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"Entry Deregulation, Firm Organization and Wage Inequality"

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Entry Deregulation, Firm Organization and Wage Inequality[*]

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Abstract

This paper identifies a causal link between changes in product market competition, firm reorganization and within-firm wage inequality. We exploit a unique episode of comprehensive firm entry deregulation as a quasi-natural experiment and use exceptionally detailed linked employer-employee data for the universe of private sector firms and workers. We find that following deregulation affected firms flatten their hierarchies: the number of layers is reduced and managers' spans of control increased. Dropping a hierarchy layer is accompanied by a significant reduction in wage inequality within the firm, by 10% for the average pay ratio between the top and the bottom layer, showing that there are real changes arising from firm reorganization. Overall dispersion is also reduced. We discuss mechanisms and interpretations for these changes.

Key Words: Firm entry deregulation, Hierarchical layers, Internal organization, Product Market Competition, Span of control, Wage Inequality.

JEL Classification Numbers: L22, L23, M12, J31.

1 Introduction

The production of any good requires time, knowledge, and collaboration between individuals and teams. Recent theories have focussed on organizations taking the form of "knowledge hierarchies", where production workers deal with routine tasks and experts specialize on giving directions to solve more complex problems.[1] The organizational choice for a firm is to determine the structure of the hierarchy, given by the number of layers of increasing knowledge and the span of control of experts. Firms tend to change the organization of production in response to shocks, such as deregulation and international trade. Increased competition and uncertainty may induce firms to significantly change their hierarchical structure. The restructuring is then expected to affect wage inequality within firms, as knowledge requirements change across the hierarchy.

Recent research has emphasized the role of hierarchies and organizational practises in explaining firm growth and productivity, and the distribution of wages (e.g., Garicano and Rossi-Hansberg, 2006; Caliendo and Rossi-Hansberg, 2012; Caliendo et al., 2015). However, there is still limited evidence on what causes firm reorganization, and particularly how competition shocks affect within-firm wage inequality as firms adjust by re-organizing production.

This paper studies how increased domestic product market competition induces firms to change their internal organization and how this change affects wage inequality. We investigate the effect of entry deregulation on the structure of a firm's hierarchy, particularly the number of layers and the average span of control of managers. We also study how these changes affect the distribution of wages within the firm and wage inequality. An important contribution of our paper is to identify a causal link between changes in competition in the domestic product market and firms' organizational change and wage inequality. To do so, we exploit a unique episode of comprehensive firm entry deregulation across industries as a quasi-natural experiment, and use exceptionally detailed employer-employee linked data for the universe of private sector firms and all of their workers.

Our main findings are that increased domestic competition leads firms to flatten their hierarchies: they reduce the number of layers and increase managers' spans of control. In addition, wage inequality between managers and workers decreases, and the pay and career transitions of individual workers are also affected, showing that there are real changes arising from firm reorganization.

To identify the causal effect of increasing domestic competition on organizational change and inequality, we exploit an exogenous change in entry barriers. We use the "On the Spot Firm" program, implemented in Portugal from 2005 to simplify business registration, as a natural experiment. The program created government offices ('one-stop shops') where entrepreneurs

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[1] See, e.g., Garicano (2000) and Garicano and Rossi-Hansberg (2006). Garicano and Rossi-Hansberg (2015) provide a review of the literature on knowledge-based hierarchies.

can register a new firm in a single visit, while prior to the reform it took 78 days on average, and the requirement to complete numerous procedures and forms, involving visits to several different public offices. The the fees were also reduced from 13.5 to 3% of GDP per capita in the "On the Spot Firm" offices. The reform was implemented in different municipalities over time randomly, and by the end of 2009, 164 municipalities had a one-stop shop, as shown in Figure 1. The initiative was hugely successful, resulting in a significant increase in firm entry. Portugal is now among the countries where starting-up a business is fastest in the world.[2]

We use the roll out of the "On the Spot Firm" program, the cross municipality-time variation in adoption, to cleanly identify the effect of increased competition on firms' corporate hierarchies and pay structure. To study firm's internal organization and wages, we use comprehensive employer-employee linked data, which tracks each firm and each employee over time. The data has unusually rich and detailed information on workers' characteristics, such as gender, age, education, skill level, occupation, experience, type of contract of employment, hours of work and earnings. We measure changes in organization using hierarchical occupations to define four layers of increasing knowledge and responsibility in the firm, following recent literature (e.g., Caliendo et al., 2015). The data also has information on the firms' industry, location, employment, number of establishments, sales volume, and legal and ownership structures.

