-zero, indicating there are three layers in the firm.

Figure 9 shows the evolution of the average value of this measure over our sample period. Interestingly, the average value exhibits a monotonically increasing trend; starting at around 1 in 1990, it almost doubles in 2006. This trend is in contrast to those found in developed economies, such as France and the U.S., where the observed trend was a decreasing one (Caliendo, Monte, and Rossi-Hansberg (2014), and Rajan and Wulf (2006)),[36] hence emphasizing the potential differences of an emerging economy in this context.[37] In addition, we note this measure provides significant variation in the average number of layers across industries (over all years), going from close to 1.5 up to almost 1.9, as well as in the average annual rate of change in the number of layers across industries, ranging from as low as around 0.02 to higher than 0.05.

In Columns (2)-(4) we look into the effects of input liberalization on this measure, which now takes the role of the outcome variable. Column (2) follows the benchmark specification, Column (3) then estimates a dynamic version with a lagged value of the dependent variable included,

[36] Nonetheless, we comment on this cautiously, given the differences in the definition of layers. For instance, Caliendo, Monte, and Rossi-Hansberg (2014) measure layers based on occupations and wages, which can be interpreted differently than the definition we study here.

[37] Conversely, one example for a study that examine a developed economy yet present patterns consistent with ours is Garicano and Hubbard (2007), who study the role of hierarchies in law firms, finding that the ratio of associates to partners increase with increased market size. This, in turn, implies for some potential commonalities between the the services and manufacturing sectors in this regard.

and finally Column (4) estimates an ordered probit version (reporting marginal effects) given the discrete nature of the layers proxy. In all cases β is negative and statistically significant, indicating that input liberalization indeed expands the firm vertically, by adding hierarchical layers. Albeit consistent with the related predictions of Caliendo and Rossi-Hansberg (2012), we note this is in contrast to findings in previous studies on developed economies, indicating the flattening effect of trade liberalization on firms' structure (Guadalupe and Wulf (2010), Marin and Verdier (2008), and Marin and Verdier (2014)), once again highlighting the distinct role of a developing economy in this.

Realizing, therefore, that trade liberalization expands the firm both horizontally and vertically, the question is then which one affects the number of managers such that the final outcome of increased relative demand is observed. While a horizontal expansion, via an additional division, is expected to rather decrease the number of managers relative to non-managers (as a new division is expected to hire a relatively greater number of non-managers), a vertical expansion on the other hand guarantees almost by definition that the relative number of managers would increase. To test that, in Column (5) we add both the vertical and horizontal proxies to the standard specification with the compensation share as the outcome variable, and the tariffs excluded. The coefficients on the two measures indicate the triggering factor. While the estimated coefficient on product scope is non-significant with virtually zero magnitude, that on the number of layers is positive and significant. Hence, trade liberalization increases the relative demand for managers via a vertical expansion of the firm that increases the number of managers.

6 Conclusion

Understanding the effects of globalization on the labor market is of first order importance, especially for developing economies. One aspect of this relates to firm organization. Recent studies indicate that globalization affects the various aspects of firm organization; their focus, however, is strictly on developed economies. Through the case of India, this paper made a first attempt to examine this link in a developing economy, through which it shed new light on the topic.

Using a rich firm-level data set that uniquely distinguishes between compensation of managers and non-managers in the manufacturing sector, and exploiting the exogenous nature of India's 1990s trade reform, we addressed a new empirical question: Does trade liberalization, vis-a-vis changes in tariffs, affect the *relative* demand of managers? We studied the causal link, as well as the underlying channel that connects the two. Through the investigation of the latter we also presented a set of additional results on a wide array of related issues, ranging from organizational design, to pay structure, and the number of managers, with some of which highlighting the distinguishing features

of a developing economy in this context.

Our preliminary analysis showed that unlike previous investigations of exports-based countries, in an importing economy trade liberalization interacts with the demand for managers through imports, and more specifically, through those of intermediate inputs – motivating our focus on tariff changes. Consistent with this, the main analysis established a causal link: decreases in input tariffs increase the relative demand for managers in a remarkably robust and persistent way that is also economically meaningful; a 10% decrease in input tariffs increases the compensation share of managers by around 1-2.3%. Interestingly, this result is not an outcome of any potential connection between managers and skill, productivity, capital-complementarity, or management technology. Further investigations identified the input-importing firms that export final goods as those that trigger the result.

Combining these results, together with our observation on the opposing patterns of input and output tariffs, lend support to an underlying channel that is reminiscent of Caliendo and Rossi-Hansberg (2012), adjusted to an emerging, import-based, economy. Firms import intermediate inputs to produce and export final goods. These inputs, together with the products they produce, are embedded with new knowledge that raises the relative demand for workers that can manage these intangible inflows. In the last section we then made an attempt to realize how this potential mechanism works in practice to increase the relative demand for managers. By disaggregating the managers' compensation share and examining firms' organizational design we observed that input liberalization increases managers' relative wages and incentive-based payments, as well as increases their number through an expansion in vertical layers – consistent as well with the framework of Caliendo and Rossi-Hansberg (2012).

The results of this study, hence, point at various potentially important implications. Policy-wise, given the established connection between better management technology and productivity, our results highlight the potential significance that trade liberalization may have in this, most notably that in intermediate inputs. In addition, the paper also stresses the need to study developing economies in the context of organizational structure and globalization. While some of our main results are consistent with the previous ones observed in developed economies, others such as for instance the general trend to vertically expand over time or otherwise the positive effect of imports and inputs liberalization on vertical expansion, showed some opposition. This, therefore, calls for further research on the dynamics of firms in developing economies, especially with respect to the link between trade and their internal organization.

References

Acemoglu, D. (2003): "Patterns of Skill Premia," *Review of Economic Studies*, 70(2), 199–230.

Acemoglu, D., P. Aghion, C. Lelarge, and J. Van Reenen (2007): "Technology, Information and the Decentralization of the Firm," *Quarterly Journal of Economics*, 122(4), 1759–1799.

Acemoglu, D., and F. Zilibotti (2001): "Productivity Differences," *Quarterly Journal of Economics*, 116(2), 563–606.

Ahsan, R. (2013): "Input Tariffs, Speed of Contract Enforcement, and the Productivity of Firms in India," *Journal of International Economics*, 90(1), 181–192.

Ahsan, R., and D. Mitra (2014): "Trade Liberalization and Labor's Slice of the Pie: Evidence from Indian Firms," *Journal of Development Economics*, 108(1), 1–16.

Allcott, H., A. Collard-Wexler, and S. D. O'Connell (2014): "How Do Electricity Shortages Affect Productivity? Evidence from India," Mimeo.

Arellano, B., and S. Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, 58(2).

Berman, E., J. Bound, and Z. Griliches (1994): "Changes in the Demand for Skilled Labor Within U.S. Manufacturing: Evidence from the Annual Survey of Manufactures," *Quarterly Journal of Economics*, 109(2), 367–397.

Bernard, B. A., and J. B. Jensen (2004): "Why Some Firms Export," *Review of Economics and Statistics*, 86(2), 561–569.

Bloom, N., E. Brynjolfsson, L. Foster, R. Jarmin, I. Saporta-Eksten, and J. Van Reenen (2013): "Management in America," CES Working Paper 2013-01.

Bloom, N., M. Draca, and J. Van Reenen (2015): "Trade Induced Technical Change: The Impact of Chinese Imports on Innovation, Diffusion and Productivity," *Review of Economic Studies, forthcoming.*

Bloom, N., B. Eifert, A. Mahajan, D. McKenzie, and J. Roberts (2013): "Does Management Matter? Evidence from India," *Quarterly Journal of Economics*, 128(1), 1–51.

