



Arthur Carvalho Brito Pereira de Souza

**Firm hierarchies, managers, and trade: reacting
to liberalization**

Dissertação de Mestrado

Dissertation presented to the Programa de Pós-graduação em Economia, do Departamento de Economia da PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Economia.

Advisor : Prof. Juliano Assunção
Co-advisor: Prof. Gustavo Gonzaga

Rio de Janeiro
April 2021



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Abstract

Carvalho Brito Pereira de Souza, Arthur; Assunção, Juliano (Advisor); Gonzaga, Gustavo (Co-Advisor). **Firm hierarchies, managers, and trade: reacting to liberalization**. Rio de Janeiro, 2021. 60p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

While it is known that international trade and organizational practices are determinants of firm productivity, empirical evidence on their relation to each other is scarce. This paper explores credible exogenous variation in tariff reductions across manufacturing sectors to show that firms in Brazil are less structured in terms of hierarchies following the shock. Consistent with the literature on knowledge-based hierarchies, increased foreign competition reduces significantly the share of managers and the number of organizational layers on a firm. Besides, we find notable compositional movements within sectors: although similarly sized, entrant firms have fewer managers and layers than leavers. By using comprehensive data with more credible identification than previous work in the literature, our paper documents stylized facts on firms' organization in a developing country, as well as contributes to the study of a potentially important determinant of aggregate productivity.

Keywords

Trade liberalization; Firm hierarchies; Manager.

Resumo

Carvalho Brito Pereira de Souza, Arthur; Assunção, Juliano; Gonzaga, Gustavo. **Hierarquias de firmas, gerentes e comércio: reagindo à liberalização**. Rio de Janeiro, 2021. 60p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Embora comércio internacional e práticas organizacionais sejam conhecidos determinantes da produtividade de firmas, a evidência empírica sobre a relação entre ambos é escassa. Este artigo explora variação exógena crível em reduções tarifárias em setores da indústria para mostrar que firmas no Brasil, após o choque, são menos organizadas em termos de hierarquias. Consistente com a literatura de hierarquias baseadas em conhecimento, aumento de concorrência estrangeira reduz significativamente a parcela de gerentes e o número de camadas organizacionais em uma firma. Além disso, nós encontramos movimentos composicionais importantes dentro dos setores: apesar de possuírem tamanhos similares, firmas entrantes possuem menos gerentes e camadas do que as que deixam o mercado. Usando dados abrangentes com identificação mais crível que trabalhos anteriores na literatura, nosso artigo documenta fatos estilizados da organização de firmas em um país subdesenvolvido, assim como contribui para o estudo de um determinante potencialmente importante da produtividade no agregado.

Palavras-chave

Liberalização comercial; Hierarquias de firmas; Gerentes.

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List of Abbreviations

CBO-94 – *Classificação Brasileira de Ocupações 94*

IBGE – *Instituto Brasileiro de Geografia e Estatística*

ISCO – *International Standard Classification of Occupations*

NTB – *Non-tariff barrier*

OLS – *Ordinary Least Squares*

RAIS – *Relação Anual de Informações Sociais*

TFP – *Total factor productivity*

1 Introduction

Management practices vary substantially across firms, even if those belong to the same industry (Bloom & Van Reenen, 2007). Managers determine how firms organize, how workers execute their tasks, and whether inputs are used as efficiently as possible. The coexistence of firms' various organizational structures in a single market may reflect not only heterogeneity in production processes but some form of misallocation of resources that enable inefficient firms to survive. Hence, some of the facts in the seminal work of Hsieh & Klenow (2009) may reflect frictions in organization too. These factors may, in turn, help map out the sources of the differences between rich in developing countries in total factor productivity (TFP), whose determinants are still undetermined quantitatively (Banerjee & Duflo, 2005; Restuccia & Rogerson, 2017).

International trade is another potentially important factor for TFP. More intense competition through trade can lead to higher productivity by selection, through a competitive push (Pavcnik, 2002) or access to modern inputs (Goldberg et al., 2010), for instance. Exposure to import competition leads to changes in relative factor prices, and the relative demand for tasks and occupations reacts accordingly. Since workers in different occupations usually incur varying degrees of authority and competencies, companies may alter their organizational and management structure in response to heightened competition of foreign firms. Also, changing labor and product market conditions may alter characteristics related to the marginal firm's organization entering or leaving the market.

This paper empirically contributes to the study of this issue by asking whether trade liberalization influences firm organization in two particular ways: altering the demand for workers in managerial occupations or changing the number of hierarchical layers. Our setting is the unilateral trade liberalization episode in Brazil in the 1990s. We explore plausibly exogenous variation in tariff reductions across manufacturing industries combined with matched employer-employee data that allows us to track firms across time. This episode is widely used in the literature to study various aspects of international trade¹ due to the

¹See Ferreira & Rossi (2003); Pavcnik et al. (2004); Kovak (2013); Dix-Carneiro (2014);

characteristics of the policy change, in which traditional concerns related to the endogeneity of trade policy are not as much of a concern. Tariff cuts were significant (the median cut between 1990 and 1994 was 18 p.p.) and negatively correlated to initial tariff levels, which reflected a structure of protection dating back to the 1950s.

Overall, estimates are significant, suggesting lower tariffs lead, on average, to a decrease in the share of managerial employment and on organizational layers in firms. Such a decrease in both variables is over and above the overall tendency of decline. Since significance generally holds with the inclusion of either firm or industry fixed effects, there is a *within-firm* effect in conjunction with a movement *between* firms within industries. The estimates are economically significant as well: the median tariff shock (18 percentage points) leads to, on average, a decrease of 2.0 p.p. on managerial shares and 0.18 on the number of layers. Relative to the sample mean these effects correspond to 61% and 10%. If we restrict our analysis to surviving firms and only exploit within-firm variation across time, results are weaker but still significant for managerial demand. These findings are robust to restricting the sample to firms with five or more and ten or more employees. Moreover, outlier firms that do not employ any managers do not drive our results.

Production organization and managerial capital can be important determinants of productivity (Syverson, 2011). In this regard, even if we can not infer anything about productivity from our data, the reorganization induced by the tariff shock could impact firms' efficiency. Managers, for instance, can have lasting impacts on firm productivity. In Bloom & Van Reenen (2007), we see that certain management practices correlate to productivity levels, survival rates, and profitability and that higher degrees of competition are associated with better management. Experimental evidence on India confirms that management consulting services can have immediate beneficial results (Bloom et al., 2013), and some of these benefits persist in the long-run Bloom et al. (2020). On the relation between management and competition, Bloom et al. (2015) show that increased competition between hospitals improves managerial performance and, consequently, health outcomes.

If we follow the empirical literature, the relation between managerial demand and trade openness is ambiguous. On the one hand, if we consider managers to be complements to modern foreign inputs, demand for them should be higher if lower tariffs enable domestic firms to modernize equipment, as Chakraborty & Raveh (2018) show for India. Nevertheless, provided that there is increased competition in product markets, firms should flatten, hiring Dix-Carneiro & Kovak (2017); Dix-Carneiro et al. (2018); Dix-Carneiro & Kovak (2019)

fewer supervisors, as Guadalupe & Wulf (2010) show for the case of the United States and Canada Free Trade Agreement in 1989. Our results indicate that the first mechanism is in play. This would be more in line with Muendler (2004), which says that selection and competition effects matter more for productivity gains than access to foreign inputs during the liberalization episode that we study. On the other hand, if in fact managers complement foreign inputs, our findings would go against what Schor (2004) and Lisboa et al. (2010) encounter on the importance of productivity gains due to access to foreign inputs.

We add to the literature on management in trade by analyzing a broad universe of firms affected by competition via trade exposure. The work of Chakraborty & Raveh (2018) focuses on liberalization on access to inputs, whereas Guadalupe & Wulf (2010) and other papers on management and trade (Cuñat & Guadalupe, 2009; Bloom et al., 2020) are restricted to studying large exporting firms. Even if these papers have detailed data on firms' organizational features, these are not representative of the manufacturing sector since smaller businesses are numerous and are also affected by import competition, as in our case.

Our analysis of layers builds upon the theory of knowledge-based hierarchies presented on Garicano (2000) and then embedded in a Melitz-type model of heterogenous firms in Caliendo & Rossi-Hansberg (2012). In this framework, firms use knowledge and time as inputs for production, and workers need to solve problems of varying difficulty to produce output. Workers incur costs to acquire knowledge and are paid accordingly. Since more difficult problems come by infrequently, firms form hierarchies. Workers accumulate less knowledge and solve elementary problems. More complex problems, called "exceptions" are passed on to managers in the hierarchy's upper layers. The firm's cost minimization problem then involves the discrete choice of picking the number of layers, the number of workers in each one, and the hired workers' knowledge.

Given that managers do not engage in production activities, firms face a trade-off when deciding whether to grow by adding layers or not. A new level on the hierarchy is analogous to a fixed cost worth paying for high enough production levels. Consequently, production workers need not be as knowledgeable and earn lower wages. In this sense, firms trade discontinuously lower marginal costs for higher fixed costs. Therefore, when facing a negative demand shock due to import competition exposure, firms may decrease the number of layers depending on how far their current production levels are from their minimum efficient scales. Brazil's trade shock may not have been strong enough for certain firms to reach the threshold that triggers layer changes.

The layer choice's discreteness could explain why we find more substantial managerial employment results in the regressions than layer results.

The empirical literature in knowledge-based layers is not very broad, Caliendo et al. (2018, 2020) study French and Portuguese firms, and are the references closer to this paper. The former focuses on the behavior of firms entering export markets, concluding that firms exporting add layers. Identification in their work is not as clean as in our paper - they derive an instrument for exports by exploiting variation in exchange rates across countries and exports' destination composition. The latter paper identifies adverse demand shocks using China's entrance into the WTO, arguing that reorganization has implications for productivity. Adding layers is associated with increased quantity-based productivity and decreased revenue-based productivity (through lower prices). At first, this result would indicate that Brazil's trade shock would similarly induce reorganization, reducing firms' productivity. However, we have shown that layers declined primarily due to compositional effects within sectors, while Caliendo et al. (2020) focuses on within-firm movements, so entrants and leavers may differ in terms of productivity for reasons other than organizational layers.

Finally, other papers model the relation between organization and competition by hierarchies that are incentive-based rather than knowledge-based. In such a framework, firm owners alter their centralization level to deal with agency issues according to competition in the market. In a sense, there is a trade-off between control of the market versus of the firm. Examples include Marin & Verdier (2008, 2012, 2014). Even though their foundations for hierarchy formation are different, both approaches arrive at similar conclusions regarding international trade's importance for firm structure.

Section 2 of the paper describes the institutional context of Brazil's trade reform. Next, we describe the dataset used in the analysis. Section 4 provides some descriptive analysis. We show the overall pattern of decline in managerial employment and firm layers. The section also characterizes our mapping of occupations into layers. Tests similar to the ones in Caliendo et al. (2015) confirm our classification implies hierarchies in employment, wages, and schooling and that layer transitions follow the theory's predictions. Section 5 describes the identification strategy—afterward, sections 6 and 7 present results and robustness tests. Lastly, Section 8 concludes.

2

Brazilian trade reform

Reforms regarding openness to trade and globalization in general in Brazil came in the wake of the exhaustion of policies related to import substitution industrialization during the 1980's decade (Abreu, 2004). Following a period marked by extremely high inflation, currency crises, and slow or negative economic growth, the dismantling of trade barriers started in 1988 as a means to induce greater allocative efficiency through the exposure of domestic firms to foreign competition.

Kume et al. (2003) split Brazil's trade policy reforms into three phases regarding tariff reductions: 1988-1989, 1991-1993, and 1994. The first stage consisted of simplifying the protective structure by removing redundancies, non-tariff barriers (NTBs), and special customs regimes. Thus, tariffs became a good measuring stick for trade policy only after it, and notwithstanding the lower quality of NTB data (Goldberg & Pavcnik, 2007). Furthermore, the period from 1991 to 1994 is our primary interest.

After the removal of tariff redundancies and quantitative restrictions before 1990, the newly appointed government unexpectedly released a schedule of gradual tariff reductions, intending to have, in the end, a modal tariff of 20% with a variation from 0% to 40% across sectors. Kume et al. (2003) state that by the end of 1993, the government had thoroughly gone through the plan, getting to tariff levels similar to other developing economies at that time.

The variation in tariff reductions across sectors was hardly subject to the traditional political economy of trade (Abreu, 2004; Kume et al., 2003). There was less space for the protectionist action of special interest groups that could potentially invalidate our analysis. According to most of the literature on the episode, tariff cuts in 1990 were strongly negatively correlated to initial tariff levels, reflecting a structure of protection dating back to the 1950's so that even if specific sectors had lobbied for higher protection levels, they would not have changed the tariff cuts. Furthermore, typical Protection for Sale arguments probably does not apply to the context, as organized sectors benefiting from higher tariff levels were the ones facing the harsher cuts.

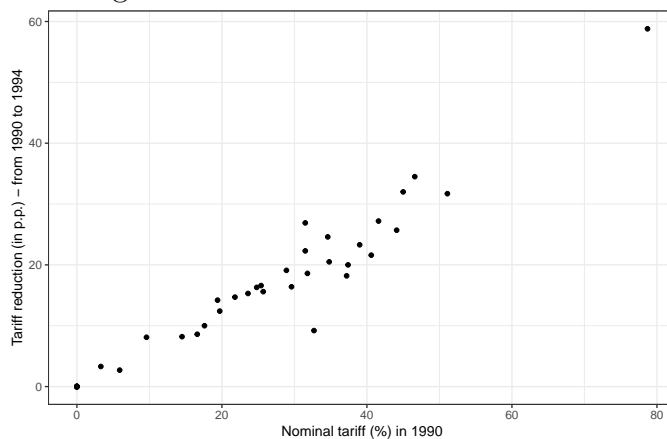
Even though the liberalization shock as a whole may be exogenous to contemporaneous sectoral characteristics, the timing of the cuts within the

1990-1994 frame was not (Kume et al., 2003). To garner popular support for the policy, the government first cut tariffs on intermediate input sectors and opened up consumer goods sectors. For this reason, we follow Dix-Carneiro & Kovak (2017) in treating Brazil's trade opening from 1990 to 1994 as a one-time shock, rather than exploiting the temporal variation in the cuts within this period.