Theories of knowledge-based and incentive-based hierarchies emphasize a positive relationship between production scale and the optimal number of layers (Caliendo and Rossi-Hansberg, 2012; Chen, 2017). An additional management layer is costly but it reduces marginal costs as worker productivity increases, through problem solving assistance or increased monitoring, respectively. Thus, adding a layer is profitable if the firms' production increases sufficiently. Similarly, a reduction in production scale may induce firms to drop layers. Since the "On the Spot Firm" program reduced entry barriers, as new firms enter the market, it is anticipated that firm-level output and sales decrease. This could induce firms to reorganize production.[3]

We show that the reform significantly increased firm entry within industries and municipalities and it reduced firm-level sales and output of affected incumbents. We find that after the reform firms changed the structure of the hierarchy. In particular, our estimates show that the depth of the hierarchy, measured by the number of layers, is significantly reduced and the span of control of top and middle managers increased after the "On the Spot Firm". The effects are largest for firms with three and four layers prior to the reform. In particular, top-managers' spans increased by 18 and 12% respectively, relative to the sample means. The data that we

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[2] As a result of the "On the Spot Firm", Portugal rose from 113th to 26th in the World Bank "Ease of Doing Business" ranking of countries and was considered top reformer in business entry in the Doing Business report.

[3] Knowledge-based hierarchy models also emphasize the trade-off between having more layers to economize on knowledge acquisition but experiencing higher communication costs, and having fewer layers but higher costs of knowledge acquisition. Increased product market competition may induce firms to add layers to screen problems. On the other hand, more layers may slow down the speed of communication and response times. Whether competition induces firms to become flatter is an empirical question that we shed light on.

use allow us to obtain estimates that control for observed firm characteristics, as well as for unobserved firm specific heterogeneity. The fact that adoption of the reform varied across municipalities and time allows us to control for municipality-specific and time-specific effects in our specifications. Our findings show that the increased firm entry induced by the reform led to organizational restructuring by firms, reducing the depth and increasing the span of the hierarchy.

We find that wage inequality decreased after the reform for affected firms. In particular, the reduction in hierarchical layers is accompanied by a 10% reduction in the ratio of average pay of the top to the bottom layer within firms, and 12% across firms, relative to the sample average ratio. We also estimate a 9% reduction in the 90-10 percentile ratio and a 6% decrease in the 90-50 wage gap within the affected firms that reorganize. These results are consistent with knowledge-based and incentive-based hierarchy theories, where reducing the number of layers in the hierarchy affects the wage distribution and inequality as the distribution of knowledge and incentives change across the organization.

Finally, we assess individual-level pay and career transitions, before and after the reform, to paint a more detailed picture of firms' changes in organizational and wage structures in response to the policy change. We find that workers in all layers are more likely to exit the affected firms and are less likely to be promoted, within the firm or across firms. Individuals in top management are also more likely to be demoted, e.g., to a position in the middle-manager layer. The flattening of firms' hierarchies induced by the reform can therefore have lasting consequences on the career paths of individual workers. Consistent with higher spans of control, individual pay of top and middle managers increased after the reform, controlling for observed and unobserved workers' skills. This suggests increased decision-making by top and middle managers (Athey and Roberts, 2001; Prendergast, 2002). The pay of workers in the bottom layer is also found to have increased.

Our results are related to Guadalupe and Wulf (2010), who show that competition from international trade liberalization, following the Canada-US free trade agreement, leads to flatter firm hierarchies. Our analysis focusses on increased domestic competition, from an exogenous shock to entry barriers. As such, we provide independent evidence of the importance of greater product market competition on firm reorganization. Additionally, our detailed employer-employee data allows us to go further in investigating the real effects of organizational change following a competition shock, particularly the distribution of wages within the firm as well as individual pay and career advancement. In that respect, our paper is related to recent research by Friedrich (2020), who uses data for Danish firms to show that trade shocks affect wage inequality through changes in firm hierarchies. We present new evidence of a causal effect of increased domestic firm entry following entry deregulation on firm organizational restructuring and reduction in within-firm wage inequality.