Bloom, N., L. Garicano, R. Sadun, and J. Van Reenen (2014): "The Distinct Effects of Information Technology and Communication Technology on Firm Organization," *Management Science, forthcoming.*

Bloom, N., R. Lemos, R. Sadun, D. Scur, and J. Van Reenen (2014): "The New Empirical Economics of Management," *Journal of the European Economics Association, forthcoming.*

Bloom, N., R. Sadun, and J. Van Reenen (2010): "Does Product Market Competition Lead Firms to Decentralize?," *American Economic Review, Papers and Proceedings*, 100(2).

Bloom, N., and J. Van Reenen (2007): "Measuring and Explaining Management Practices Across Firms and Countries," *Quaterly Journal of Economics*, 122(4), 1351–1408.

——— (2010): "Why Do Management Practices Differ across Firms and Countries?," *Journal of Economic Perspectives*, 24(1), 203–224.

Bonfatti, R., and M. Ghatak (2013): "Trade and the Allocation of Talent with Capital Market Imperfections," *Journal of International Economics*, 89(1).

Caliendo, L., F. Monte, and E. Rossi-Hansberg (2014): "The Anatomy of French Production Hierarchies," *Journal of Political Economy, forthcoming.*

Caliendo, L., and E. Rossi-Hansberg (2012): "The Impact of Trade on Organization and Productivity," *Quarterly Journal of Economics*, 127(3), 1393–1467.

Carpenter, M. A., and W. G. Sanders (1998): "Internationalization and Firm Governance: The Roles of CEO Compensation, Top Team Composition, and Board Structure," *Academy of Management Journal*, 41(2), 158–178.

Chamarbagwala, R., and G. Sharma (2011): "Industrial de-licensing, trade liberalization, and skill upgrading in India," *Journal of Development Economics*, 96(2), 314–336.

Chen, C. (2014): "Management Quality, Firm Organization and International Trade," Mimeo.

Conconi, P., P. Legros, and A. Newman (2012): "Trade Liberalization and Organizational Change," *Journal of International Economics*, 86(2), 197–208.

Cunat, V., and M. Guadalupe (2009): "Globalization and the Provision of Incentives inside the Firm," *Journal of Labor Economics*, 27(2), 179–212.

De Loecker, J., P. Goldberg, A. Khandelwal, and N. Pavcnik (2014): "Prices, Markups and Trade Reform," mimeo.

Debroy, B., and A. T. Santhanam (1993): "Matching Trade Codes with Industrial Codes," *Foreign Trade Bulletin*, XXIV, 5–27.

Eaton, J., and S. Kortum (1996): "Trade in Ideas Patenting and Productivity in the OECD," *Journal of International Economics*, 40(4), 251–278.

Eaton, J., and S. Kortum (2001): "Trade in Capital Goods," *European Economic Review*, 45(7), 1195–1235.

Fernandes, P. A., P. Ferreira, and L. A. Winters (2014): "The Effect of Competition on Managersï£¡ Compensation: Evidence from a Quasi-natural Experiment," CEPR Working Paper 10054.

Garicano, L. (2000): "Hierarchies and the Organization of Knowledge in Production," *Journal of Political Economy*, 108(5), 874–904.

Garicano, L., and N. Hubbard (2007): "Managerial Leverage is Limited by the Size of the Market: Theory and Evidence from the Legal Services Industry," *Journal of Law and Economics*, 50(1 pages = 1-43).

Garicano, L., and E. Rossi-Hansberg (2004): "Inequality and the Organization of Knowledge," *American Economic Review, Papers and Proceedings*, 94, 197–202.

——— (2006): "Organization and Inequality in a Knowledge Economy," *Quarterly Journal of Economics*, 121(4), 1383–1435.

——— (2012): "Organizing Growth," *Journal of Economic Theory*, 147(2), 623–656.

Ghosh, S. (2014): "Manufacturing Sector in India: Role of External Economies and Industrial Policy," Mimeo.

Goldberg, P. K., A. K. Khandelwal, N. Pavcnik, and P. Topalova (2010): "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India," *Quarterly Journal of Economics*, 125(4), 1727–1767.

Goldberg, P. K., and N. Pavcnik (2007): "Distributional Effects of Globalization in Developing Countries," *Journal of Economic Literature*, 45(1), 39–82.

Griliches, Z. (1969): "Capital-Skill Complementarity," *Review of Economics and Statistics*, 51(4), 465–468.

Guadalupe, M., and J. Wulf (2010): "The Flattening Firm and Product Market Competition: The Effect of Trade Liberalization on Corporate Hierarchies," *American Economic Journal: Applied Economics*, 2(4).

Hsieh, C., and P. Klenow (2009): "Misallocation and Manufacturing TFP in China and India," *Quarterly Journal of Economics*, 124(4), 1403–1448.

Krusell, P., L. E. Ohanian, J.-V. Rios-Rull, and G. L. Violante (2000): "Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis," *Econometrica*, 68(5), 1029–1053.

Lerner, A. P. (1934): "The Concept of Monopoly and the Measurement of Monopoly Power," *Review of Economic Studies*, 1(3), 157–175.

Levinsohn, J., and A. Petrin (2003): "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, 70(2), 317–341.

Ma, L. (2015): "Globalization and Top Income Shares," Miemo.

Marin, D. (2009): "The Battle for Talent: Globalisation and The Rise of Executive Pay," Bruegel Working Paper 2009-01.

Marin, D., and T. Verdier (2008): "Power Inside the Firm and the Market: A General Equilibrium Approach," *Journal of the European Economic Association*, 6(4), 752–788.

——— (2014): "Corporate Hierarchies and International Trade," *Journal of International Economics*, 94(2), 295–310.

Michaels, G., A. Natraj, and J. Van Reenen (2014): "Has ICT Polarized Skill Demand? Evidence from Eleven Countries over 25 Years," *Review of Economics and Statistics*, 96(1), 60–77.

Mion, G., and L. D. Opromolla (2014): "Managers' Mobility, Trade Performance, and Wages," *Journal of International Economics*, 94(1), 85–101.

Moulton, B. R. (1990): "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Unit," *Review of Economics and Statistics*, 72(2), 334–338.

Nataraj, S. (2011): "The Impact of Trade Liberalization on Productivity: Evidence from India's Formal and Informal Manufacturing Sectors," *Journal of International Economics*, 85(2), 292–301.

Nouroz, H. (2001): *Protection in Indian Manufacturing*. MacMillan Publishers, MacMillan India Ltd., India.

Oxelheim, L., and T. Randoy (2005): "The Effects of Internationalization on CEO Compensation," *Journal of International Business Studies*, 36(4), 470–483.

Rajan, R., and J. Wulf (2006): "The Flattening Firm: Evidence on the Changing Nature of Firm Hierarchies from Panel Data," *Review of Economics and Statistics*, 88(4), 759–773.

Raveh, O., and A. Reshef (2015): "Capital Imports Composition, Complementarities, and the Skill Premium in Developing Countries," *Mimeo*.

Topalova, P., and A. Khandelwal (2011): "Trade Liberalization and Firm Productivity: The Case of India," *Review of Economics and Statistics*, 93(3), 995–1009.

Verhoogen, E. A. (2008): "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector," *Quarterly Journal of Economics*, 123(2), 489–530.

Zeira, J. (2007): "Wage Inequality, Technology, and Trade," *Journal of Economic Theory*, 137(1), 79–103.

Zhu, S. C., and D. Trefler (2005): "Trade and Inequality in Developing Countries: A General Equilibrium Analysis," *Journal of International Economics*, 65(1), 21–48.