Despite a slight rebound of tariff rates in 1994 amidst the Real stabilization plan and the Mexican crisis, effective rates of protection would be much lower than in the previous decade: Ferreira & Rossi (2003) document that nominal tariffs in 1997 were a tenth of those in 1987. Moreover, sectorial dispersion on tariff rates decreased by a wide margin, even though few changes were in the order of those rates.

Pavcnik et al. (2004) say that import penetration in Brazil more than doubled through the decade, albeit still low compared to countries such as Colombia. There was considerable variation across sectors - the higher gain accrued to industries with more significant tariff declines. They also show Brazil's protection structure was profoundly altered at the end of the 1990s, as evidenced by the low year-to-year correlations of industry tariffs from 1987 to 1998.

Figure 2.1: Initial tariff levels and tariff reductions



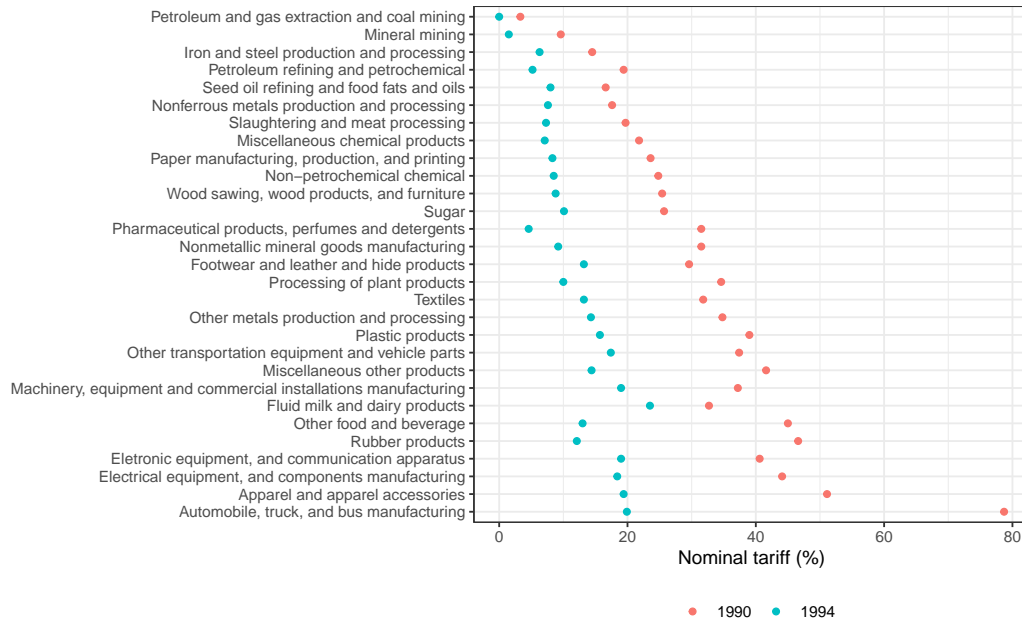
Notes: Data points represent manufacturing sectors (*Nível 50*)

Figures 2.1 and 2.2 illustrate the magnitude and nature of the policy change across manufacturing. The median tariff reduction was close to 20 percentage points, the cuts were proportional to initial tariff levels, and there was almost no reordering on protection levels among sectors. Note that by 1994 tariffs are clustered around two points: approximately 10% and approximately 20%.

To conclude, due to the nature of the shock, we do not have enough variation in tariffs to say whether our estimates of the tariff shock impact vary

with the initial tariff level.

Figure 2.2: Tariff reductions by sector



Notes: In the vertical axis are manufacturing sectors ordered by tariffs in 1994. Check table A.1 in the appendix for definitions and precise values.

3 Data

The primary dataset used in our analysis comes from the *Relação Anual de Informações Sociais* (RAIS) from 1990 and 1994, an employer-employee matched administrative dataset from Brazil's former Ministry of Labor documenting formal employment relations, just as other studies on the Brazilian trade reform (Menezes-Filho & Muendler, 2011; Dix-Carneiro, 2014; Dix-Carneiro & Kovak, 2017).

An advantage of the data is its comprehensiveness, especially considering Brazil is a developing country: all employers in the formal sector have to fill out forms detailing worker and establishment characteristics. Firms have strong incentives to comply, being fined in case of non-compliance, since many worker benefits are conditioned to registration.

RAIS allows us to track workers and firms through time, providing detailed worker information, such as wages, education levels, experience, and occupation. The details on all employees and the consideration of manufacturing firms' universe are an advantage relative to the literature on managerial work and trade. Cuñat & Guadalupe (2009); Guadalupe & Wulf (2010); Bloom et al. (2020), for instance, only consider a small subset of large companies, not representative of the set of firms affected by foreign competition. Chakraborty & Raveh (2018) considers a more extensive set of firms but does not have information at the employee level.

On the other hand, our data has nothing to say at a more detailed level on managers' actual work practices and responsibilities as these papers do. Besides, we do not have access to value-added, sales, technology, or international trade information as other works on hierarchies (Caliendo et al., 2015, 2018, 2020).

The central unit of analysis on our work is a manufacturing firm in 1990 and 1994. After discarding workers' observations with null wages and those whose reported occupations are likely incorrect ¹, we use all firms with non-zero employment in December. For the period considered, the most detailed sectoral classification is *IBGE subatividade*, comprising about 280 categories. We collapse these to the level in which there is reliable tariff data - IBGEs

¹examples include military occupations, members of the justice system, and doctors

Nível 50 definition consisting of 30 manufacturing industries, regularly used on Brazilian National Accounts².

We identify managers by their occupational codes in the *Brazilian Classification of Occupations 1994* (CBO-94). We identify managers following Reijnders & de Vries (2017), who categorize workers as managers, professionals, clericals, production, sales, or service workers based on an occupation's first three digits in ISCO. A simple crosswalk between CBO-94 and ISCO identifies managers in RAIS, and we compute the share of managers on total employment on a firm.

We follow Cruz et al. (2018) to get a definition of knowledge-based hierarchies compatible with CBO-94. Their paper splits occupations into five groups, ordered as follows: CEOs and managers, professionals (senior staff), technicians (middle-level), clerks and services (white-collars), production workers (blue-collars). This division is based on each occupation's tasks' complexity and the level of authority and competencies typically required. The classification from CBO, in turn, is based on the first digit from ISCO. We then say a given firm has x layers if its workers are spread onto occupations corresponding to x hierarchical groups. The next section of the paper provides descriptive evidence that such division is not arbitrary and has economic sense regarding the workers' characteristics in each layer.

Although the source used to tabulate managers' share is different from the number of layers', there is almost perfect overlap between them. In that sense, the analysis of managerial demand using Reijnders & de Vries (2017) focuses on the higher bracket of the classification used by Cruz et al. (2018).

Even though the literature on firm hierarchies also predicts wage movements in reaction to shocks, we refrain from using compensation variables in our analysis. We focus instead on managerial employment and layer numbers as our outcome variables. Due to the Brazilian hyperinflation in the early 1990s, wage figures are more subject to significant measurement errors, so that this variable only complements our work.

Finally, the data on Brazilian trade policy comes from Kume et al. (2003): we use primarily nominal tariff rates at the IBGE *Nível 50* level. Table A.1 on the appendix details industry definitions and tariff levels.

²See Muendler (2002) for detailed information on Brazilian sectoral classifications and their mapping to international ones.

4

Descriptive analysis

Before looking at the causal impact of Brazil's trade liberalization on firm organization, it is helpful to motivate the analysis with some descriptive statistics in the following subsections. The first describes managerial demand behavior. The second focuses on our layer categorization, showing that our mapping of occupation into layers has economic sense: replicating some of the empirical tests usually done in the literature (as in Caliendo et al. (2015, 2018)), we see that predictions in the theory of Caliendo & Rossi-Hansberg (2012) hold. This division into layers implies a hierarchical structure in wages, jobs, and schooling levels to varying degrees.

4.1

Managers

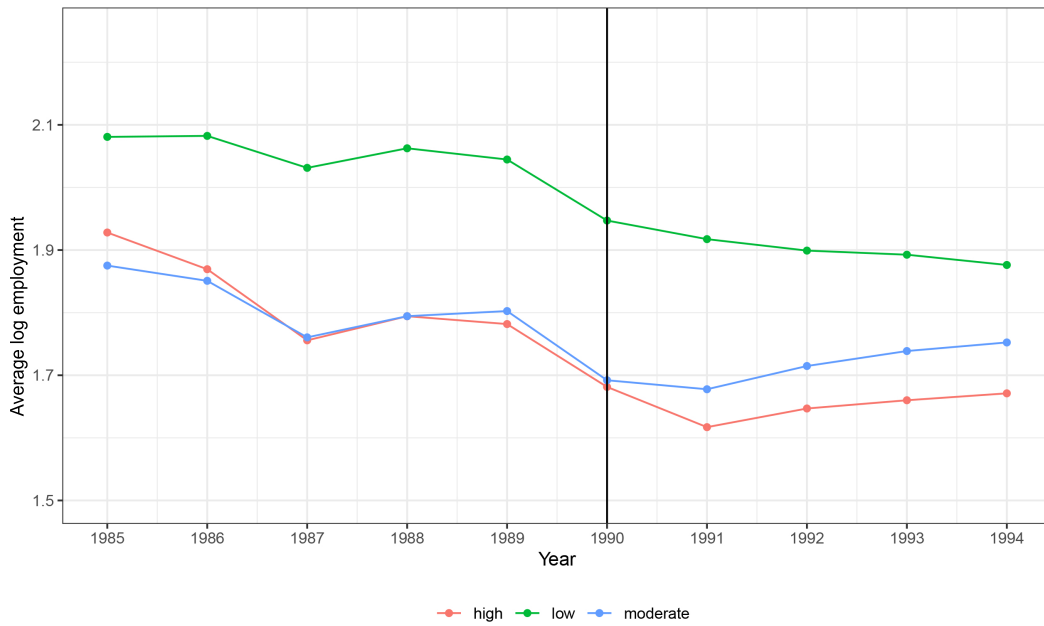
We split our industries into three "tariff groups": low, moderate, and high reductions from 1990 to 1994. Each group has approximately the same number of firms in 1990. From figures 4.1, 4.2, and 4.3, we see that groups *moderate* and *high* are more similar to each other in terms of total employment, managerial shares and number of layers. Meanwhile, firms on the *low* group are larger and have more managers and organizational layers.

Moreover, the trends for all variables are parallel, giving more validity to a difference-in-differences analysis. There is a decline after 1990 in managerial shares and layers for all groups, especially for the former. The only large discrepancy across groups in post-1990 trends is regarding total employment, in which there was growth for *moderate* and *high* and decrease in the *low* group.

Now that we have established the overall decline in manager employment, we check how firm entry and exit contributed to this behavior. Table 4.1 shows important movements in both extensive and intensive margins: entrants employ proportionately fewer managers than leavers, and survivors decrease their demand for them after 1990. As for the number of layers, the intensive and extensive margins move in opposite directions - surviving firms add layers, on average, while entrants have less of them than leavers.

We quantify these contributions across tariff groups following Davis & Haltiwanger (1999), Biscourp & Kramarz (2007). Let $\Delta L_i = \frac{L_{i,1994} - L_{i,1990}}{L_i}$, with

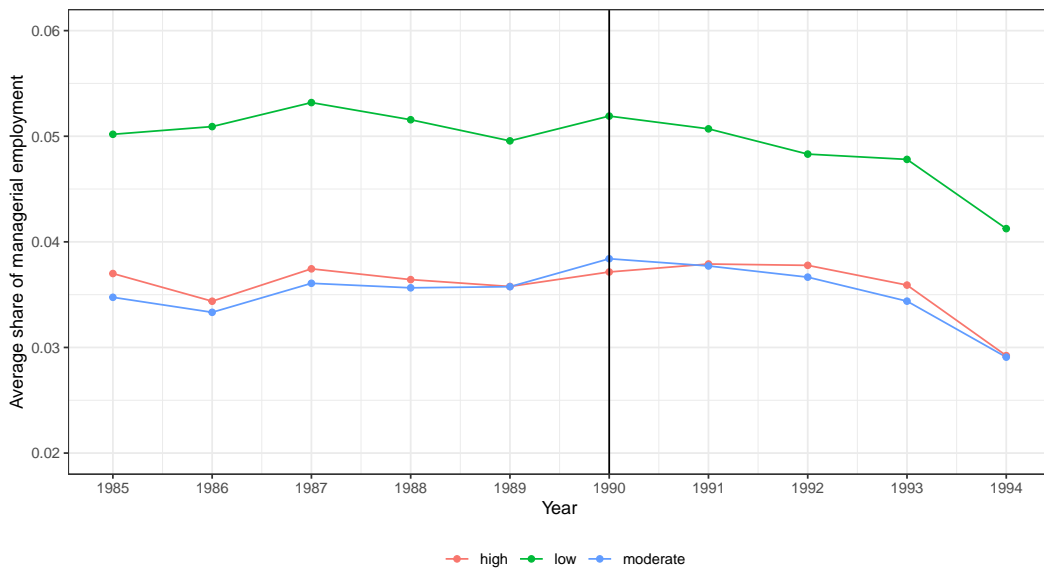
Figure 4.1: Evolution of mean log employment in a firm in each tariff group.