Our paper also contributes to the literature that has used theories of knowledge-based hierarchies to understand economic phenomena such as firm productivity, wage inequality, and the gains from trade liberalization (e.g., Caliendo and Rossi-Hansberg, 2012). Caliendo et al. (2015) show that reorganization within French firms, through changes in hierarchical layers of workers, is important to understand how firms grow and contract and the evolution of wages and employment in each layer, as predicted by the theory. A related literature focusses on incentive-based hierarchies, where supervisors, in higher layers, incentivize workers to exert more effort by increased monitoring of subordinates (see Chen, 2017; Chen and Suen, 2019).

Previous studies investigate the effect of product market and entry regulation on labor market outcomes. Notably, Bertrand and Kramarz (2002) show that entry regulation in the retail sector increased retailer concentration and slowed down employment growth in France. Blanchard and Giavazzi (2003) develop a macroeconomic model to study distribution effects of product and labor market deregulation; the entry of new firms reduces mark-ups thus increasing the probability of unemployment for workers employed in incumbent firms, even if overall unemployment falls. Finally, our paper contributes more generally to a literature on within-firm wage inequality. Mueller et al. (2017) show that firms with higher pay inequality between top- and bottom-level jobs have higher valuations and stronger operating performance. Song et al. (2019) document the rise in earnings inequality between workers in the US and show that the rise in within-firm inequality occurred mostly within large firms.

The rest of the paper is organized as follows. The next section describes the "On the Spot Firm" quasi-natural experiment. Section 3 describes the data used and presents descriptive statistics. Section 4 documents stylized facts about the relationship between firm scale, organization and wage inequality. In section 5 we outline the empirical strategy. Section 6 presents and discusses the results on the effect of the policy change on firm creation, production scale, changes in the firm hierarchical structure as well as on wage inequality within the firm. The last section concludes.

2 Natural experiment for product market competition: the "On the Spot Firm" reform

In this section we describe the natural experiment for product market changes that we exploit in this paper: the "On the Spot Firm" reform. In March 2005 a new elected government took office in Portugal, and in the following May, the government introduced the "On the Spot Firm" program to reform business registration and reduce the cost and bureaucracy of starting a firm. The objective was to encourage national and foreign investment. Prior to the reform, to register a new firm in Portugal, an entrepreneur had to visit multiple separate public offices, of the Ministries of Justice, Finance, Economy and Labor and Social Security, to obtain the

necessary documents and approvals, and was required to complete 20 forms and 11 procedures. The process took on average 78 days and the fees were equivalent to 13.5% of GDP per capita.

In May 2005, the Ministry of Justice announced the "On the Spot Firm" program (Empresa na Hora), which was coordinated by the newly created Agency for Administrative Modernization.[4] The program was implemented in cooperation with various ministries to improve the efficiency of public services and reduce the red tape associated with setting up a new firm. The program makes it possible to register a company in a single office – a 'one-stop shop' – in a single visit. The entrepreneurs no longer need to obtain in advance a certificate of company admissibility from the National Registry of Companies or to sign a public deed. During the simplified process, the company identification card and social security number are handed over, and the company receives its memorandum and articles of association, as well as an extract of the entry in the Commercial Register. All of the details are then sent to the tax authorities.[5]

The business registration reform was unannounced and unanticipated. The program introduced the one-stop shops, which are non-profit seeking government offices, where entrepreneurs can register a company at a single office desk in less than an hour. The fees were reduced to 3% of GDP per capita, below the OECD average of 6.8%.[6] Resource constraints and uncertainty about its success meant that the "On the Spot Firm" was not introduced simultaneously in all municipalities. In July 2005 four pilot one-stop shops were opened in the municipalities of Coimbra, Aveiro, Barreiro and Moita.[7] The program was then expanded over time to municipalities across the country. By the end of 2009, 164 municipalities had a one-stop shop. Figure 1 shows the geographical dispersion and opening dates of the one-stop shops across Portugal. As the Figure shows, the program was progressively rolled-out randomly across municipalities over time. Our analysis exploits this cross-municipality-time-specific variation in the implementation of the "On the Spot Firm" program to identify the effect of the resulting increase in competition on firms' internal organization.[8]

The policy was very successful in simplifying business registration. After the reform, the average number of days, procedures, office visits and costs in fees were significantly reduced for entrepreneurs. The reform also significantly increased the number of new firms created. Portugal is now one of the fastest countries in the world in starting-up a business, and was

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[4]http://www.empresanahora.mj.pt/ENH/sections/EN_homepage.html

[5]State-owned firms or firms in industries with industry-specific requirements or permits are not allowed to be registered in the one-stop shops of the "On the Spot Firm" program. These are mainly in the finance, insurance and transportation sectors. We exclude observations in these industries from our analysis.