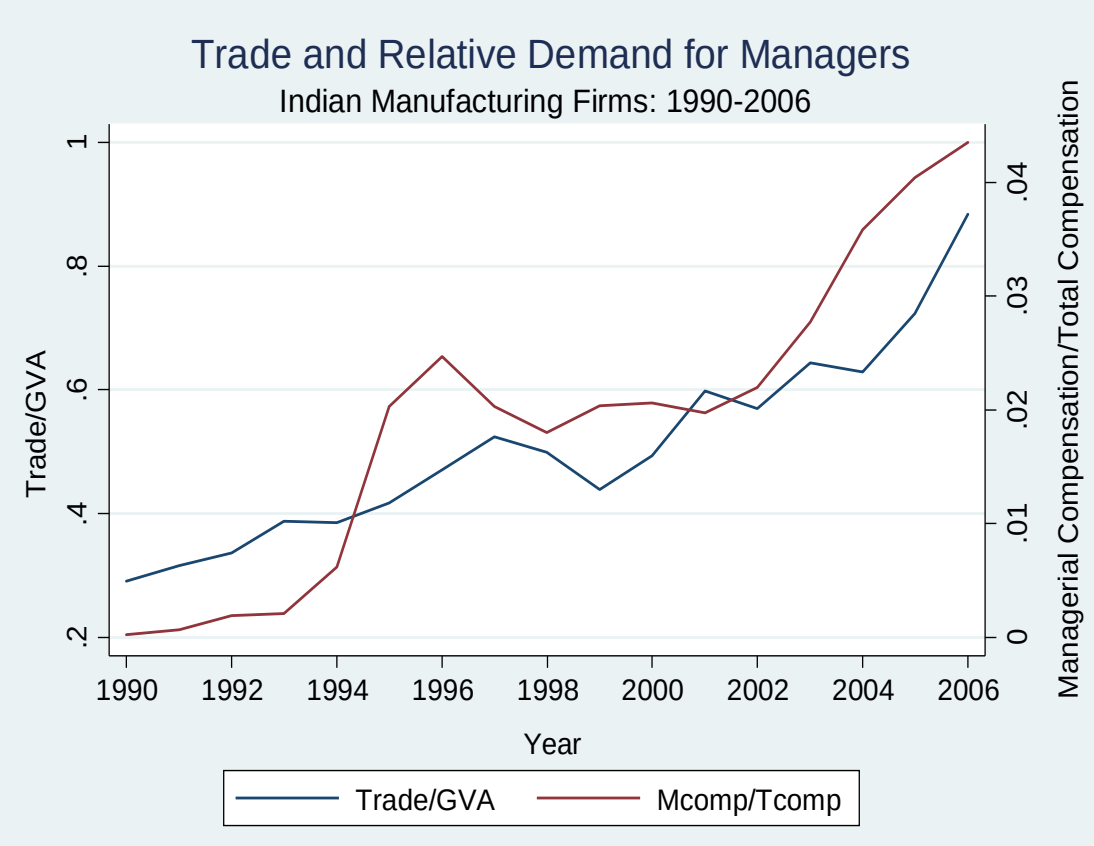

Figure 1: Trade and the Relative Demand for Managers

Notes: Figure presents the average GVA share of trade (exports plus imports) and the average compensation share of managers, 1990-2006 (ρ=0.85)

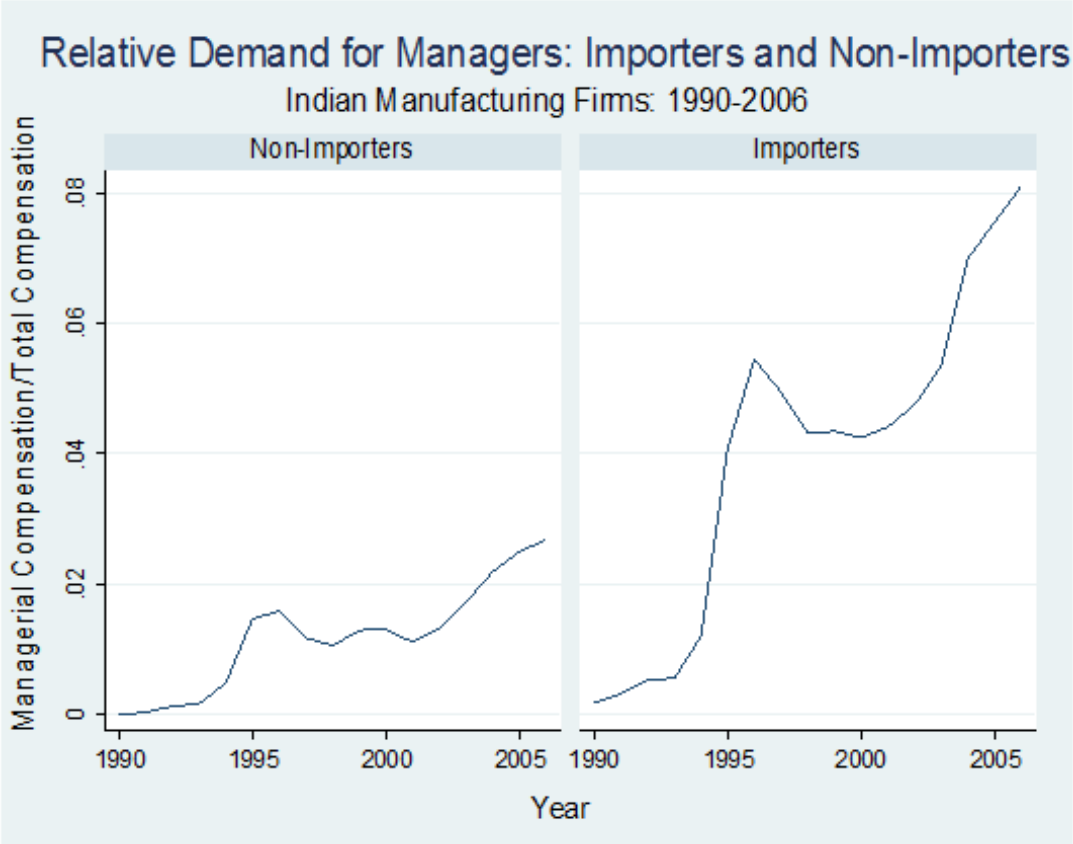

Figure 2: Relative Demand for Managers, Importers and Non-Importers, 1990-2006

Notes: Figure presents the average compensation share of managers' for importing and non-importing firms, 1990-2006

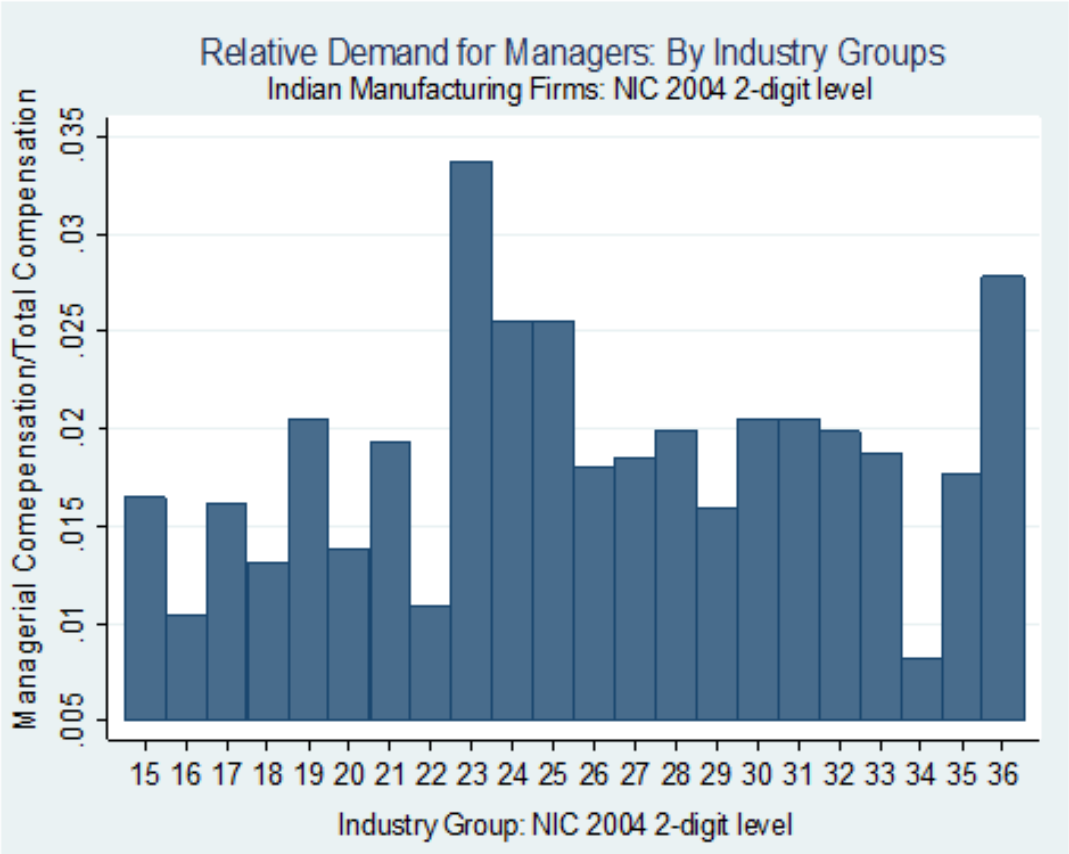

Figure 3: Average Compensation Share of Managers across Industries, 1990-2006

Notes: Figure presents the average compensation share of managers across NIC 2004 2-digit level industries, 1990-2006