Notes: Groups are equally sized in terms of firms in 1990

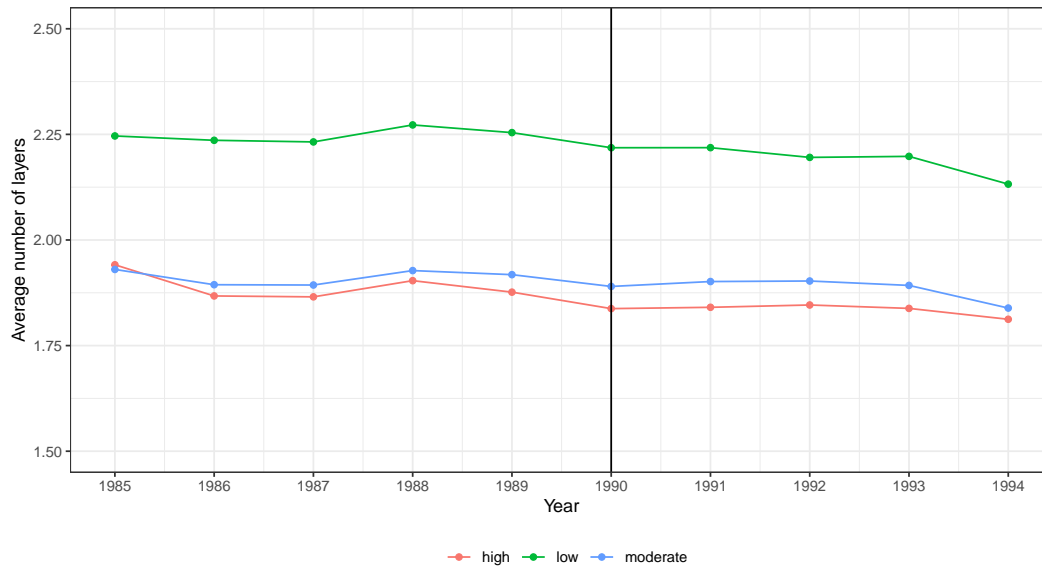
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Figure 4.2: Evolution of the mean share of managers in a firm in each tariff group



Notes: Groups are equally sized in terms of firms in 1990

Figure 4.3: Evolution of mean number of layers in a firm by tariff groups.



Notes: Groups are equally sized in terms of firms in 1990

Table 4.1: Descriptive statistics - continuing firms, leavers and entrants

Firm group (g)	Variable	1990	1994	Δ
Leavers/Entrants	Number of firms	66.368	80.652	14.284
Continuing		64.611	64.611	0
Leavers/Entrants	% of. agg. firms	50.67	55.52	4.85
Continuing		49.32	44.48	-4.85
Leavers/Entrants	$100 \times \frac{L_g}{\sum L_g}$	26.86	26.65	-0.21
Continuing		73.14	73.35	0.21
Leavers/Entrants	$100 \times \frac{L_{Manager,g}}{L_g}$	5.78	4.39	-1.39
Continuing		5.79	4.96	-0.83
Leavers/Entrants	$L_{Manager,g}$	60.147	48.367	-11.780
Continuing		164.179	150.524	-13.655
Leavers/Entrants	# layers	1.57	1.50	-0.07
Continuing		2.09	2.11	0.02

Notes: Subscript g refers to a firm being an entrant, leaver or continuing firm according to its existence or not in 1990 and 1994.

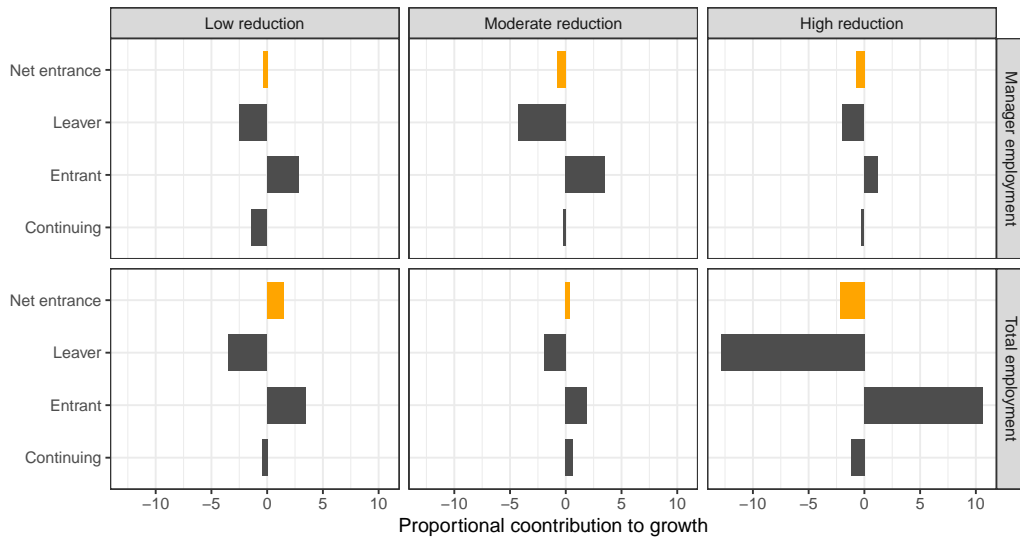
$\bar{L}_i = \frac{L_{i,1990} + L_{i,1994}}{2}$, noting $\Delta L_i \in [-2, 2]$. By construction, $\Delta L_i = -2$ for leavers and $\Delta L_i = 2$ for entrants. Computing changes in each firm i and aggregating weighting by average employment in the firm.

$$\Delta L = \sum_{k=1}^3 \frac{\sum_{i \in I_k} \bar{L}_i}{\sum_i \bar{L}_i} \sum_{i \in I_k} \frac{L_i}{\sum_{j \in I_k} \bar{L}_j} \Delta L_i$$

I_k represents the set of i firms in tariff group k .

Figure 4.4 illustrates the decomposition for managerial and total employment¹. We see that neither group increased managerial employment on the intensive or extensive margins. As expected, churning on the extensive margin is much larger than on the intensive. Regarding managerial employment, movements for surviving firms are more important than net entry only at the *low* group.

Figure 4.4: Decomposition of employment flows - intensive and extensive margins



Notes: See tables A.2 and A.3 for numbers related to the graphs. Note that the dark bars in each panel do not sum to 1. Naturally, 'Leaver' and 'Entrant' are always negative and positive, respectively. To ease on the interpretation, entries on 'Continuing' have the same sign as the movement in the intensive margin - so if overall employment increased by 100 and decreased by 10 in the intensive margin, the value will be -0.1 . Furthermore, the gray bars in each panel do not sum to 1.

Figure 5 in the appendix shows patterns of entry and exit in each entrant and leaver cohort in a given year. Even though there are no differences in patterns across tariff groups, we see that after 1990 firms that leave the market have consistently fewer layers and managers than those entering, but the same does not hold for overall employment.

¹Tables A.2 and A.3 in the appendix details the numbers

As the literature on hierarchies would, managerial employment is related to firm size. Table 4.2 confirms this by presenting quantiles of the managerial employment share across different brackets of firm size. While it is true that across all groups there are anomalous firms not employing any managers, this is rarer for larger firms. Except for quantile 100%, quantiles associated to larger firms present a larger share of manager employment. These statistics in fact show that it makes more sense to incur in a fixed cost by adding a layer/manager if output/employment is sufficiently large.

Table 4.2: Quantiles of the managerial share distribution across different firm size groups

Firm size group	0%	25%	50%	75%	100%
(0, 10]	0	0	0	0	100
(10, 20]	0	0	0	6.25	100
(20, 50]	0	0	2.67	6.45	100
(50, 250]	0	1.51	3.77	7.48	100
(250, ∞)	0	2.40	4.89	8.19	97.41

Notes: Firm size is defined according to employment.

In figure 4.5 we examine the interaction of managers, firm size and salaries and schooling levels of non managers. As the literature documents, there is a size premium, so that larger firms pay higher salaries on average and their workers have more schooling. Note also that for a given firm size bracket, firms with more managers pay on average higher wages and have more schooled workers. This could be going against the theory, which states that a firm adds layers in order to pay lower salaries and reduce marginal costs. Firm size, however, is endogenous, so that the graph does not necessarily have a causal interpretation. Besides, even if size was in fact exogenous, these facts could be reconciled with the data: if a firm grows without adding layers, wages should grow in all preexisting layers (and more so for the bottom layers).

4.2

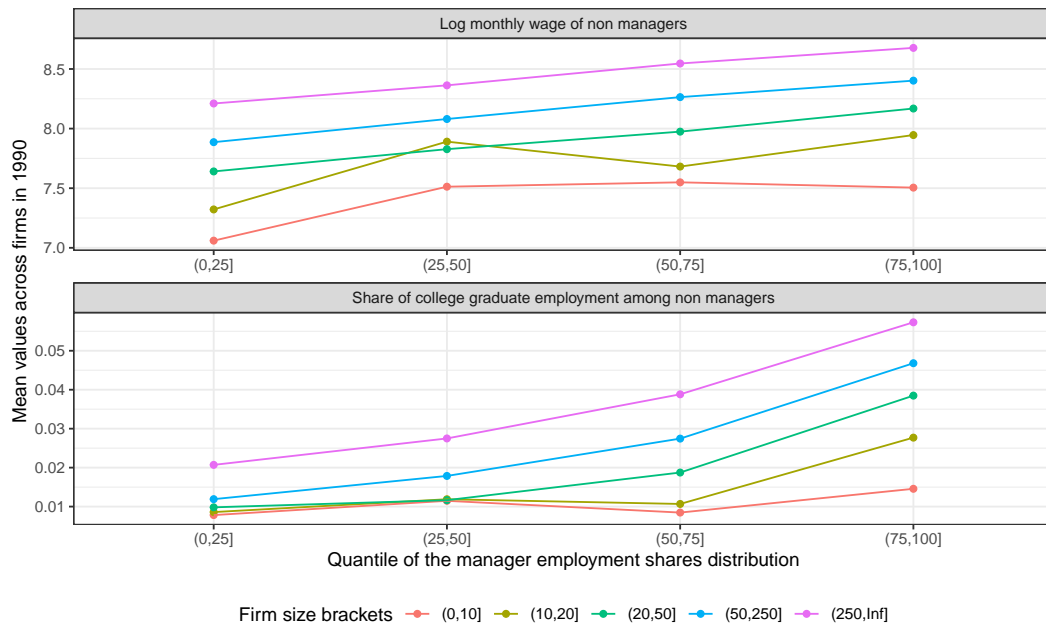
Layers

4.2.1

Static description - Hierarchies in firms

We now move on to the analysis of the layer categories. In a similar vein to Caliendo et al. (2015), we show that this classification has economic sense - we should expect that workers on top layers receive the higher wages and that top layers employ fewer workers than layers below. Also, according to Caliendo

Figure 4.5: Average schooling and wages of non-managers-1990 across the managerial share distribution



Notes: Each dot represents the the mean for non managers in 1990 on a given bracket of firm sizes and manager employment shares.

& Rossi-Hansberg (2012), when reducing their number of layers, firms reduce employment on all of them.

Figure 4.6: Distribution of number of layers by firm - 1990 and 1994

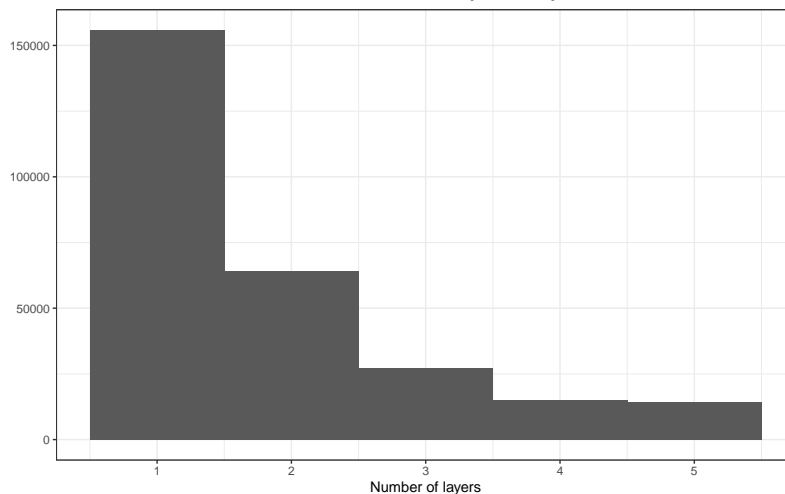


Figure 4.6 shows that the distribution of firms by the number of layers is decreasing, and according to figure 4.7, on average, firms are hierarchical in terms of jobs. From 1990 to 1994, the pyramid's base got wider: the production layer grew at the other four categories' expense. Additionally, the top layers did pay higher wages on average (figure 4.8). The hierarchy in salaries is not caused by schooling levels, since *professionals* are more educated than *CEOs*

and managers, per figure 4.2.1. This inversion is probably due to entrepreneurs and owners of small businesses not engaging in technical tasks requiring higher education, as engineers and scientists do.

Figure 4.7: Share of manufacturing jobs by layer

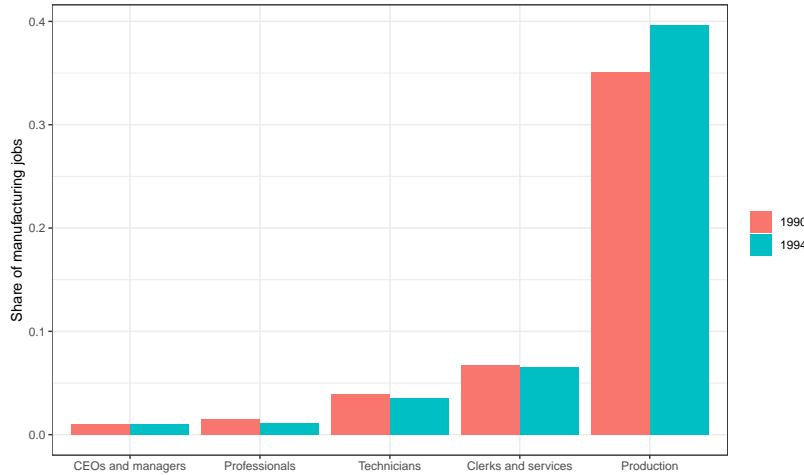


Table 4.3 shows that, for the most part, the firms on the sample do have consecutively ordered layers. By this, we mean that, for example, 88.1% of firms with one layer have only production workers employed, or that 76.5% of those with two layers only employ production workers or clerks. Conditioning on the number of layers, this holds especially for larger firms. These figures are comparable to the ones in Caliendo et al. (2015)². This matters in the sense that, provided that the underlying theory and our categorization make economic sense, we should expect that if a production worker at the bottom of the hierarchy encounters a problem that he cannot solve, he would be able to refer first to a clerk or to a technician in the firm, rather than to senior staff. A firm would only hire these more knowledgeable workers once workers in its existing layers could not resolve such issues.