[6]World Bank (2006).

[7]Administratively, Portugal is divided into 308 municipalities which are the seat of local administrative and executive power.

[8]In previous work we discuss further the exogenous nature of the reform and its implementation, and the fact that the rollout of the program is unrelated with the political affiliation of the municipality chief executive. We also show that there are no statistically significant pre-reform differences in firm entry and other economic outcomes between municipalities that introduce the policy in the first two years and those that do so in subsequent years, supporting our identification (Fernandes et al., 2014, 2018).

considered top reformer in business entry in the World Bank Doing Business report.

3   Data description

The main dataset used in this paper is the Portuguese longitudinal linked employer-employee data *Quadros de Pessoal* (QP), which covers virtually the universe of private sector firms and all of their employees. The data are collected annually, since 1985, by the Portuguese Ministry of Labor and Social Solidarity. Response to the survey is legally mandatory for all private sector firms with at least one registered employee, and the survey has to be publicly available for consultation. Those two requirements ensure coverage and accuracy of the data. Each firm and each worker are assigned a unique identification number in the data, and can therefore be traced over time. The reference month for the data is October since 1994.

The data has comprehensive and uniquely detailed information on firms and workers, including the firm's employment, sales volume, industry, location, number of establishments, age, legal structure and ownership structure (equity breakdown among domestic private, public or foreign). Worker-level information includes demographic characteristics, such as gender, age, level of education, and level of qualification; job characteristics, including occupation, type of contract of employment, job tenure, promotions, hours of work, and components of compensation: wage, seniority payments, regular and irregular benefits and overtime pay.

Importantly for our analysis, in addition to the workers' occupation (according to the International Standard Classification of Occupations, ISCO), it is also mandatory to classify workers in levels of qualification, which are defined by Law. These levels categorize workers according to the complexity, responsibility and skill requirement of the tasks they perform, and reflect layers of increasing knowledge and skills within the firm.[9] We use this information on the level of qualification of each worker to define four hierarchical layers in the firm: layer 3 includes "Top executives (top management)", layer 2 includes "Intermediary executives (middle management)" and "Supervisors and team leaders"; layer 1 includes "Higher-skilled professionals" and some "Skilled professionals";[10] and layer 0 the remaining workers, including some "Skilled professionals", "Semi-skilled professionals", "Non-skilled professionals" and "Apprentices, interns and trainees", these categories are typically production workers.

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[9]The eight levels of qualification defined in the Law Decree no. 121/78 of July are the following: 1 – Top executives (top management); 2 – Intermediary executives (middle management); 3 – Supervisors, team leaders and foremen; 4 – Higher-skilled professionals; 5 – Skilled professionals; 6 – Semi-skilled professionals; 7 – Non-skilled professionals; 8 – Apprentices, interns and trainees. Appendix Table A.1 describes in detail the hierarchical levels and their skill content in accordance with the law; see also Fernandes et al. (2014).

[10]We include in layer 1 "Skilled professionals" with average pay larger or equal to the median pay of "Higher-skilled professionals".

Our analysis covers the period from 2002 to 2009 and includes manufacturing and services firms (46 industries at the 2-digit SIC classification). The full employer-employee sample includes 433,384 distinct firms (contributing with 1,846,277 firm-year observations) over the period.[11] To study the effect of increased product market competition on firm organization, we will focus on several outcomes: the number of hierarchical layers within the firm, the average span of control of managers and other top layers, layer-level employment, and measures of wage inequality within the firm. We also assess the effect of the reform on firm production scale, measured by the firm's sales volume, output and employment.

For the results on workers' compensation, we obtain the worker's monthly pay by summing the monthly base pay (wage for the normal hours of work), tenure related payments, and regular, irregular, and extraordinary benefits. The monthly pay is deflated to obtain real pay. We then obtain each worker's (real) hourly pay by dividing the (real) monthly pay by total hours of work.