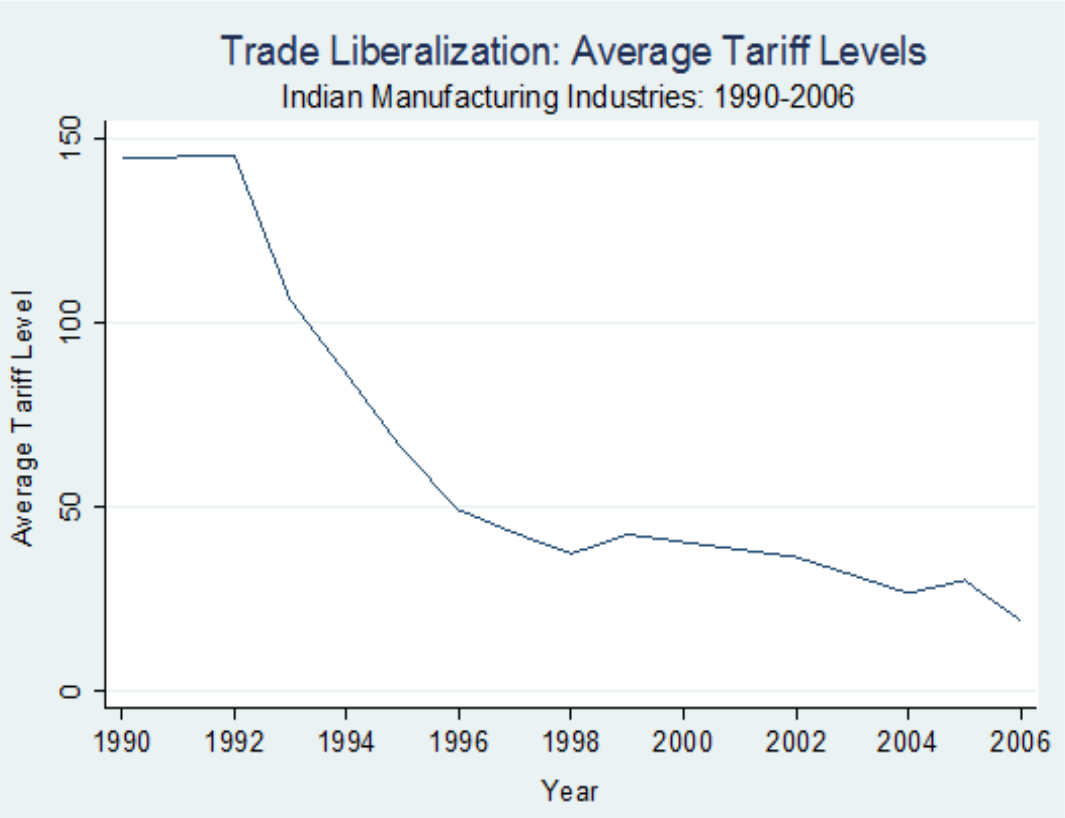

Figure 4: Average Tariff Level, Manufacturing Sector, 1990-2006

Notes: Figure presents the average tariff level in the manufacturing sector, 1990-2006

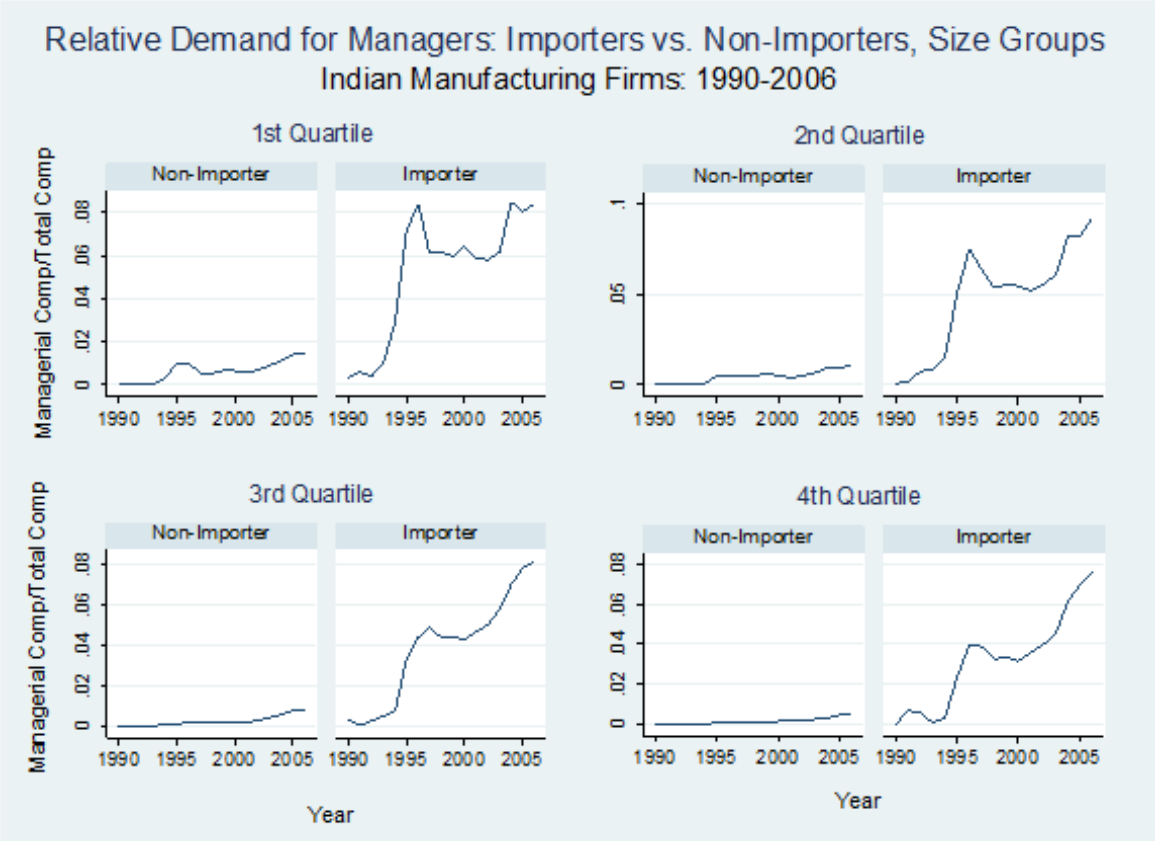

Figure 5: Relative Demand for Managers, Importers and Non-Importers, 4 Size Quartiles, 1990-2006

Notes: Figure presents the average compensation share of managers for importing and non-importing firms, divided to 4 size quartiles, 1990-2006