Looking at the distribution of firms, tables 4.4 and 4.5 show that hierarchies follow a pyramidal shape according to our definitions, especially in jobs. The lower share of hierarchical firms concerning wages is possibly due to salary variables' mismeasure in a hyperinflation context. Once again, the numbers are similar to the ones in Caliendo et al. (2015).³

²In our case, 88.1%, 76.5%, and 47.2% of firms with one, two, and three layers have them consecutively ordered. On their paper, the proportions are 87.4%, 67.4%, and 80.0%. Note, however, that their categorization is coarser, consisting of only four possible layers.

³Tables A.4 and A.5 in the appendix replicate the analysis weighting by total employment.

Figure 4.8: Average monthly wages in Dec-1990 by layer

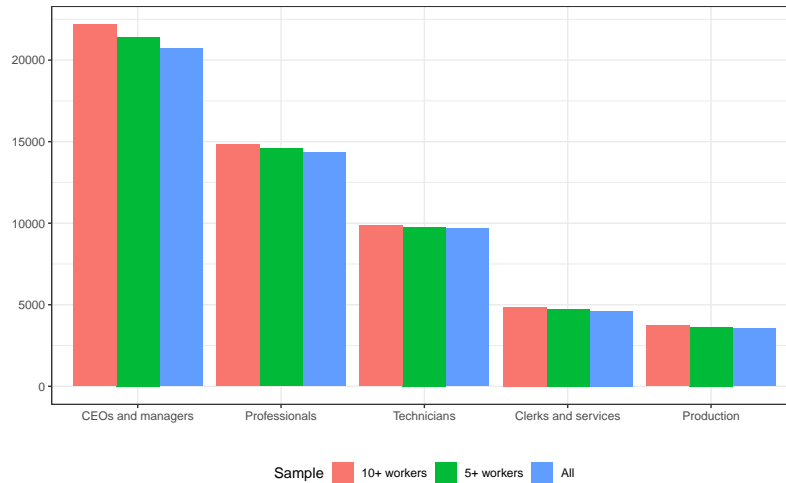


Figure 4.9: Share of college graduates in 1990 by layer

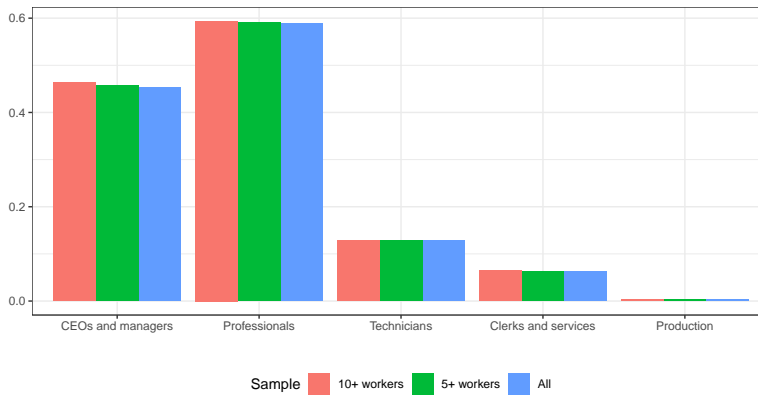


Table 4.3: Firms with consecutively ordered layers.

	All firms		5+ employees		10+ employees	
	Firms (%)	Jobs (%)	Firms (%)	Jobs (%)	Firms (%)	Jobs (%)
1 layer	88.1	93.4	95.9	95.6	96.2	95.4
2 layers	76.5	79.7	80.0	80.5	81.2	81.0
3 layers	47.2	54.1	48.1	54.3	50.3	55.1
4 layers	27.7	36.2	27.7	36.2	27.8	36.2
5 layers	100.0	100.0	100.0	100.0	100.0	100.0
Any	78.7	84.9	75.0	85.0	71.0	85.2

Notes: The table presents the number of firms and jobs in firms with consecutively ordered layers. As an example, the value 88.1% on the first row, second column, indicates that 88.1% of the firms with only one layer have workers occupied exclusively at the first knowledge layer, namely, of production workers. These, in turn, correspond to 93.4% of the jobs on firms with only one layer. Columns 4 and 5 present the same number but considering only the universe of firms with 5 or more employees, and so on

Table 4.4: % of firms with hierarchical layers in terms of jobs

	$N_l \geq N_{l+1} \forall l$	$N_1 \geq N_2$	$N_2 \geq N_3$	$N_3 \geq N_4$	$N_4 \geq N_5$
2 layers	92.6	92.6			
3 layers	79.2	91.2	87.5		
4 layers	59.4	90.1	86.2	79.0	
5 layers	32.8	91.5	80.1	90.5	54.5
Any	78.3	91.9	40.1	20.7	6.5

Notes: N_l refers to employment level N on layer l . Each row considers firms with a given number of organizational layers.

Table 4.5: % of firms with hierarchical layers in terms of average monthly wages

	$w_l \leq w_{l+1} \forall l$	$w_1 \leq w_2$	$w_2 \leq w_3$	$w_3 \leq w_4$	$w_4 \leq w_5$
2 layers	53.7	53.7			
3 layers	39.7	53.4	81.8		
4 layers	33.6	59.0	83.5	76.9	
5 layers	34.9	67.2	92.3	73.1	81.9
Any	45.8	55.9	39.8	18.4	9.7

Notes: w_l refers to average monthly wage level w on December on layer l . Each row considers firms with a given number of organizational layers.

4.2.2

Dynamic description - Layer addition, subtraction, and employment flows

Having established that firms seem to be hierarchical, we show how frequently firms add or subtract layers in tables 4.6 and 4.7. The first one considers only continuing firms, and the latter also contemplates those exiting. For survivors, the most likely outcome for all initial numbers is maintaining the same number of layers. When we take leavers into account, exiting is the most likely outcome for all initial values except for the more structured category of 5 layers. Note also in table 4.6 that values to the left of the diagonal are larger than the ones to the right: it is more likely that firms subtract rather than add layers, irrespective of their initial organization. From these tables, we see that the organizational structure is a relatively persistent outcome, consistent with the firm's decision-making discreteness, as in the theory of Garicano (2000) and Caliendo & Rossi-Hansberg (2012).

How does employment in each layer react after transitions? Table 4.8 displays average changes in log employment from 1990 to 1994 for each possible combination of layer, number of layers in 1990 and 1994. When firms delayer, employment falls on average on all previously existent layers. This behavior is consistent with the theory on knowledge-based hierarchies: by eliminating

Table 4.6: Distribution of the number of layers of survivor firms in 1994 according to the number of layers in 1990.

Layers in 1990	Layers in 1994					Total
	1	2	3	4	5	
1	75.1	19.5	4.2	0.9	0.3	100
2	30.8	48.3	16.1	4.1	0.8	100
3	11.6	30.7	36.9	16.6	4.2	100
4	4.7	11.4	26.0	39.0	18.9	100
5	1.9	2.8	7.1	20.1	68.1	100

Notes: The table presents transition rates of the number of layers of firms from 1990 to 1994. Each line sums to 100 and we only consider firms present in the data in 1990 and 1994.

Table 4.7: Distribution of the number of layers of firms in 1994 according to the number of layers in 1990.

Layers in 1990	Layers in 1994					Exit	Total
	1	2	3	4	5		
1	30.2	7.8	1.7	0.4	0.1	59.8	100
2	16.7	26.3	8.8	2.2	0.4	45.5	100
3	7.2	19.1	23.0	10.3	2.6	37.7	100
4	3.2	7.9	18.0	27.0	13.1	30.7	100
5	1.4	2.1	5.4	15.1	51.4	24.5	100

Notes: The table presents transition rates of the number of layers of firms from 1990 to 1994. Each line sums to 100 and we only consider firms that are present in the data in 1990.

their top layer, the firm decreases its production capacity since the remaining leadership cannot solve all problems faced by workers in production.

The theory in Caliendo & Rossi-Hansberg (2012) predicts the amount of knowledge in firms changes whether firms add or subtract levels. For example, if a firm adds management layers, managers in preexisting layers can now refer to upper levels to solve problems requiring more knowledge. For this reason, the firm can afford to have workers in preexisting layers with less knowledge and thus receiving lower wages. Table 4.9 confirms this pattern in the data: for the most part, the average share of college graduates significantly decreases in each preexisting layer in a firm that added layers and vice-versa.

Finally, we use in figure 4.10 a decomposition similar to the one in figure 4.4 to study employment flows in each layer. Besides flows due to the growth of existing layers, we split the extensive margin component in two: net creation of a firm or the net creation of a layer in an existing firm. For most *layer by*

Table 4.8: Average log change in employment by layer for firms changing the number of layers

# layers 1990	# layers 1994	Layer number	Estimate	SE	P-value	N
1	2	1	0.328	0.011	0.000	5709
1	3	1	0.662	0.029	0.000	1248
1	4	1	1.074	0.080	0.000	273
1	5	1	1.481	0.193	0.000	85
2	1	1	-0.122	0.011	0.000	5033
2	3	1	0.349	0.017	0.000	2650
2	3	2	0.084	0.011	0.000	2650
2	4	1	0.724	0.039	0.000	665
2	4	2	0.254	0.028	0.000	665
2	5	1	1.401	0.124	0.000	127
2	5	2	0.840	0.097	0.000	127
3	1	1	-0.344	0.033	0.000	936
3	2	1	-0.003	0.017	0.883	2465
3	2	2	-0.060	0.010	0.000	2465
3	4	1	0.422	0.023	0.000	1332
3	4	2	0.136	0.018	0.000	1332
3	4	3	0.069	0.015	0.000	1332
3	5	1	0.776	0.064	0.000	337
3	5	2	0.488	0.046	0.000	337
3	5	3	0.388	0.048	0.000	337
4	1	1	-0.946	0.086	0.000	246
4	2	1	-0.325	0.042	0.000	597
4	2	2	-0.332	0.028	0.000	597
4	3	1	0.026	0.024	0.268	1365
4	3	2	-0.150	0.017	0.000	1365
4	3	3	-0.055	0.015	0.001	1365
4	5	1	0.474	0.031	0.000	988
4	5	2	0.179	0.023	0.000	988
4	5	3	0.222	0.024	0.000	988
4	5	4	-0.174	0.021	0.000	988
5	1	1	-2.095	0.171	0.000	106
5	2	1	-1.288	0.141	0.000	155
5	2	2	-1.101	0.100	0.000	155
5	3	1	-0.407	0.063	0.000	401
5	3	2	-0.554	0.045	0.000	401
5	3	3	-0.389	0.041	0.000	401
5	4	1	-0.043	0.027	0.118	1130
5	4	2	-0.299	0.021	0.000	1130
5	4	3	-0.149	0.022	0.000	1130
5	4	4	0.074	0.019	0.000	1130

Notes: Average log variation on employment on a firm's layer. Each row considers firms surviving between 1990 and 1994 and transitioning from L to L' layers, with $L \neq L'$. We can only evaluate changes for layer number $l = 1, \dots, \min\{L, L'\}$.

Table 4.9: Average change in percentage points of the college graduated share by layer for firms changing the number of layers

# layers 1990	# layers 1994	Layer number	Estimate	SE	P-value	N
1	2	1	-0.708	0.123	0.000	5709
1	3	1	-1.448	0.325	0.000	1248
1	4	1	-3.089	0.890	0.001	273
1	5	1	-12.473	3.706	0.001	85
2	1	1	0.546	0.125	0.000	5033
2	3	1	-0.282	0.112	0.012	2650
2	3	2	-2.323	0.472	0.000	2650
2	4	1	-1.062	0.386	0.006	665
2	4	2	-4.338	1.001	0.000	665
2	5	1	-2.149	1.017	0.037	127
2	5	2	-11.520	2.821	0.000	127
3	1	1	1.822	0.417	0.000	936
3	2	1	-0.028	0.118	0.812	2465
3	2	2	2.412	0.490	0.000	2465
3	4	1	-0.398	0.158	0.012	1332
3	4	2	-0.851	0.515	0.099	1332
3	4	3	-5.177	1.229	0.000	1332
3	5	1	-0.981	0.420	0.020	337
3	5	2	-3.800	1.210	0.002	337
3	5	3	-16.220	2.647	0.000	337
4	1	1	7.161	1.564	0.000	246
4	2	1	0.117	0.362	0.747	597
4	2	2	4.654	1.131	0.000	597
4	3	1	0.282	0.187	0.132	1365
4	3	2	1.763	0.515	0.001	1365
4	3	3	5.092	1.231	0.000	1365
4	5	1	-0.330	0.209	0.115	988
4	5	2	0.456	0.470	0.332	988
4	5	3	-4.305	1.231	0.000	988
4	5	4	18.822	2.275	0.000	988
5	1	1	16.946	3.465	0.000	106
5	2	1	3.376	1.719	0.051	155
5	2	2	12.743	2.823	0.000	155
5	3	1	0.359	0.202	0.077	401
5	3	2	2.369	1.108	0.033	401
5	3	3	12.228	2.309	0.000	401
5	4	1	0.002	0.589	0.997	1130
5	4	2	1.324	0.452	0.003	1130
5	4	3	5.938	1.002	0.000	1130
5	4	4	-5.883	1.780	0.001	1130

Notes: Average percentage point change on a firm's share of college graduates in a given layer. Each row considers firms surviving between 1990 and 1994 and transitioning from L to L' layers, with $L \neq L'$. We can only evaluate changes for layer number $l = 1, \dots, \min\{L, L'\}$.

tariff-group pairs, a firm adding or subtracting layers is not very significant to employment changes. Therefore, the bulk of the movement in each occupational group comes from either firms entering and leaving the market or from firms that already had a given layer hiring or firing workers in it⁴. This result is perhaps because adding or subtracting a layer is an incremental process, wherein a firm does not employ many workers at once in a recently created spot in the hierarchy.