Our specifications control for observable firm characteristic including the firm's size, age, ownership type (private, public or foreign), whether the firm is multi-plant and whether the firm is an exporter. Information on exporters is obtained by merging the employer-employee data with data from the International Trade data set collected by the Portuguese National Institute of Statistics. We also account for industry and municipality unobserved heterogeneity and for aggregate shocks, common to all firms. Table 1 reports summary statistics of firm-level variables, for the full sample as well as by firms' number of layers prior to the reform. Individual-level specifications control for observed workers' characteristics, gender, age, tenure, education, and type of contract, as well as for unobserved heterogeneity.

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[11]The final estimation sample is smaller due to missing data for some variables.

Table 1: Summary statistics

Variables	All firms (1)	Pre-reform number of layers:			
		1 layer (2)	2 layers (3)	3 layers (4)	4 layers (5)
ln(real sales)	11.989	11.379	12.152	13.183	14.636
ln(employment)	1.321	0.765	1.502	2.265	3.412
ln(hourly pay)	1.156	1.097	1.161	1.278	1.365
No. of Layers	1.766	1.186	1.960	2.730	3.633
ln(employment)					
Layer 3	0.329	0.200	0.264	0.405	0.891
Layer 2	0.491	0.167	0.248	0.474	1.161
Layer 1	0.787	0.266	0.445	0.813	1.684
Layer 0	0.948	0.563	0.942	1.523	2.533
ln(mean hourly pay)					
Layer 3	1.965	1.579	1.698	2.057	2.419
Layer 2	1.703	1.432	1.539	1.753	1.987
Layer 1	1.760	1.660	1.711	1.775	1.885
Layer 0	1.113	1.043	1.118	1.240	1.344
Span of control (empl layer below/layer)					
Layer 3	2.192	-	2.261	2.115	2.286
Layer 2	3.514	-	3.283	3.807	3.465
Layer 1	4.743	-	3.530	4.574	6.418
Top-bottom-layer hourly pay ratio	1.538	-	1.500	2.081	3.104
Standard deviation of hourly pay	1.893	-	1.590	2.604	4.237
90-10 hourly pay ratio	1.739	-	1.864	2.533	2.941
90-50 hourly pay ratio	1.388	-	1.465	1.799	1.998

Own calculations based on Portugal's LEED, MTSS (2002-2009). The table reports averages of the variables.

4   Stylized facts: Firm scale, organization and wage inequality

In both knowledge-based and incentive-based hierarchy models, the optimal number of layers is positively related to production scale (Caliendo and Rossi-Hansberg, 2012; Chen, 2017). Adding a layer of management is costly but it reduces marginal costs by increasing worker's productivity, through either more problem solving or more intensive monitoring, respectively. As a result, adding a layer is profitable if the firms' production increases sufficiently. Similarly, a reduction in firm scale may induce firms to drop a hierarchical layer. Since the "On the Spot Firm" program we analyze implies an increase in competition through a reduction in barriers to firm entry, as new firms enter the market firm-level output and sales are expected to decrease, potentially inducing firms to reduce the number of layers.

Therefore, in this section, we start by presenting stylized facts to document the relationship between firm sales and the number of hierarchy layers, and between the number of layers and pay inequality in our data. This motivates the main analysis of the paper that uses the "On the Spot Firm" reform as a quasi-natural experiment to study how competition through a reduction in entry costs affects firm organization and wage inequality. Figure 2 starts by presenting in the left panel the firm size distribution in the data, according to the number of hierarchical layers

in the firm. It shows clear evidence that firms with a larger number of layers have higher sales. This is consistent with the summary statistics for log firm sales presented in Table 1. The right panel of Figure 2 shows that there is a positive relationship between the number of layers in the firm and the gap between average pay of workers in the top and of those in the bottom layer, the measure of pay inequality, which is closely related to the theoretical predictions.
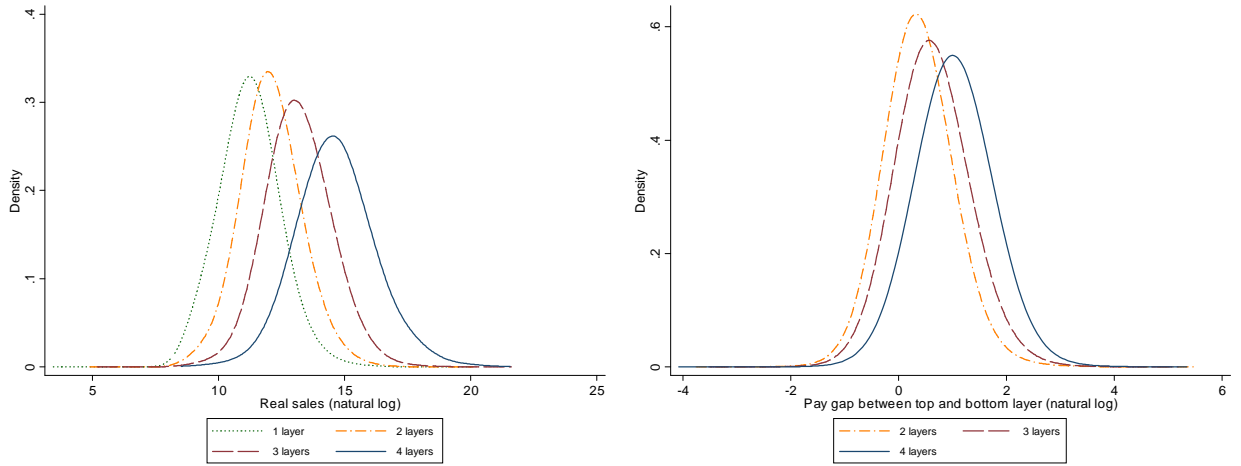