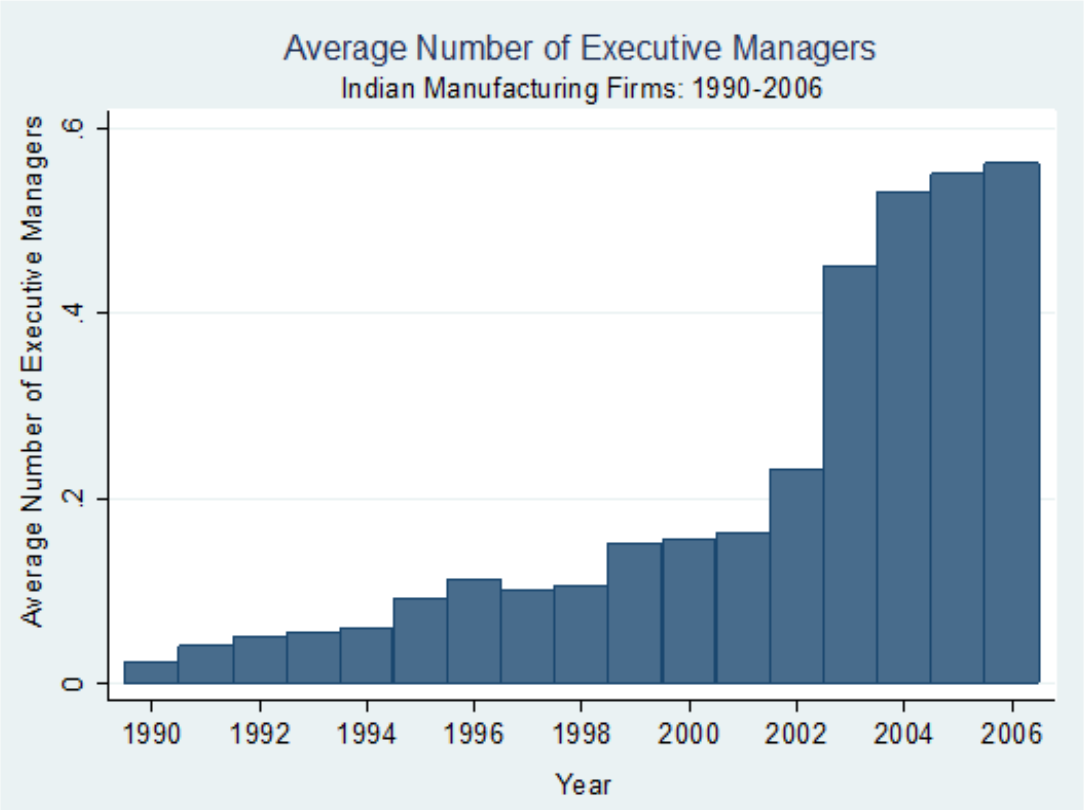

Figure 6: Average Number of Executive Managers, 1990-2006

Notes: Figure presents the average number of executive managers, 1990-2006

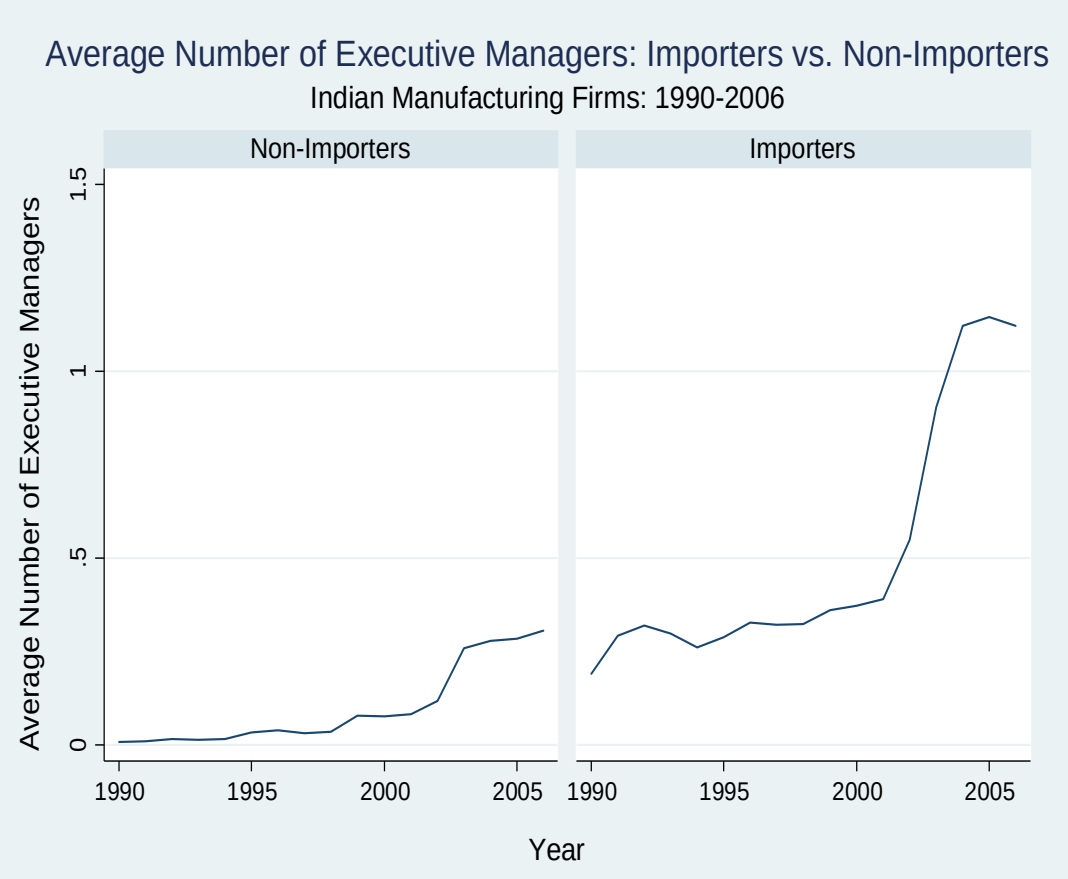

Figure 7: Average Number of Executive Managers, Importers and Non-Importers, 1990-2006

Notes: Figure presents the average number of executive managers for importing and non-importing firms, 1990-2006