According to the last column in the figure, for each of the five layers, compositional movements negatively affected employment in industries facing more significant tariff shocks: the set of firms entering the market employed fewer workers than the set of leavers in each layer. For other tariff groups, compositional firm effects were not as adverse.

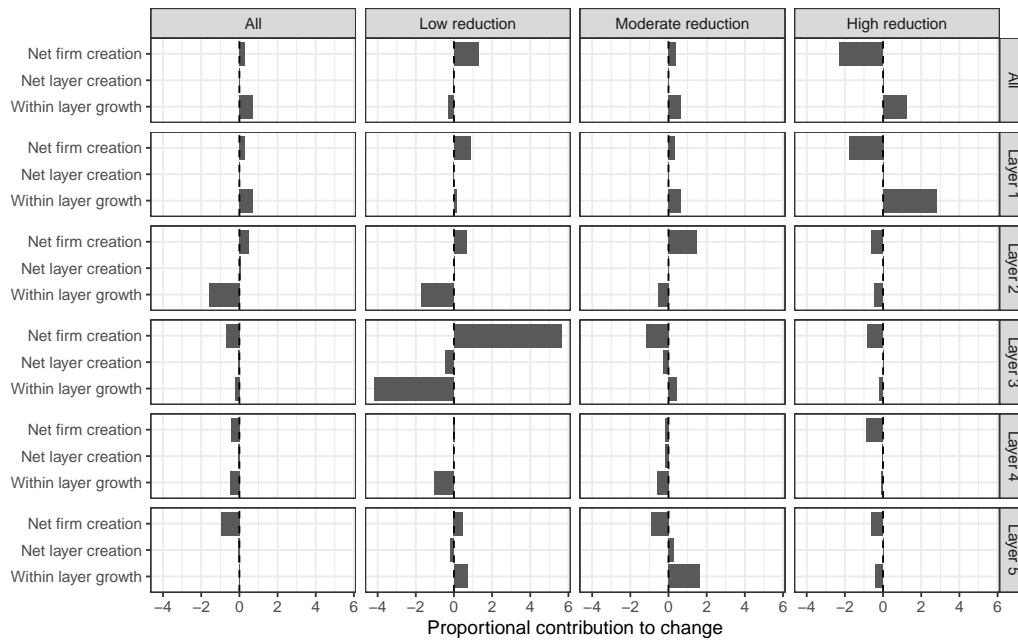
Besides the pyramid's base (Layer 1), intensive margin employment changes were negative for all layers in firms on the *high reduction* group. Meanwhile, intensive margin effects are heterogeneous across the other tariff groups, being positive at the pyramid's extremes but negative for layers in the middle.

Tariff groups differ in the intensive margin (*within layer growth*) only for layer five employment flows (the last line on the figure). Conditioning on having all five levels, firms in industries more affected by liberalization decreased employment in occupations with higher authority, whereas those in sectors less affected increased employment in such occupational group.

This may be an explanation for the regression estimates showing a decrease in managerial demand. The figure has already shown that the addition/subtraction of layers is not a relevant factor for overall employment change in each layer. However, intensive margin movements in the top-level (the last line in the graph) behave differently according to the tariff shock. For firms that did not delete the fifth layer, and given that managers are likely allocated in layer 5, companies on more exposed sectors that kept the previous hierarchical structure shrank the top level, while firms less exposed that maintained five layers increased the last layer's size.

⁴conditioned, by construction, on the firm not deleting the layer altogether

Figure 4.10: Decomposition of employment flows due to layer creation/destruction across tariff groups



Notes: The panels decompose employment flows by layer from 1990 to 1994 into three forces: 1-changes due to entry/exit of firms, 2-changes in employment due to creation or destruction of a layer in existing firms, or changes in employment in a preexisting layer. Each panel presents decomposition for employment in a *layer-tariff group* pair. Measures of employment flows are similar to the ones in figure 4.4.

4.3 How do layers and managers interact?

We now briefly describe how our main outcomes interact with each other. We should expect that they are indeed related, given that managers are thought as members of the top layers. Table 4.10 confirms that firms with more layers employ relatively more managers. This is not news because layers and, according to table 4.2, managerial employment, are associated with larger firm size.

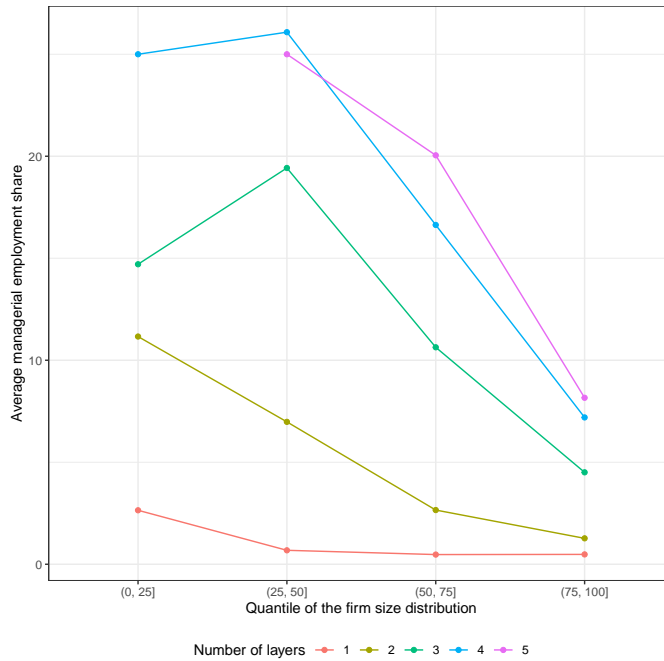
Table 4.10: Quantiles of the managerial share distribution across different number of layers

Number of layers	0%	25%	50%	75%	100%
1	0	0	0	0	100
2	0	0	0	0	100
3	0	0	4.34	10.53	100
4	0	2.86	6.06	11.11	100
5	0	3.86	6.84	10.97	64.52

We explicitly inspect the interaction of layers, managers, and firm size in 4.11, plotting the mean managerial share in each quantile of the firm size

distribution. What we see is exactly what the theory in Caliendo & Rossi-Hansberg (2012) would predict: for a given number of layers, firms grow by adding workers on bottom layers, and hence become flatter. For the most part, we see that firms that belong to the same quantile (same x-coordinate) that have more layers also employ more managers, which is also expected.

Figure 4.11: Average managerial share in employment across the size distribution by number of layers



Notes: Each dot represents the the mean employment share of managers for firms with a given number of layers and part of a certain quantile of the overall size distribution.

5 Empirical strategy

We have shown significant decreases in the relative demand for managers and the average number of layers during Brazil's trade liberalization. We investigate in a causal matter if the tariff shock led to such movements.

It is often hard to talk about causality in international trade. Protection levels may differ across sectors due to unobservable characteristics correlated to the outcomes of interest. For instance, politically more organized sectors may pressure for higher tariffs, or the government may favor opening up better-performing sectors with a comparative advantage. If firms in these industries have higher output-elasticity of demand for managerial labor, our regression estimates would be biased upward, for instance.

The literature on the Brazilian shock is adamant on the exogeneity of the tariff reductions ¹. As argued in a previous section, initial tariff levels almost exclusively determined the tariff cuts, and those levels reflected a structure of protection of the 1950s. Additionally, this was an unexpected shock led by the newly minted government (so that the private sector had little bearing on trade policy), indicating that we are, for the most part, free of the traditional concerns of the trade literature.

Figures 5.1 and 5.2 further assure us that prior trends in economic outcomes are not biasing the identification. The three dispersion plots show that variation from 1985 to 1990 in either total employment, managerial employment or the share of net revenue in the manufacturing sector ² does not correlate with the overall tariff shock that we study. This is an additional confirmation of the validity of parallel trends assumption in differences-in-differences designs.

Since RAIS allows us to track firms over time, regression models with fixed effects enable us to control time-invariant heterogeneity in firms or sectors that would bias our estimates otherwise. In this regard, our research design is a differences-in-differences model with a continuous treatment:

¹See Ferreira & Rossi (2003); Kume et al. (2003); Abreu (2004); Pavcnik et al. (2004); Kovak (2013); Dix-Carneiro (2014); Dix-Carneiro & Kovak (2017); Dix-Carneiro et al. (2018); Dix-Carneiro & Kovak (2019)

²Data on revenue come from Brazil's survey of manufacturing firms, *Pesquisa Industrial Anual* (PIA)

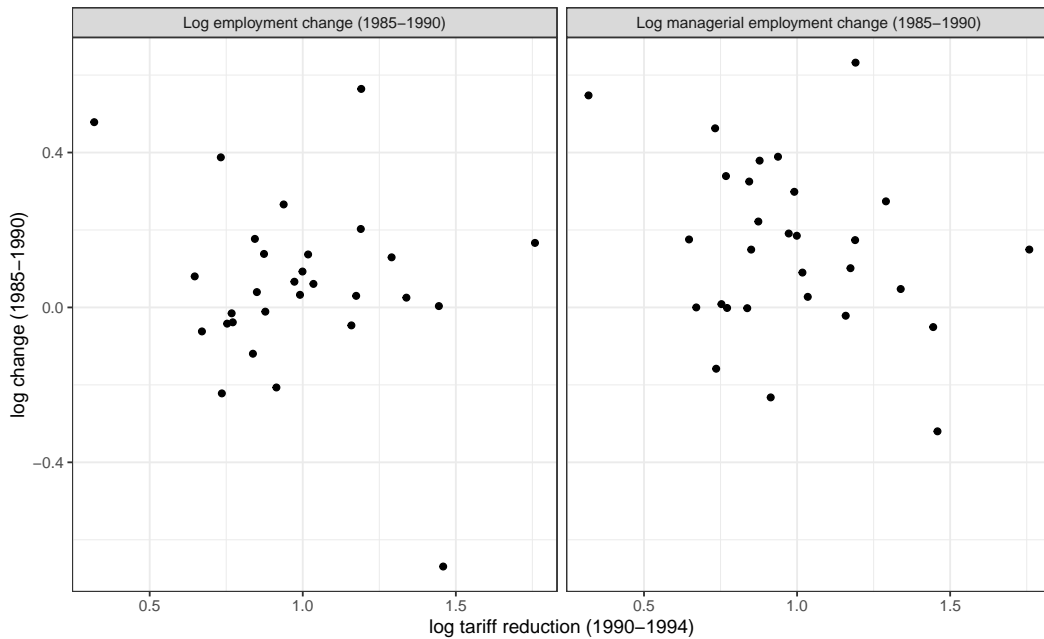
$$y_{ist} = \alpha_0 + \alpha_1 \cdot \mathbb{I}_{1994} + \alpha_2 \cdot \tau_{st} + \beta \cdot \mathbb{I}_{1994} \cdot \tau_{st} + \gamma_i + \epsilon_{ist}$$

y_{ist} is an outcome variable for firm i belonging to sector s in year $t \in \{1990, 1994\}$. Variable \mathbb{I}_{1994} is an indicator variable for the year 1994, τ_{st} is the negative of the tariff level in sector s ³, year t in percentage points. Provided that our identification strategy is valid, coefficient β would be the causal effect of the tariff shock on y . We cluster standard errors at the sectoral level to allow for arbitrary within-sector correlation in y_{ist} . As said before, we follow Dix-Carneiro & Kovak (2017) in restricting the data to one year before the tariff shock and one year after it to avoid the possible endogeneity of the differential timing of cuts across sectors between 1990 and 1994.

Finally, γ_i are firm fixed effects, so on the equation above, we only explore *within-firm* variation in outcomes. However, since the analysis only uses two years of data and not all firms are present on both of them, the inclusion of γ_i would only capture the average variation effects in *survivors*. Although the literature on knowledge-based hierarchies speaks explicitly to a within-firm phenomenon, we have already shown in the previous section that compositional effects matter. Composition effects within sectors mattered insofar as incoming firms differed from the ones leaving. Restricting ourselves to using firm fixed effects would not capture those movements. Thus, we use sector fixed effects, replacing γ_i with λ_s in some regressions and using the entire sample of firms instead of only surviving ones.

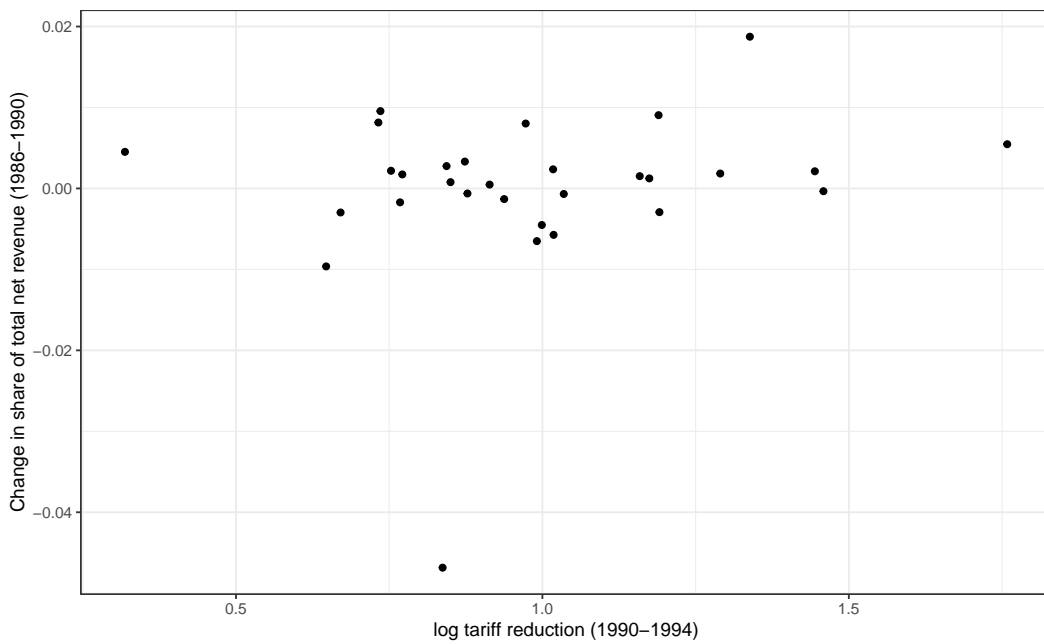
³We use the negative to ease the interpretation of the regression results since tariffs fell in the time frame.