Figure 2: Distribution of sales and pay inequality by firms' number of layers

To complement the evidence from Figure 2 and empirically document the relationship between firm scale, hierarchy and inequality at the micro level, controlling for firm observable and unobservable characteristics, we present regression results relating to those relationships. Table 2 documents the relation between production scale and the number of layers. We estimate the following equation:

$$layers_{jt} = \beta \cdot \ln(sales_{jt}) + \gamma \cdot layers_{j,t-1} + d_t + d_j + \epsilon_{jt} \tag{1}$$

The dependent variable is the number of layers in the firm. We control for the number of layers in the previous period, $layers_{j,t-1}$, to account for the effect of previous organizational structure on current scale and organization. We include firm fixed effects (d_j) in odd-number columns and municipality (d_m) and industry (d_s) fixed effects in even-number columns, and always control for time effects (d_t), to absorb aggregate shocks that affect all firms. As expected, according to the theory, the coefficient estimate of β is positive and statistically significant across all specifications, confirming that there is a positive correlation between firm sales and hierarchy. This is consistent with the cross-sectional evidence from Figure 2.

Table 2: Firm production scale and hierarchy

Dependent variable:	Layers$_t$			
	(1)	(2)	(3)	(4)
ln(sales$_t$)	0.100***	0.359***	0.080***	0.108***
	(0.003)	(0.002)	(0.002)	(0.001)
Layers$_{t-1}$			0.161***	0.715***
			(0.002)	(0.002)
Firm fixed effects	yes		yes	
Municipality fixed effects		yes		yes
Industry fixed effects		yes		yes
Year fixed effects	yes	yes	yes	yes
R^2	0.014	0.402	0.038	0.703
No. Obs.	1,620,350	1,620,350	1,326,948	1,326,948

The dependent variable is the number of layers in the firm. Observations are by firm-year. Robust standard errors, clustered by municipality are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 3 presents estimates for the correlation between firm hierarchy and pay inequality within the firm:

$$\ln inequal_{jt} = \beta \cdot layers_{jt} + d_t + d_j + \epsilon_{jt} \qquad (2)$$

The dependent variable, pay inequality, is measured by the ratio of average pay of the top layer to average pay of the bottom layer in the firm; alternatively, we use the standard deviation of hourly pay as a measure of dispersion at the firm-year level. The results in columns (1) and (2) of Table 3, confirm that a higher number of layers is associated with increased inequality, within and across firms, consistent with the graphical evidence from Figure 2. It is important to note that this relationship is not mechanical, since we measure firm organization, the hierarchical layers in the firm, based on workers' occupations. We still find that reorganizing by adding (dropping) layers is accompanied by an increase (decrease) in pay inequality. An additional layer is associated with a 35% higher top-to-bottom wage ratio, relative to the sample average. We also find that within industries and municipalities, firms with more layers have higher pay inequality. Columns (3) and (4) show that more hierarchy layers are also associated with higher overall pay dispersion both within firms and across firms in an industry and municipality. The facts presented in this section are consistent with evidence for Danish firms (see Friedrich, 2020).

In the following sections, we use the reform as an exogenous shock to product market competition, and assess its effects on firms' production scale, organization and pay structure.