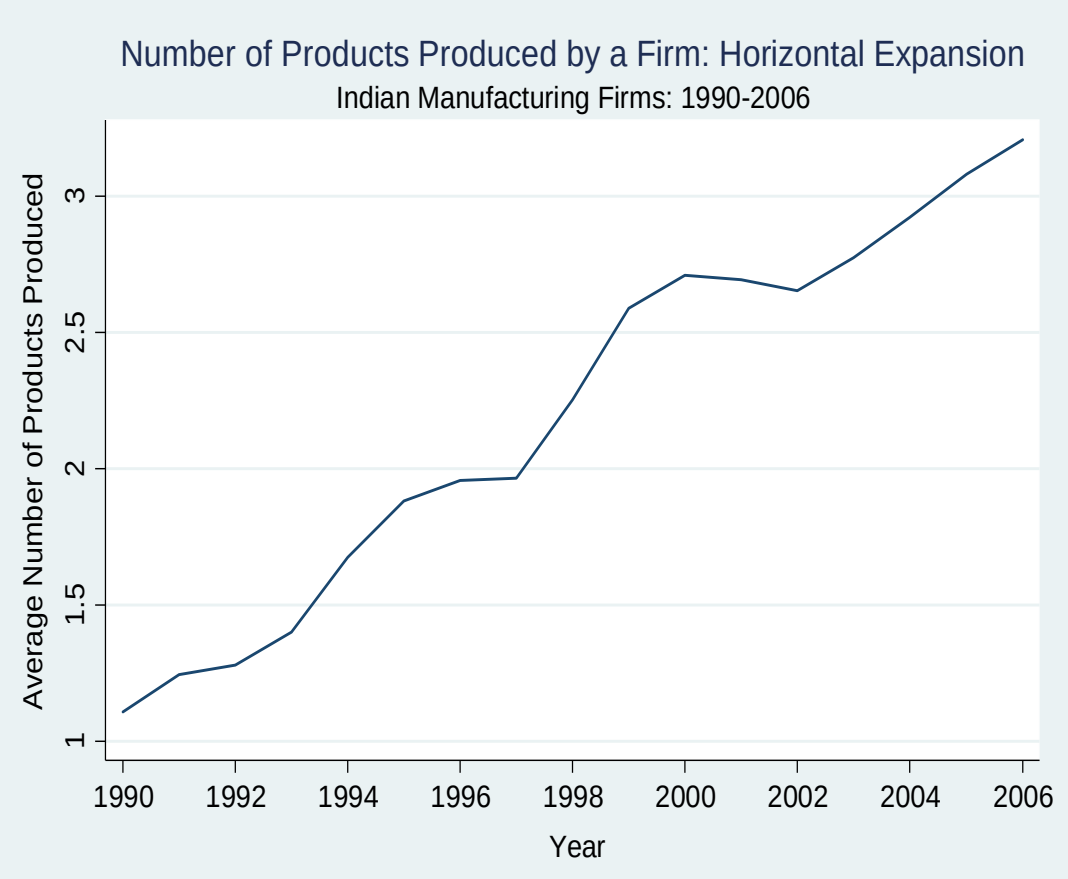

Figure 8: Average Number of Products Produced by a Firm, 1990-2006

Notes: Figure presents the average number of products produced by a manufacturing firm, 1990-2006

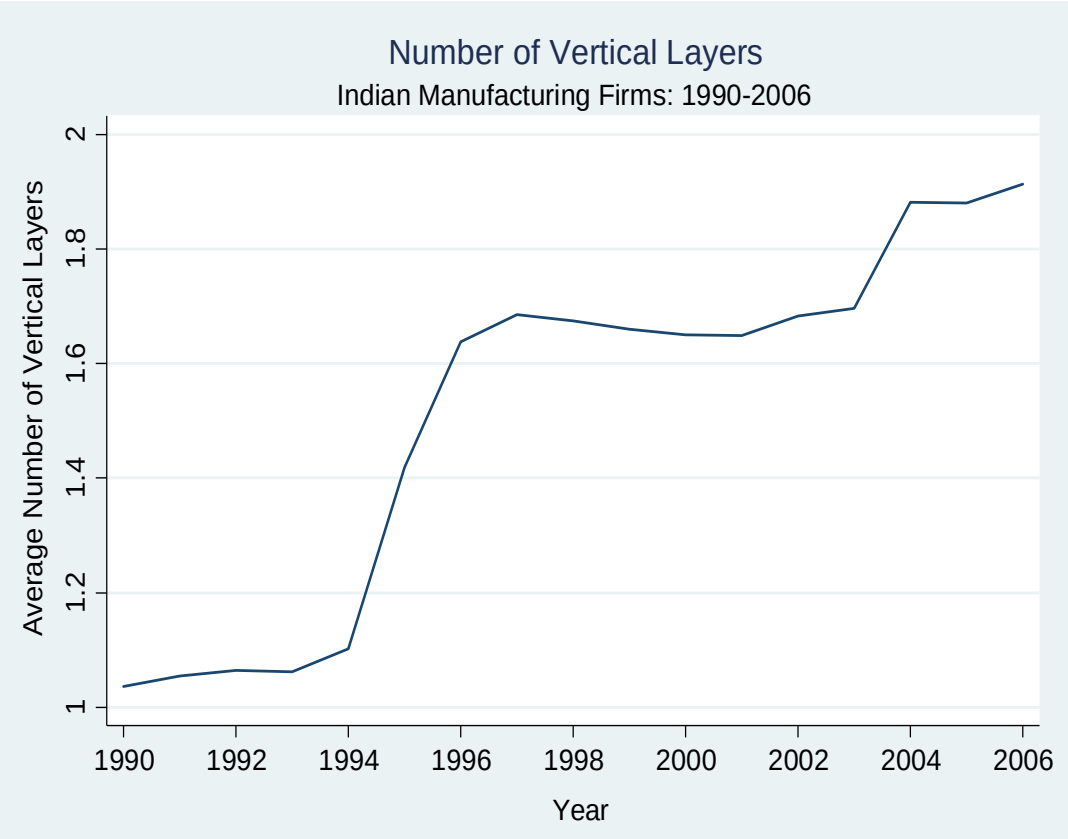

Figure 9: Average Number of Organizational Vertical Layers, 1990-2006

Notes: Figure presents the average number of organizational vertical layers in manufacturing firms, 1990-2006

Table 1: Descriptive Statistics

	Mean	Median	Std. Dev.	Min	Max
Panel A: Organizational Variables - Dependent Variables					
MComp/TComp	0.02	0	0.07	0	1
Layers	1.61	2	0.62	1	3
Product Scope	4.49	3	4.45	1	86
Managers' Compensation	1.31	0	169.65	0	66315.1
Non-Managers' Compensation	95.53	14.4	631.83	0	47619.5
Managers' Wages	0.63	0	147.11	0	57590.5
Non-Managers' Wages	93.73	13.6	624.18	0	39720.6
Managers' Bonuses	0.12	0	3.55	0	8724.6
Non-Managers' Bonuses	4.61	0	66.26	0	9053.9
Number of Top Managers	1.56	1	0.72	1	7
Panel B: Firm/Industry-level Determinants - Explanatory Variables					
Total Imports/GVA	0.89	0.04	39.63	0	7323.5
Import of Raw Materials/GVA	0.68	0.15	10.25	0	1142.67
Import of Capital Goods/GVA	0.40	0.02	12.66	0	1192
Import of Stores and Spares/GVA	0.059	0.01	0.58	0	40.45
Import of Finished Goods/GVA	5.65	0.04	149.59	0	7323.5
Technology Adoption/GVA	0.07	0	9.77	0	2163
Capital Employed/GVA	8.82	1.76	128.57	0	16789
Productivity	0.48	0.42	0.34	0	5.50
GVA	1181.05	127.48	16000.95	0.086	1031605
Skill Intensity	0.26	0.25	0.07	0.04	0.71
Factories	3870.49	3304	3021.15	15	13893
Management Technology	2.49	2.48	0.42	0	3.17
Input Tariffs	73.02	48.83	49.40	17.34	202.02
Output Tariffs	75.93	50	57.14	14.5	298.07

Notes: Annual data at the firm-level, covering the period of 1990-2006. Monetary values are in real INR Millions. 'Mcomp/Tcomp' is the share of managerial compensation in total labor compensation. 'Product Scope' is the number of products manufactured by each firm in a single year. 'Layers' is the number of vertical layers. Compensation is the sum of 'Wages' and 'Bonuses'. Regarding managers, it is the sum of Executives (top management) and Directors (middle management), whereas for Non-managers, it is all the other employees. 'Top Managers' is the number of executive managers. 'Total Imports' = Imports of Raw Materials + Imports of Capital Goods + Imports of Stores and Spares + Imports of Finished Goods. 'Technology Adoption' = R&D expenditure + Royalty payments for technical knowhow. 'Productivity' is a measure for firm productivity computed following the Levinsohn and Petrin (2003) methodology. 'GVA' is gross value added, defined as total sales - total raw material expenditure. 'Capital Employed' is the amount of capital employed. 'Skill Intensity' is the ratio of non-production workers to total employees at 3-digit level of National Industrial Classification (NIC) 2004. 'Factories' is the number of factories at 3-digit level of NIC 2004. 'Management technology' is the management quality score obtained from Bloom and Van Reenen (2010) at 2-digit level of NIC 2004. Tariffs (input and output) are at the 4-digit NIC 2004.