Figure 5.1: Employment changes from 1985-90 and tariff shocks from 1990 to 1994 by industry



Notes: Each graph plots the relation between log employment changes *before the tariff shock* and the tariff shock in each sector. The first panel considers total employment, and the second only managerial employment

Figure 5.2: Share of total revenue changes from 1985-90 and tariff shocks from 1990 to 1994 by industry



Notes: The graph plots the relation between the change in the share of total gross manufacturing revenue *before the tariff shock* and the tariff shock in each sector. Revenue data come from PIA (*Pesquisa Industrial Anual*), Brazil's survey of manufacturing firms

6 Results

6.1 Managers

We start presenting our results for regressions with the share of managers as the outcome variable. Table 6.1 shows the basic results.

Model 1 presents OLS estimates without any fixed effects to control for sector-invariant confounders. Model 2 includes sector fixed effects. Models 3 and 4 include sector and firm fixed effects, respectively, and both consider only firms present in the data on both 1990 and 1994. Tariffs are on percentage points and multiplied by -1 , and the dependent variable is on percentage points, too. Furthermore, the estimate for the interaction coefficient in model 2, for example, implies that a one percentage point *reduction* on tariffs causes a 0.112 percentage point decrease in the share of firms' managerial employment on average.

Firstly, in all models, the coefficient associated with \mathbb{I}_{1994} is significantly negative, reflecting the general decrease in the relative demand for managers from 1990 to 1994, illustrated in the descriptive section.

As evidenced by the significant difference from estimates in model 1 from the rest, we see that it is vital to include fixed effects to deal with unobserved confounders specific to industries or firms. The tariff reduction had a significant adverse effect on managerial employment according to any more credible specifications. The impact is economically meaningful: taking the median tariff reduction (18 p.p.) and the average managerial share in the sample (3.3 %), this would entail an effect of $18 \times \frac{0.112}{3.3} = 61\%$ on average.

Comparing models 2 to 4, we conclude that compositional effects within sectors reinforce the negative shock. Specifications 2 and 3 use the same set of fixed effects but different samples. When the estimation applies only to surviving firms, the interaction's estimate drops, even if it is still significant, indicating that entrant firms employ fewer managers than leavers in reaction to trade liberalization. Moreover, 3 and 4 use the same sample with different sets of fixed effects, the former considering within sector, and the latter within firm variations. Once again, the coefficient drops if we shut down possible

Table 6.1: Main regression results - managers

	<i>Dependent variable: % managerial employment</i>			
	(1)	(2)	(3)	(4)
$-Tariff(\%)$	0.032 (0.029)	-0.048*** (0.015)	-0.026* (0.015)	-0.008 (0.011)
\mathbb{I}_{1994}	-1.290* (0.667)	-1.367*** (0.381)	-1.144*** (0.371)	-1.038** (0.415)
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.034 (0.029)	-0.112*** (0.031)	-0.092*** (0.030)	-0.054*** (0.020)
Firm FE				✓
Sector FE		✓	✓	
Balanced panel			✓	✓
Mean dep. var	3.3%	3.3%	3.6%	3.6%
Observations	273,588	273,588	127,993	127,993
Adjusted R ²	0.003	0.015	0.022	0.346

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Sectors refer to IBGE's *Nível 50* classification.

compositional reactions (even if only between surviving firms).

Table 6.2 presents results from regressions exploring further heterogeneity on firm status (i.e. entrants, leavers, continuing firms). Models 1 and 2 are triple-differences, adding to the previous interaction a dummy equalling one if a firm survived from 1990 to 1994. Specification 3 has the usual interaction but controls for the indicator for surviving firms. Model 4, in turn, adds survival-by-sector fixed effects. We do not exclude leavers and entrants from the sample, while the coefficient does not reflect comparing survivors in a given sector to firms entering the market.

The triple interaction in either model is not significant so that there is no differential effect for survivors. The positive coefficient for *Continuing firm* \times \mathbb{I}_{1994} in both models confirms for the most part what figure 4.4 shows - irrespective of the intensity of the liberalization, managerial employment had a more negative shock on the extensive than on the intensive margins. The differences-in-differences coefficients in models 2 to 4 are similar to their counterparts in table 6.1, giving robustness to our findings. The pattern shown is once again the same - the more we account for firm status, the lower the estimate.

These findings go against what Chakraborty & Raveh (2018) encounter when studying trade liberalization in India, which we somewhat expect. The shock in India was very much focused on input liberalization. Given

Table 6.2: Auxiliar regression results - managers

	<i>Dependent variable: % managerial employment</i>			
	(1)	(2)	(3)	(4)
\mathbb{I}_{1994}	-1.752** (0.753)	-1.878*** (0.494)	-1.359*** (0.378)	-1.383*** (0.368)
$-Tariff(\%)$	0.032 (0.028)	-0.046** (0.017)	-0.047*** (0.015)	-0.045*** (0.014)
<i>Continuing firm</i>	-0.053 (0.328)	-0.009 (0.309)	0.225 (0.126)	
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.025 (0.022)	-0.117*** (0.039)	-0.110*** (0.031)	-0.108*** (0.030)
$Continuing\ firm \times \mathbb{I}_{1994}$	0.883* (0.451)	0.883** (0.423)		
$-Tariff(\%) \times Continuing\ firm$	0.001 (0.009)	0.006 (0.009)		
$-Tariff(\%) \times Continuing\ firm \times \mathbb{I}_{1994}$	0.011 (0.029)	0.012 (0.026)		
Firm FE				
Sector FE	✓	✓	✓	
Balanced panel				
$Survival \times Sector\ FE$				✓
Mean dep. var	3.3%	3.3%	3.6%	3.6%
Observations	273,588	273,588	273,588	273,588
Adjusted R ²	0.003	0.016	0.015	0.016

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Sectors refer to IBGE's *Nível 50* classification. The models in this table explore the interaction of the trade shock with a firm's status (i.e. continuing or leaver/entrant). Models 1 and 2 interact the DiD coefficients with a status dummy. Model 3 controls for status, but without the interaction. Model 4 adds *Nível 50* by status fixed effects.

that managers complement foreign, more modern inputs, their employment increases with greater access to new machines by Indian firms. Meanwhile, our results for Brazil are more similar to Guadalupe & Wulf (2010), showing that greater competition due to trade flattens firms, increasing manager span of control and thus reducing demand for them. We see expect that the mechanism in India does not apply in Brazil: our results go hand in hand what Muendler (2004) finds, that what he calls a "*competitive push*" and "*competitive elimination*" matter much more than a "*foreign input push*" for productivity gains following the liberalization, suggesting that access to new machinery was not as important as in the Indian case. To what extent this is view is consolidated in the Brazilian liberalization literature is not clear - Schor (2004) argue that productivity gains due to tariff reductions are heterogeneous, and that lower input tariffs can matter, too.

6.2 Layers

After studying the demand for professionals typically on the upper part of firms' hierarchies, in this section, we present causal estimates of the impact of trade liberalization on firms' hierarchical structure as a whole.

Table 6.3 has the same structure of table 6.1, with the number of layers in a firm as the dependent variable. The results are not as striking as the previous ones, even though there is still some significance to them - our base model, number 2, states that a tariff shock for the median sector (18 p.p.) would cause a reduction of $18 \times \frac{0.01}{1.8} = 10\%$ in the number of layers for the average firm. Besides, the weakening of the effects from models 2 to 4 highlights the value of controlling for entry and exit. Estimates in the last column are insignificant when we only allow for *within-firm* movements, whereas accounting for reallocation movements within sectors turns on our coefficients. Table 6.4 shows the same pattern of results when we run a linear probability model on the firm's probability of having more than one layer. One is the median value of layers in our sample. Besides, to have more than one means there is some form of hierarchy between workers in the company. On such table, our findings are similar to the previous ones.

In table 6.5, we replicate table 6.2 for layer outcomes, and both show consistent results. Coefficients for the triple interaction are insignificant. The point estimate for models 3 and 4 is much higher than model 2 in table 6.3, which is their counterpart, meaning that controlling for surviving firms' layers is important.

As mentioned in section 2, the nature of Brazil's reform was such that

Table 6.3: Main regression results - layers

	<i>Dependent variable: number of layers in the firm</i>			
	(1)	(2)	(3)	(4)
$-Tariff(\%)$	-0.193 (0.161)	-0.077 (0.057)	-0.097** (0.040)	-0.017 (0.040)
\mathbb{I}_{1994}	0.006 (0.008)	-0.005* (0.003)	0.000 (0.002)	0.001 (0.001)
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.001 (0.010)	-0.010** (0.004)	-0.009* (0.004)	-0.000 (0.002)
Firm FE				✓
Sector FE		✓	✓	
Balanced panel			✓	✓
Mean dep. var	1.80	1.80	2.10	2.10
Observations	273,588	273,588	127,993	127,993
Adjusted R ²	0.003	0.091	0.109	0.779

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Sectors refer to IBGE's *Nível 50* classification.

Table 6.4: Main regression results - Layers II

	<i>Dependent variable: $\mathbb{I}_{n.layers>1}$</i>			
	(1)	(2)	(3)	(4)
$-Tariff(\%)$	-0.062 (0.051)	-0.024* (0.014)	-0.097** (0.040)	-0.017 (0.040)
\mathbb{I}_{1994}	0.002 (0.003)	-0.002* (0.001)	0.000 (0.002)	0.001 (0.001)
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.001 (0.004)	-0.003** (0.001)	-0.009* (0.004)	-0.000 (0.002)
Firm FE				✓
Sector FE		✓	✓	
Balanced panel			✓	✓
Mean dep. var	43.6%	43.6%	55.4%	55.4%
Observations	273,588	273,588	127,993	127,993
Adjusted R ²	0.002	0.052	0.109	0.779

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Sectors refer to IBGE's *Nível 50* classification. The dependent variable is an indicator for the firm having more than one layer. The median value for the number of layers in a firm is one as well.

more protected sectors faced a bigger tariff shock than those with lower baseline protection. Since initial protection and the tariff shock significantly correlated, we cannot interact the treatment effect with initial tariff levels in the regression. In that regard, our estimates may be a lower bound for the actual effect. This is especially true for results on the number of layers. Theoretical work on layers argues that firms reorganize once demand reaches certain thresholds. Given that this is a discontinuous process, it could be that some firms were protected in 1990 to such a degree that even with significant cuts, tariffs, in the end, would still be too high to induce delayering, even if there are adjustments at the margin in managerial demand.

Table 6.5: Auxiliary regression results - Layers

	<i>Dependent variable: number of layers in the firm</i>			
	(1)	(2)	(3)	(4)
\mathbb{I}_{1994}	-0.156 (0.108)	-0.078 (0.052)	-0.059 (0.042)	-0.070* (0.034)
$-Tariff(\%)$	0.004 (0.005)	-0.004 (0.003)	-0.003 (0.002)	-0.002 (0.002)
<i>Continuing firm</i>	0.518*** (0.162)	0.541*** (0.162)	0.522*** (0.048)	
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.001 (0.007)	-0.005 (0.006)	-0.007* (0.004)	-0.006* (0.003)
$Continuing\ firm \times \mathbb{I}_{1994}$	0.033 (0.078)	0.016 (0.066)		
$-Tariff(\%) \times Continuing\ firm$	-0.000 (0.005)	0.002 (0.004)		
$-Tariff(\%) \times Continuing\ firm \times \mathbb{I}_{1994}$	-0.004 (0.009)	-0.004 (0.008)		
Firm FE				
Sector FE		✓	✓	
Balanced panel				
$Survival \times Sector\ FE$				✓
Mean dep. var	1.80	1.80	2.10	2.10
Observations	273,588	273,588	273,588	273,588
Adjusted R ²	0.063	0.142	0.141	0.148

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Sectors refer to IBGE's *Nível 50* classification. The models in this table explore the interaction of the trade shock with a firm's status (i.e. continuing or leaver/entrant). Models 1 and 2 interact the DiD coefficients with a status dummy. Model 3 controls for status, but without the interaction. Model 4 adds *Nível 50* by status fixed effects.

This section's results agree only in part with the theory on hierarchies in Caliendo & Rossi-Hansberg (2012). Their model describes, in essence, a *within-firm* phenomenon, while the evidence shown in this paper says extensive margin movements, rather than on surviving firms, drive the decrease in the average number of layers caused by trade liberalization.

7 Robustness

The evidence presented so far is consistent: trade liberalization had a significant negative impact on managers' demand and firm hierarchies. Besides, one innovation of this work relative to the literature on managerial demand and international trade is that the dataset includes the universe of manufacturing firms and large corporations exposed to foreign competition. However, a potential drawback from this approach is tiny firms not relevant to the economy as a whole may be driving our results. Figure 2 in the appendix stresses that: 78% of firms do not employ any managers, and these represent 19% of total employment in the sample. Since we are not weighing our results, there is a concern that such firms would bias our estimates.

Tables 7.1 and 7.2 address these issues. The first table takes as the base sample firms active in 1990, and either filter out the ones whose share of managers was 0% or 100%. The resulting estimates for the interaction coefficient are still negative and significant. As expected, the time dummy is significantly negative for the set of firms with at least one manager, and the interaction is much stronger in absolute value. The effect for a firm facing the median tariff shock and having the mean share of managers drops from 61% to $18 \times \frac{0.316}{13.1} = 43\%$.