Table 3: Firm hierarchy and wage inequality

Dependent variable:	top-bottom pay ratio		std. dev.(hourly pay)	
	(1)	(2)	(3)	(4)
Layers$_t$	0.540***	0.673***	0.569***	0.878***
	(0.024)	(0.022)	(0.018)	(0.035)
Firm fixed effects	yes		yes	
Municipality fixed effects		yes		yes
Industry fixed effects		yes		yes
Year fixed effects	yes	yes	yes	yes
R^2	0.016	0.137	0.002	0.023
No. Obs.	1,090,124	1,090,124	1,088,657	1,088,657

The dependent variable is pay inequality, measured by the ratio of average pay of the top to the bottom layer in columns (1)-(2) and by the standard deviation of hourly pay in columns (3)-(4). Observations are by firm-year. Robust standard errors, clustered by municipality are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

5 Identification strategy

To identify the effects of increased product market competition on firm's internal organization and pay structure, we use the "On the Spot Firm" program as a quasi-natural experiment. We exploit the roll-out of the program across municipalities over time as an exogenous source of increased firm entry, thus estimating the effects from variation in the timing of the policy change across municipalities. We therefore obtain difference-in-differences estimates. The variable of main interest in our specifications is the reform variable, $OTSF_{mt}$, which takes the value 1 in all periods since the program is adopted in municipality m, and 0 otherwise. We include the variable lagged by one year.[12] Firms and individuals in municipalities that introduce the "On the Spot Firm" program are the treatment group.

In our specifications, among a host of factors that may affect the variables of interest, we include municipality fixed effects, which absorb any potential unobservable differences across municipalities. In addition, we also estimate treatment effects in each year, prior to the reform and after its introduction, to confirm the assumption that the shock was unanticipated. The main empirical specification that we estimate is the following reduced form:

$$y_{jsmt} = \beta \cdot OTSF_{m,t-1} + \lambda \cdot Z_{jt} + d_t + d_j + \epsilon_{jmst} \tag{3}$$

The dependent variable y_{jsmt} is one of the organizational measures, such as the number of layers, span of control, and wage inequality, for firm j, industry s, municipality m and year t. Z_{jt} includes firm characteristics, such as size, whether the firm is an exporter, whether it is multi-establishment, ownership type, and age. We control for time effects, d_t, and for firm fixed effects,

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[12]Some municipalities introduce additional one-stop shops in subsequent years. The treatment dummy variable is set to one when the municipality adopts the policy, that is, when the first "On the Spot Firm" office is opened.

d_j, or alternatively for industry, d_s, and municipality, d_m, fixed effects. This is a difference-in-differences specification, where the coefficient of main interest, β, on the reform dummy variable, captures the differential effect of the policy for firms and workers in municipalities that adopt the "On the Spot Firm". ϵ_{jmst} is a white noise disturbance term. We cluster the standard errors at the municipality level, at which the policy was introduced.

We also estimate specifications at the worker-level, to assess whether changes in hierarchy and span of control are accompanied by changes in individual's outcomes in affected firms after the policy. To that end, we estimate the following specification:

$$
\begin{aligned}
y_{ijsmt} &= \sum_{l=0}^{3} \beta_{1l} \cdot (OTSF_{m,t-1} \times layer_{pre\text{-}spot=l,i}) + \sum_{l=0}^{3} \beta_{2l} \cdot layer_{pre\text{-}spot=l,i} + \\
& \quad \gamma \cdot X_{it} + \lambda \cdot Z_{jt} + d_t + d_i + d_j + \epsilon_{ijsmt}
\end{aligned} \tag{4}
$$

Here, the dependent variable is one of the individual outcomes: natural log of real hourly pay of worker i in firm j, industry s, municipality m in year t, probability of exit from the firm, probability of demotion or probability of promotion. As above, $OTSF_{m,t-1}$ is the reform treatment variable. We estimate separate effects according to the layer the worker was in prior to the reform; $layer_{pre\text{-}spot=l,i}$ is a vector of dummy variables for whether the worker was in layer l (where $l=3$ is a top executive and $l=0$ a production worker). X_{it} includes individual characteristics, tenure and age and their squares, gender, level of education, and type of employment contract. Firm characteristics are included in Z_{jt}, as discussed above.