Table 2: Trade and the Relative Demand for Managers, 1990-2006

	Managerial Compensation/Total Compensation						
	Imports			Exports			Both first difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Imp/GVA	0.007^{a} (0.002)	0.007^{a} (0.002)	0.004^{b} (0.002)				0.003^{a} (0.001)
Exp/GVA				0.003^{c} (0.002)	0.002 (0.002)	0.001 (0.002)	-0.001 (0.002)
$(\text{Mcomp/Tcomp})_{t-1}$			0.256^{a} (0.017)			0.256^{a} (0.017)	
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.64	0.66	0.68	0.64	0.66	0.68	0.02
N	54628	54628	52023	54628	54628	52023	44763
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	Yes	No	Yes	No
Industry*Year FE	No	Yes	No	No	Yes	No	No

Notes: The dependent variable is the compensation share of managers. 'Imp/GVA' is the GVA share of total imports. 'GVA' is gross value added, defined as total sales - total raw material expenditure. 'Exp/GVA' is the GVA share of total exports. Firm controls include age of a firm and its squared term, GVA, 'TechAdop/GVA', and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the firm level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 3: Imports and the Relative Demand for Managers, Disaggregated Analysis, 1990-2006

	Managerial Compensation/Total Compensation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ImpInput/GVA	0.007^a		0.007^a					
	(0.002)		(0.002)					
ImpNInput/GVA		0.002	0.002					
		(0.004)	(0.004)					
ImpRaw/GVA				0.003				0.002
				(0.002)				(0.002)
ImpCap/GVA					0.015^a			0.015^a
					(0.004)			(0.004)
ImpStoSpa/GVA						−0.001		−0.005
						(0.006)		(0.006)
ImpFin/GVA							0.004	0.004
							(0.004)	(0.004)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
N	54628	54628	54628	54628	54628	54628	54628	54628
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the compensation share of managers. 'ImpRaw', 'ImpCap', 'ImpStoSpa' and 'ImpFin' are imports of raw materials, capital goods, stores and spares and finished goods, respectively. 'ImpInput' is imports of intermediate inputs, equal to imports of raw materials and capital goods. 'ImpNInput' is imports of non-inputs, equal to imports of stores and spares and finished goods. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Firm controls include age of a firm and its squared term, GVA, 'TechAdop/GVA', and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the firm level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 4: Trade Liberalization and the Relative Demand for Managers, Causal Inference

	Managerial Compensation/Total Compensation								
	Input Tariffs				Output Tariffs				Both
	1990-2006			1990-1997	1990-2006			1990-1997	1990-2006 first difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
InpTariffs_{t-1}	-0.013^{a} (0.003)	-0.010^{a} (0.003)	-0.007^{a} (0.002)	-0.014^{b} (0.006)					-0.012^{a} (0.003)
OutTariffs_{t-1}					-0.010^{a} (0.002)	-0.008^{a} (0.002)	-0.006^{a} (0.001)	-0.010^{a} (0.003)	0.002 (0.002)
$(\text{Mcomp/Tcomp})_{t-1}$			0.554^{a} (0.018)				0.554^{a} (0.018)		
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.13	0.13	0.44	0.16	0.13	0.13	0.44	0.16	0.06
N	52023	52023	52023	17417	52023	52023	52023	17417	44763
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Industry FE*TimeTrend	No	Yes	No	No	No	Yes	Yes	No	No

Notes: The dependent variable is the compensation share of managers. 'InpTariffs' ('OutTariffs') is input (output) tariffs at the 4-digit NIC 2004 level. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA', and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 5: Trade Liberalization and the Relative Demand for Managers, Potential Channels, 1990-2006

	Managerial Compensation/Total Compensation				
	(1)	(2)	(3)	(4)	(5)
InpTariffs_{t-1}	-0.010^{a}	-0.010^{a}	-0.008^{b}	-0.017^{a}	-0.009^{a}
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
Skill Intensity	0.001				
	(0.005)				
Cap/GVA		0.016^{a}			
		(0.002)			
Productivity			0.001		
			(0.004)		
InpTariifs_{t-1}*MT				0.006	
				(0.004)	
Factories					0.005^{b}
					(0.003)
Firm Controls	Yes	Yes	Yes	Yes	Yes
R-Square	0.13	0.14	0.09	0.13	0.13
N	52020	51550	29836	50886	52020
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE*TimeTrend	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the compensation share of managers. 'InpTariffs' is input tariffs at the 4-digit NIC 2004 level. 'Skill intensity' is the ratio of non-production workers to total employees at 3-digit level NIC 2004. 'Factories' is the number of factories at 3-digit level of NIC 2004. 'MT' is Management Technology, obtained from Bloom and Van Reenen (2010), at 2-digit NIC 2004. 'Cap' is the amount of capital employed. 'Productivity' is a measure for firm productivity computed following the Levinsohn and Petrin (2003) methodology. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA' and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 6: Trade Liberalization and the Relative Demand for Managers, Firm Characteristics, 1990-2006

	Managerial Compensation/Total Compensation										
	Size	Export Orientation		End Use					Ownership		
		Exporters	Non-Exp	ConNDur	Inter	Basic	Capital	ConDur	Dom Private	Dom Public	Foreign Owned
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
InpTariffs_{t-1}	0.007	-0.013^{a}	-0.006	-0.009^{b}	-0.004	-0.021^{b}	-0.011	0.014	-0.012^{a}	-0.010	-0.011
	(0.005)	(0.005)	(0.004)	(0.004)	(0.010)	(0.011)	(0.015)	(0.009)	(0.002)	(0.007)	(0.008)
(InpTa_{t-1})*1stQr	-0.009^{a}										
	(0.003)										
(InpTa_{t-1})*2ndQr	-0.013^{a}										
	(0.003)										
(InpTa_{t-1})*3rdQr	-0.013^{a}										
	(0.003)										
(InpTa_{t-1})*4thQr	-0.011^{a}										
	(0.003)										
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.13	0.22	0.10	0.11	0.15	0.12	0.15	0.14	0.13	0.15	0.33
N	52023	23799	21427	17215	12441	9239	6852	6276	46517	2011	3495
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the compensation share of managers. 'InpTariffs' is input tariffs at the 4-digit NIC 2004 level. Size quartiles are defined according to the total assets of a firm. All the regressions include the individual terms of the interactions. 'Non-Exp' is the group of non-exporting firms. 'ConNonDur', 'Inter', 'Basic', 'Capital', 'ConDur' are Consumer Non-Durable, Intermediate, Basic, Capital and Consumer Durable goods sector, respectively. 'Dom Private', 'Dom Public' 'Foreign Owned' are domestic-private, domestic-public and foreign-owned firms, respectivel. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA', and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 7: Tracing the Effect, Disaggregation of the Compensation Ratio, 1990-2006

	Compensation/GVA		Managers	
	Managers'	Non-Managers'	Wages/Total Wages	Bonuses/Total Bonuses
	(1)	(2)	(3)	(4)
InpTariffs_{t-1}	-0.087^{b}	0.001	-0.013^{a}	-0.029^{b}
	(0.04)	(0.02)	(0.003)	(0.014)
Firm Controls	Yes	Yes	Yes	Yes
R-Square	0.93	0.91	0.15	0.21
N	52023	52023	52023	16220
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: Columns (1) and (2) use the compensation of managers and non-managers as the dependent variable. Both columns use the dependent variable in natural logarithm. Columns (3) and (4) use wage and bonuses share of managers, respectively as the dependent variable. 'InpTariffs' is input tariffs at the 4-digit NIC 2004 level. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA', and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 8: Tracing the Effect, Organizational Design, 1990-2006

	Executives	Vertical Layers			Mcomp/Tcomp
	[OLS]	[OLS]	[OLS]	[Ordered Probit]	[OLS]
	(1)	(2)	(3)	(4)	(5)
InpTariffs_{t-1}	-0.058^{b}	-0.053^{b}	-0.059^{a}	-0.142^{a}	
	(0.029)	(0.022)	(0.016)	(0.038)	
Executives_{t-1}	0.817^{a}				
	(0.011)				
Layers_{t-1}			0.409^{a}		
			(0.004)		
Layers					0.071^{a}
					(0.001)
Product Scope					-0.000
					(0.0001)
Firm Controls	Yes	Yes	Yes	Yes	Yes
R-Square	0.69	0.31	0.5	n/a	0.38
N	7934	52023	52023	52023	38912
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: Column (1) uses the the number of executive directors as the dependent variable; Columns (2) - (4) use number of vertical/management layers; Column (5) uses compensation share of the managers. 'InpTariffs' is input tariffs at the 4-digit NIC 2004 level. 'Executives' is the number of executive managers. 'Layers' is the number of vertical organizational layers. 'Mcomp/Tcomp' is the compensation share of managers. 'Product Scope' is the number of products produced by a firm. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA', and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. *,**,*** denotes 10%, 5% and 1% level of significance, respectively.