Next, table 7.2 removes from the analysis firms at either extreme of managerial shares and then splits the remaining ones into two groups - above and below the median fraction of managers (8%). Similarly to the previous table, the time dummy is strongly negative for firms above the median.

Strikingly, none of the interaction coefficients are significant. This points again to a compositional movement: our main findings' drive seems to be a substitution of firms above the median for firms below it in industries facing a significant competition shock. Once we split these groups, the impact ceases to exist. To illustrate this, take the median tariff shocks of 18 pp. According to the main results in table 6.1, this would entail a 2.0 p.p. decrease of the managerial share, on average. Such shock would be large enough to make 18% of the firms above the median sample shift to the sample of firms below the median.

To further assure that micro firms do not drive our findings, we restricted

Table 7.1: Robustness tests - Managers - excluding extreme manager shares

	<i>Dependent variable: % managerial employment</i>							
	$\%_{1990} > 0$				$\%_{1990} < 1$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$-Tariff(\%)$	0.019 (0.044)	-0.171* (0.099)	-0.091* (0.050)	-0.052 (0.044)	0.033 (0.027)	-0.012 (0.015)	-0.017 (0.013)	-0.004 (0.011)
\mathbb{I}_{1994}	-7.775*** (1.766)	-9.215*** (2.079)	-6.495*** (1.369)	-6.828*** (1.888)	-0.274 (0.561)	-0.409 (0.319)	-0.668* (0.332)	-0.535 (0.393)
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.141* (0.074)	-0.316** (0.122)	-0.248*** (0.076)	-0.210** (0.088)	0.027 (0.044)	-0.057** (0.023)	-0.067** (0.026)	-0.035* (0.018)
Firm FE				✓				✓
Sector FE		✓	✓			✓	✓	
Balanced panel			✓	✓			✓	✓
Mean dep. var	13.1%	13.1%	10.2%	10.2%	3.1%	3.1%	3.3%	3.3%
Sample	$C + L$	$C + L$	C	C	$C + L$	$C + L$	C	C
Observations	48,883	48,883	37,895	37,895	192,351	192,351	127,389	127,389
Adjusted R ²	0.058	0.077	0.057	0.317	0.002	0.024	0.026	0.338

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Sectors refer to IBGE's *Nível 50* classification.

C = continuing firms, L = leaving firms, E = entrant firms.

our analysis in tables 7.3 and 7.4 to firms with at least five and at least ten workers in 1990. Point estimates are not much different from one another or from the main results, evidencing that firm size is not a relevant source of heterogeneity.

The main innovation of the theory on knowledge-based hierarchies is the discreteness of the firm's problem. To better represent their decision process empirically, we repeat the analysis by estimating ordered probit models instead of linear regressions. Figure 7.1 replicates the specifications in models 1, 2, and 4 in table 6.3, albeit with an ordered probit.

We abstract from reporting the estimated coefficients in such models and instead plot, for each of the three specifications, predicted probabilities of a firm having 1, 2, 3, 4, or 5 layers. We take as a reference point the textile sector, whose corresponding shock was at the median. We then evaluate average probabilities using textile tariffs in 1990 and 1994: 31.8% and 13.2%.

The graph confirms the results using the linear model for each of the three specifications. When considering within-sectoral variation in layer numbers, there is a decrease in the probability of firms having more than one layer and an increase of having only one. On the other hand, using firm fixed

Table 7.2: Robustness tests - Managers - results above and below median manager shares

	<i>Dependent variable: % managerial employment</i>							
	$\%_{1990} \leq median$				$\%_{1990} \geq median$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$-Tariff(\%)$	0.002 (0.007)	-0.011 (0.011)	-0.005 (0.010)	-0.008 (0.012)	0.021 (0.028)	-0.111 (0.084)	-0.078 (0.071)	-0.045 (0.060)
\mathbb{I}_{1994}	0.180 (0.441)	0.117 (0.358)	0.538* (0.305)	0.623 (0.448)	-10.361** (1.540)	-11.177*** (2.040)	-9.155*** (1.904)	-9.115*** (2.664)
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.015 (0.032)	-0.013 (0.030)	-0.001 (0.027)	0.000 (0.030)	0.143 (0.096)	-0.162 (0.140)	-0.160 (0.124)	-0.100 (0.159)
Firm FE				✓				✓
Sector FE		✓	✓			✓	✓	
Balanced panel			✓	✓			✓	✓
Mean dep. var	5.0%	5.0%	4.6%	4.6%	17.5%	17.5%	14.2%	14.2%
Sample	$C + L$	$C + L$	C	C	$C + L$	$C + L$	C	C
Observations	25,307	25,307	18,740	18,740	23,057	23,057	18,676	18,676
Adjusted R ²	0.000	0.012	0.012	0.088	0.141	0.153	0.119	0.270

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the *Nível 50* level. Standard errors clustered at the *Nível 50* level.

C = continuing firms, L = leaving firms, E = entrant firms. The first four models consider observations whose share of managers in 1990 is below the median share (8%) of those whose share is different from 0 or 1. As for the latter four, only observations above the median.

effects, probabilities do not change significantly. These figures confirm previous findings and illustrate that the reduction in the average number of layers came exclusively through more firms having only one layer.

Table 7.3: Robustness tests - Managers - splitting the sample by size

	<i>Dependent variable: % managerial employment</i>							
	5+ ₁₉₉₀				10+ ₁₉₉₀			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$-Tariff(\%)$	0.045 (0.037)	-0.015 (0.012)	-0.018 (0.012)	-0.007 (0.013)	0.046 (0.039)	-0.011 (0.013)	-0.009 (0.013)	0.000 (0.014)
\mathbb{I}_{1994}	-1.019 (0.764)	-1.113*** (0.335)	-0.975** (0.388)	-0.806 (0.517)	-0.974 (0.881)	-1.082*** (0.381)	-1.025** (0.394)	-0.802 (0.563)
$-Tariff(\%) \times \mathbb{I}_{1994}$	0.033 (0.049)	-0.078*** (0.022)	-0.080*** (0.026)	-0.051** (0.023)	0.030 (0.052)	-0.076*** (0.023)	-0.079*** (0.025)	-0.046* (0.026)
Firm FE				✓				✓
Sector FE		✓	✓			✓	✓	
Balanced panel			✓	✓			✓	✓
Mean dep. var	4.2%	4.2%	4.1%	4.1%	4.7%	4.7%	4.6%	4.6%
Sample	$C + L$	$C + L$	C	C	$C + L$	$C + L$	C	C
Observations	104,169	104,169	80,241	80,241	66,176	66,176	53,721	53,721
Adjusted R ²	0.004	0.038	0.039	0.367	0.004	0.048	0.046	0.363

Notes: *p<0.1; **p<0.05; ***p<0.01 Standard errors clustered at the *Nível 50* level. Standard errors clustered at the *Nível 50* level.

C = continuing firms, L = leaving firms, E = entrant firms.

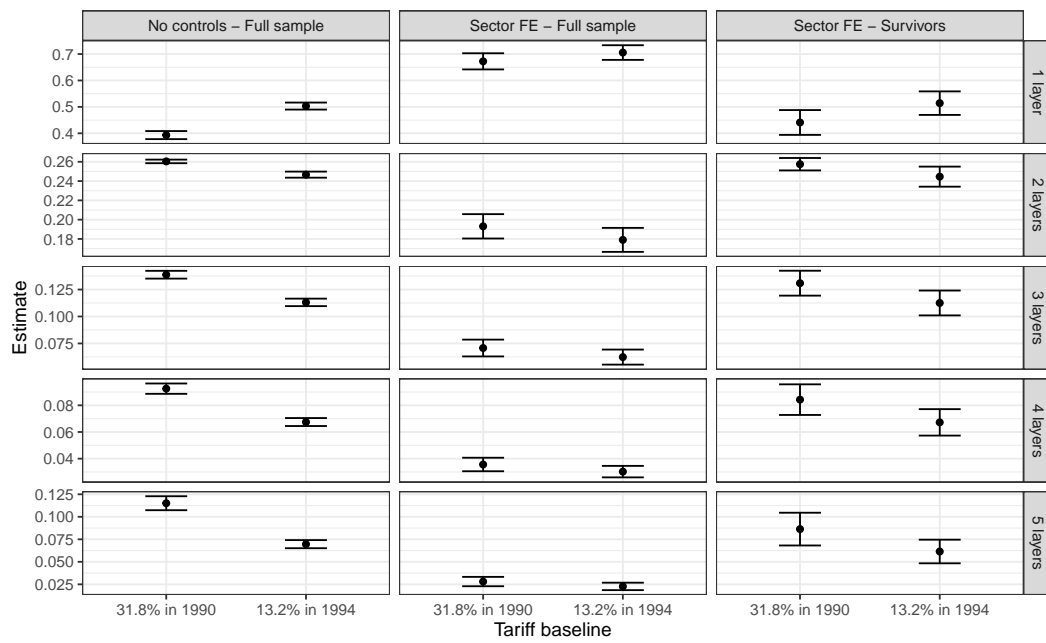
Table 7.4: Robustness tests - Layers - splitting the sample by size

	<i>Dependent variable: number of layers in the firm</i>							
	5+ ₁₉₉₀				10+ ₁₉₉₀			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$-Tariff(\%)$	-0.171 (0.188)	-0.127*** (0.044)	-0.200*** (0.042)	-0.100** (0.043)	-0.210 (0.211)	-0.181*** (0.038)	-0.225*** (0.036)	-0.125*** (0.044)
\mathbb{I}_{1994}	0.009 (0.011)	0.000 (0.002)	0.001 (0.002)	0.002 (0.002)	0.009 (0.012)	0.001 (0.002)	0.002 (0.002)	0.002 (0.002)
$-Tariff(\%) \times \mathbb{I}_{1994}$	-0.002 (0.018)	-0.012*** (0.004)	-0.009** (0.004)	-0.001 (0.002)	0.002 (0.018)	-0.010*** (0.003)	-0.008** (0.003)	0.000 (0.003)
Firm FE				✓				✓
Sector FE		✓	✓			✓	✓	
Balanced panel			✓	✓			✓	✓
Mean dep. var	2.52	2.52	2.59	2.59	2.98	2.98	3.02	3.02
Sample	$C + L$	$C + L$	C	C	$C + L$	$C + L$	C	C
Observations	104,169	104,169	80,241	80,241	66,176	66,176	53,721	53,721
Adjusted R ²	0.004	0.126	0.124	0.753	0.005	0.128	0.127	0.721

Notes: *p<0.1; **p<0.05; ***p<0.01 Standard errors clustered at the *Nível 50* level. Standard errors clustered at the *Nível 50* level.

C = continuing firms, L = leaving firms, E = entrant firms.

Figure 7.1: Robustness - Estimated predicted probabilities of the number of layers of firms



Notes: The columns replicate models 1, 2, and 4 in table 6.3 by estimating an ordered probit on the number of layers. Each row plots average predicted probabilities of firms' having each number of layers. We consider 95% confidence intervals and robust standard errors. Predicted probabilities are evaluated at tariff levels in 1990 and 1994 for the textile sector, which experienced the median tariff reduction.

The competitive environment faced by firms alters their optimal production scale and, in turn, affects their structure. How firms organize production has important implications for knowledge accumulation of workers and compensation levels, all of which may reflect in productivity growth.

This paper bridges two pieces of the literature dealing with firm organization: managerial demand and knowledge-based hierarchies. We have presented causal evidence that increased exposure to import competition induces firms, on average, to employ fewer managers and to have fewer hierarchical layers. Base results show that the median tariff shock during Brazil's liberalization leads to a 60% and a 10% reduction in managers and the number of layers. These estimates are lower once we include firm fixed effects in regressions rather than sectoral fixed effects. The literature on organization and competition focuses on within-firm analysis to shed light on a new mechanism through which trade influences organization: alterations of firms' patterns of entry and exit. Previous work had not evaluated both forms of restructuring within the same policy setting, and we have shown that adjustments on layers are less significant than on managerial employment.

There is still research to be done on the topic. Availability of data on outputs and inputs at the firm level would allow researchers to evaluate this reallocation movement's aggregate productivity effects. Even if the model in Caliendo & Rossi-Hansberg (2012) predicts heterogeneous responses in productivity after bilateral liberalization, and that the evidence in Caliendo et al. (2020) says decreasing layers decreases quantity-based TFP, this may not be true on the aggregate. Changes in entry and exit profiles may be such that leaving firms were less productive and had more layers than firms entering the market after the shock for reasons other than organization.

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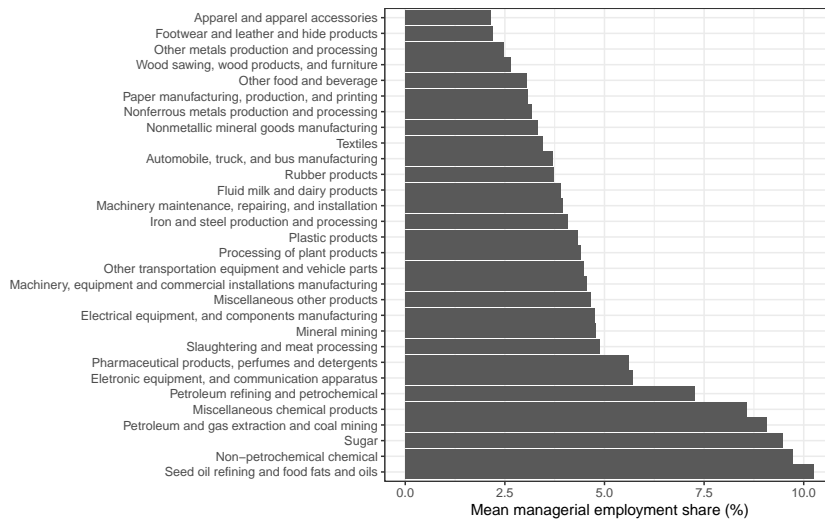
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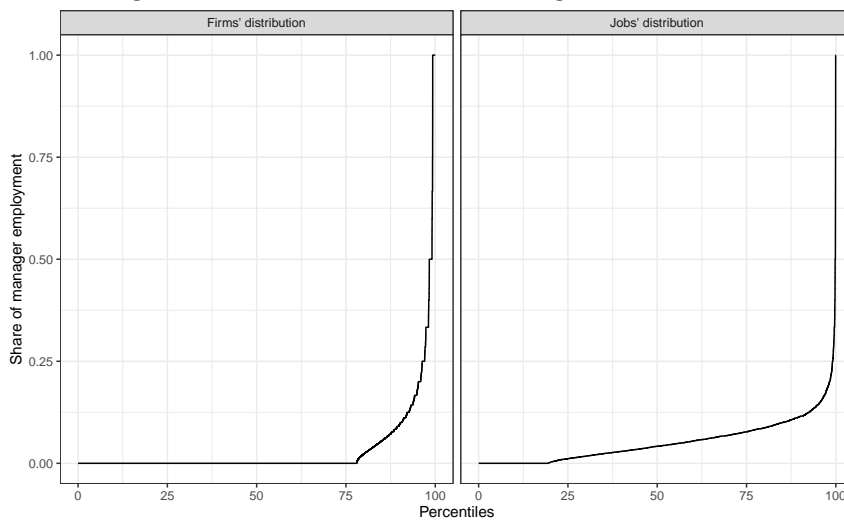
A Appendix

Figure A.1: Average manager shares across sectors



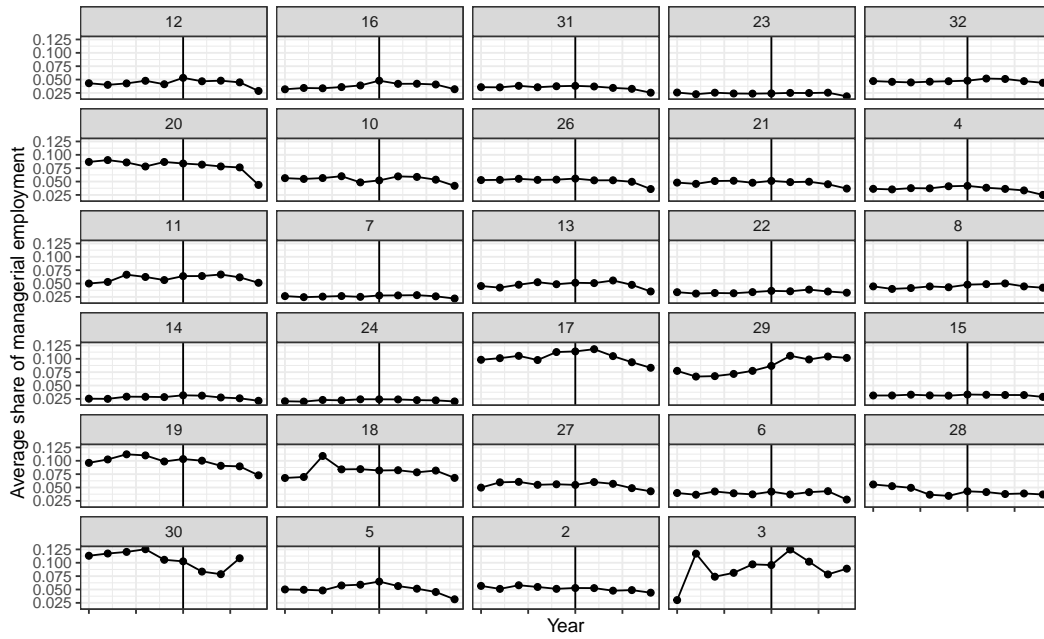
Notes: Average manager shares in employment in firms across industries

Figure A.2: Distribution of manager shares across firms



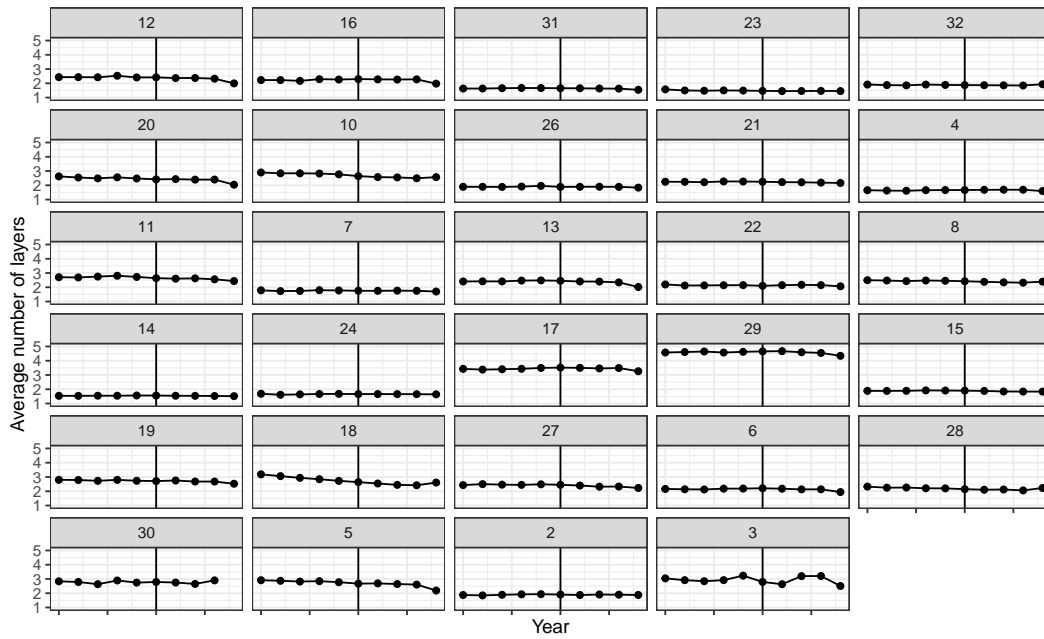
Notes: Distribution of manager shares in employment in 1990 - Considering either each centile as 1% of jobs or as 1% of firms

Figure A.3: Average manager shares in firms by industries across time



Notes: Sectors ordered in descending tariff reduction order

Figure A.4: Average number of layers in firms by industries across time

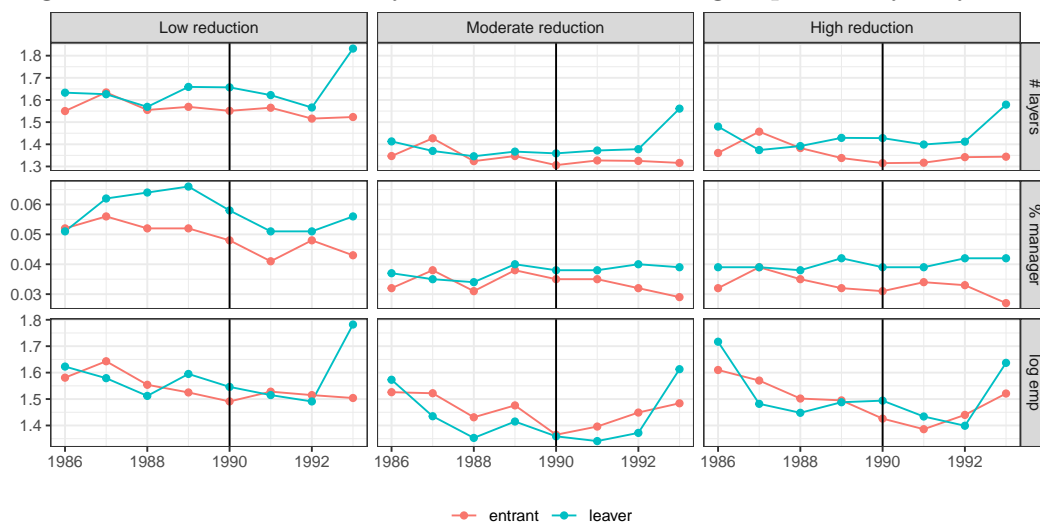


Notes: Sectors ordered in descending tariff reduction order

Table A.1: *Nível 50* manufacturing sectors description and nominal tariff rates (%)

Code	Industry name	1987	1990	1994
2	Mineral mining (except combustibles)	43.0	5.9	3.2
3	Petroleum and gas extraction and coal mining	22.0	9.6	1.5
4	Nonmetallic mineral goods manufacturing	15.6	3.3	0.0
5	Iron and steel production and processing	63.8	31.5	9.2
6	Nonferrous metals production and processing	29.9	14.5	6.3
7	Other metal products manufacturing	35.0	17.6	7.6
8	Machinery, equipment and commercial installations manufacturing (including parts)	60.8	34.8	14.3
9	Machinery maintenance, repairing and installation	49.0	37.2	19.0
10	Electrical equipment and components manufacturing	65.4	44.1	18.4
11	Electronic equipment and communication apparatus	54.1	40.6	19.0
12	Automobile, truck and bus manufacturing	92.6	78.7	19.9
13	Other transportation equipment and vehicle parts	61.7	37.4	17.4
14	Wood sawing, wood products and furniture	50.0	25.4	8.8
15	Paper manufacturing, publishing and printing	59.5	23.6	8.3
16	Rubber products	82.0	46.6	12.1
17	Non-petrochemical chemical	63.0	24.8	8.5
18	Petroleum refining and petrochemical	31.6	19.4	5.2
19	Miscellaneous chemical products	25.4	21.8	7.1
20	Pharmaceutical products, perfumes and detergents	72.3	31.5	4.6
21	Plastics products	56.6	39.0	15.7
22	Textiles	87.4	31.8	13.2
23	Apparel and Apparel Accessories	102.7	51.1	19.4
24	Footwear and Leather and Hide Products	74.1	29.6	13.2
25	Coffee	69.1	28.9	9.8
26	Processing of Plant Products (including tobacco)	70.3	34.6	10.0
27	Slaughtering and Meat Processing	43.7	19.7	7.3
28	Fluid Milk and Dairy Products	69.2	32.7	23.5
29	Sugar	77.5	25.7	10.1
30	Seed Oil Refining and Food Fats and Oils	48.5	16.6	8.0
31	Other Food and Beverage	73.8	45.0	13.0
32	Miscellaneous Other Products	53.2	41.6	14.4

Figure A.5: Patterns of entry and exit across tariff groups in an yearly basis



Notes: Each dot on a given year shows the mean value for the outcome for firms that enter/leave the market on such year. Note that this implies a different universe of firms from the main analysis.

Table A.2: Total employment flows - decomposition

Firm Group	Tariff reduction	ΔL_k	$\frac{\bar{L}_k}{\sum \bar{L}_k}$	$\Delta L_k \cdot \frac{\bar{L}_k}{\sum \bar{L}_k}$	$\frac{\Delta L_k}{\Delta L} \cdot \frac{\bar{L}_k}{\sum \bar{L}_k}$
All		0,056	1,000	0,056	1,000
Entrants	low	2,000	0,027	0,054	0,959
	moderate	2,000	0,062	0,125	2,215
	large	2,000	0,048	0,096	1,705
Leavers	low	-2,000	0,019	-0,038	-0,684
	moderate	-2,000	0,053	-0,105	-1,869
	large	-2,000	0,058	-0,116	-2,058
Continuing	low	-0,034	0,146	-0,005	-0,087
	moderate	0,100	0,348	0,035	0,619
	large	0,047	0,239	0,011	0,199

Notes: The table presents numerically the results in figure A.3. The third column shows the ratio between the variation and the mean level of employment. The fourth shows the share of the group in average employment. Next, there is the product of the previous ones (i.e contribution of each group in terms of ΔL). Finally, column six displays proportionate contributions.

Table A.3: Managerial employment flows - Decomposition

Firm Group	Tariff reduction	ΔL_k	$\frac{\bar{L}_k}{\sum L_k}$	$\Delta L_k \cdot \frac{\bar{L}_k}{\sum L_k}$	$\frac{\Delta L_k}{\Delta L} \cdot \frac{\bar{L}_k}{\sum L_k}$
All		-0,107	1,000	-0,107	1,000
Entrants	low	2,000	0,030	0,060	-0,559
	moderate	2,000	0,048	0,095	-0,889
	large	2,000	0,037	0,073	-0,686
Leavers	low	-2,000	0,026	-0,052	0,482
	moderate	-2,000	0,057	-0,115	1,072
	large	-2,000	0,059	-0,118	1,099
Continuing	low	-0,158	0,182	-0,029	0,268
	moderate	-0,023	0,326	-0,007	0,069
	large	-0,065	0,236	-0,015	0,143

Notes: The table presents numerically the results in figure A.3. The third column shows the ratio between the variation and the mean level of employment. The fourth shows the share of the group in average employment. Next, there is the product of the previous ones (i.e contribution of each group in terms of ΔL). Finally, column six gives proportionate contributions - note that since in the aggregate $\Delta L < 0$, a positive value shows the contribution to the *decrease* in L , and vice-versa

Table A.4: % of jobs in firms with hierarchical layers in terms of jobs

	$N_l \geq N_{l+1} \forall l$	$N_1 \geq N_2$	$N_2 \geq N_3$	$N_3 \geq N_4$	$N_4 \geq N_5$
2 layers	95.4	95.4			
3 layers	83.3	95.4	87.6		
4 layers	61.2	95.0	85.2	78.0	
5 layers	35.0	96.7	71.1	92.0	65.2
Any	50.2	96.1	67.2	70.8	42.2

Notes: N_l refers to employment level N on layer l . Each row considers firms with a given number of organizational layers.

Table A.5: % of jobs in firms with hierarchical layers in terms of average monthly wages

	$w_l \leq w_{l+1} \forall l$	$w_1 \leq w_2$	$w_2 \leq w_3$	$w_3 \leq w_4$	$w_4 \leq w_5$
2 layers	59.2	59.2			
3 layers	49.4	63.7	82.3		
4 layers	43.5	69.5	86.2	78.6	
5 layers	50.5	74.9	95.5	81.1	90.1
Any	50.3	71.3	82.7	63.8	58.3

Notes: w_l refers to average monthly wage level w in December on layer l . Each row considers firms with a given number of organizational layers.