Appendix

A Tables

Table 9: Trade Liberalization and the Relative Demand for Managers, Robustness Tests

	Managerial Compensation/Total Compensation								
	Different Indices, Methods and Time-Periods								
	1990-2006				1990-2011	1990-2006			
	Industry-level	Log Version	First Difference	Arellano Bond	Benchmark	Different Indices			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
InpTariffs_{t-1}	-0.005^{a} (0.000)	-0.005^{b} (0.002)	-0.009^{a} (0.001)	-0.023^{a} (0.001)	-0.006^{a} (0.002)				
Imp/DomSales						0.004^{b} (0.002)			
$\text{Lerner Index}_{t-1}$							0.001^{a} (0.000)		
AvgT94*Post94								-0.0001^{c} (0.000)	
ChineExp_{t-1}									0.033^{a} (0.003)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.82	0.14	0.05	n/a	0.13	0.64	0.13	0.05	0.11
N	52023	50997	44763	52023	71645	53272	53622	44763	48546
Industry FE	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Year FE	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Firm FE	No	No	No	No	No	Yes	No	No	No
Industry FE*TimeTrend	No	No	No	No	No	No	No	No	No

Notes: The dependent variable is the compensation share of managers. 'InpTariffs' is input tariffs at the 4-digit NIC 2004 level. 'Imp/DomProd' is total imports by domestic sales. 'Lerner Index' (1 – profits/sales) is the 4-digit (NIC 2004) industry-level index of competition. 'AvgT94*Post94' is the interaction term of 'AvgT94' and 'Post94'. 'Post94' is a year dummy variable, which takes a value 1 if the year is greater than 1994. 'AvgT94' is the average of input tariffs at the 4-digit (NIC 2004) industry-level for the years 1990-1993. 'ChineExp' is total Chinese exports to the World minus those to India. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA' and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

Table 10: Trade Liberalization and the Relative Demand for Managers, Robustness Tests, 1990-1997

	Managerial Compensation/Total Compensation								
	Total Imports		Dynamic Version	Log Version	First Difference	Arellano Bond	Different Indices		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Imp/GVA	0.006^{a} (0.002)								
ImpInput/GVA		0.006^{a} (0.002)							
ImpNInput/GVA		-0.001 (0.005)							
InpTariffs_{t-1}			-0.014^{a} (0.005)	-0.01^{b} (0.004)	-0.012^{a} (0.002)	-0.006^{b} (0.002)			
$(\text{Mcomp/Tcomp})_{t-1}$			0.284^{a} (0.026)						
Imp/DomSales							0.004^{b} (0.002)		
$\text{Lerner Index}_{t-1}$								0.001^{c} (0.000)	
AvgT94*Post94									-0.0001^{b} (0.000)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.70	0.68	0.27	0.17	0.01	n/a	0.68	0.15	0.09
N	19210	19210	17417	17417	14559	17417	19058	17373	14559
Firm FE	Yes	Yes	No	No	No	No	Yes	No	No
Industry FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Industry FE*Time FE	Yes	Yes	No	No	No	No	No	No	No

Notes: The dependent variable is the compensation share of managers. 'Imp/GVA' is the GVA share of total imports. 'ImpInput' is imports of intermediate inputs, equal to the sum of imports of raw materials and capital goods. 'ImpNInput' is imports of non-inputs, equal to imports of stores and spares and finished goods. 'InpTariffs' is input tariffs at the 4-digit NIC 2004. 'Imp/DomProd' is total imports by domestic sales. 'Lerner Index' (1 – profits/sales) is the 4-digit (NIC 2004) industry-level index of competition. 'AvgT94*Post94' is the interaction term of 'AvgT94' and 'Post94'. 'Post94' is a year dummy variable, which takes a value 1 if the year is greater than 1994. 'AvgT94' is the average of input tariffs at the 4-digit (NIC 2004) industry-level for the years 1990-1993. Firm controls include age of a firm and its squared term, GVA, ownership dummy (either domestic or foreign owned), 'TechAdop/GVA' and firm assets. 'TechAdop' measures the level of technology adoption, defined as the sum of R&D expenditure and royalty payments for technical knowhow. 'GVA' is gross value added, defined as total sales - total raw material expenditure. Independent variables are in their natural logarithm form (converted as per discussed in text), wherever possible. Numbers in the parenthesis are robust clustered standard errors at the industry level. Intercepts included but not reported. ^{c},^{b},^{a} denotes 10%, 5% and 1% level of significance, respectively.

B Data

We use an annual-based panel of Indian firms that covers up to 8,000 firms, across 108 industries within the manufacturing sector, over the period of 1990-2006 (with the exception of specific cases, where specified so). Unless otherwise specified, variables are based on data from the Prowess database of the Centre for Monitoring Indian Economy (CMIE). All monetary-based variables measured in millions of Rupees, deflated to 2005 using the industry-specific Wholesale Price Index (derived from Allcott, Collard-Wexler, and O'Connell (2014)). All industry level cases are based on the 2004 National Industrial Classification (NIC).

Variable definitions

Mcomp/Tcomp: The share of managerial compensation in total labor compensation; compensation defined as the sum of all salaries, and additional bonuses.

Imp/GVA: Share of total imports in Gross Value Added.

ImpRaw/GVA: Share of raw material imports in Gross Value Added.

ImpCap/GVA: Share of capital imports in Gross Value Added.

ImpSto/GVA: Share of stores and spares imports in Gross Value Added.

ImpFin/GVA: Share of final goods imports in Gross Value Added.

Exp/GVA: Share of total exports in Gross Value Added.

GVA: Gross Value Added; defined as the difference between total sales and expenditures on raw materials.

Age: Age of a firm in years.

TechAdop/GVA: Share of R&D expenditure and royalty payments for technical knowhow in Gross Value Added.

Assets: Total firm assets.

Productivity: Firm TFP computed using the Levinsohn and Petrin (2003) methodology.

Input/output *tariffs:* Input/output tariffs at the 4-digit industry level, obtained from Ahsan and Mitra (2014) for the period of 1990-2003, with the balance collected from the TRAINS-WITS tariff database.

Cap/GVA: Share of total amount of capital employed in Gross Value Added.

Skill intensity: The 3-digit industry level ratio of non-production workers to all workers, obtained from the Indian Annual Survey of Industries (2001-2006) and from Ghosh (2014) (1990-2000).

Management technology: The 4-digit industry level management quality score in 2004, obtained from Bloom and Van Reenen (2010); the score is between 1 and 5, with 5 denoting the highest quality.

Executives/Directors/Non-managers compensation/wages/bonuses: Total compensation, wages, or bonuses of executives, directors, or non-managers. Compensation is defined as the sum of wages and bonuses. Executives are the top management with executive powers, directors are the mid-ranked managers with no executive powers, and non-managers are workers who do not manage others.

Layers: The number of vertical layers (1, 2, or 3). '1' denotes having no managerial layers, or otherwise only one such layer with no non-managers; '2' denotes having either directors or executives in the firm, but not both, when there are non-managers, or otherwise having both directors and executives, with no non-managers; '3' denotes having both directors and executives, together with non-managers, in the firm.

Product scope: The number of products produced.

Top Managers: The number of executive managers.

Factories: The 3-digit industry level number of factories/plants .