We continue to control for year (d_t) as well as firm (d_j), or industry (d_s) and municipality (d_m), fixed effects. In addition, we also include worker or worker-firm (match) fixed effects, d_i and d_{ij}, respectively, in the compensation regressions. Therefore, this specification accounts for individual observed skills and unobserved heterogeneity in the structure of compensation. The coefficients of main interest in this specification are those in vector β_{1l}, on the interaction terms between the reform variable and the indicators for the occupational layer of the worker prior to the reform. Each element captures the differential effect of the reform on the hourly pay of top-managers, middle-managers, higher-skilled professionals and other workers in treated municipalities. In the next sections we assess the effect of our quasi-natural experiment on the firms' organizational and pay structure.

6   Empirical results

6.1   Effect of the "On the Spot Firm" reform on firm entry

Before we assess the firms' organizational response to the product market changes following the "On the Spot Firm", in this section we start by showing that the reform led to significant changes

in firm entry, and thus contributed to increase product market competition. In particular, this confirms the use of the exogenous competitive shock to investigate how firms adapted by changing their hierarchical structure. We estimate a specification for the number of new entrants, over the period of analysis, 2002 to 2009:

$$entry_{mst} = \beta \cdot OTSF_{m,t-1} + d_m + d_s + d_t + \epsilon_{mst} \tag{5}$$

The dependent variable, $entry_{mst}$, is the number of new firms in a municipality, industry and year (mst). $OTSF_{m,t-1}$ is the "On the Spot Firm" policy variable, as described in the previous section. d_t are year dummies, which account for aggregate shocks, common to all municipalities, and d_m are municipality fixed effects, which absorb any permanent differences across municipalities in firm entry, in particular between municipalities that adopt the policy and those that do not. We also include industry fixed effects, d_s, to account for time-invariant industry characteristics that may be related to entry. ϵ_{mst} is an error term. Standard errors are clustered by municipality.

Table 4: Effect of the "On the Spot Firm" program on firm entry

Dependent variable:	No. new firms			
	(1)	(2)	(3)	(4)
$OTSF$ reform	0.670***	0.624***	0.100***	0.095***
	(0.201)	(0.199)	(0.020)	(0.021)
Marginal Effect			0.248***	0.242***
			(0.050)	(0.055)
Municipality fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects		Yes		Yes
Year fixed effects	Yes	Yes	Yes	Yes
R^2	0.126	0.344	0.061	0.291
No. Obs.	56,257	56,257	56,257	56,257

The dependent variable is the number of new firms. The $OTSF$ variable, for municipality-years with "On the Spot Firm" one-stop shops, is lagged one year. Columns (1) and (2) report estimates from an OLS specification. Columns (3) and (4) report estimates from a Negative Binomial specification. Observations are by municipality-industry-year. Robust standard errors, clustered by municipality are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

The coefficient of interest, β, captures the differential effect of the "On the Spot Firm" reform on firm entry in affected municipalities, relative to other municipalities. We expect β to be positive if the reform induced higher firm entry in affected municipalities. Table 4 reports the results. In columns (1) and (2) we estimate a linear model for the number of entrants, while in columns (3) and (4) we estimate a negative binomial specification for the same variable. Odd-number columns include municipality and year fixed effects, while even-number columns

additionally include industry fixed effects.

We find that the "On the Spot Firm" reform is associated with increased firm entry within municipalities and industries. The coefficient on the reform variable, $OTSF_{m,t-1}$, is positive and statistically significant at the 1% level for both the linear and the negative binomial results. The linear estimates imply a 25% increase in the number of entrants within a municipality-industry, relative to average entry in the sample (column 2). This result shows that the policy change is associated with a economically significant increase in entry, and therefore competition.[13]

In Table 4 above, we obtain the average effect of the policy on firm entry over the post-reform period. Next, we also provide event study evidence, estimating the effects in each year.[14] This assesses whether the effects vary with the duration of the program and, importantly, confirms our identification strategy that the introduction of one-stop shops in particular municipalities and time periods is not correlated with prior trends. To that end, we run the following event-study specification for firm entry:

$$entry_{mst} = \sum_{\tau} \beta_{\tau} \cdot OTSF_{m,t=\tau} + d_m + d_s + d_t + \epsilon_{mst} \qquad (6)$$

We continue to include the same sets of fixed effects. This specification includes a set of dummy variables for each lead and lag, with regard to the year of adoption in a municipality, $OTSF_{m,t=\tau}$. This estimates the effects over time, relative to the year prior to the adoption of the policy, which is the reference year.[15] In Figure 3, we plot out the estimated coefficients β_{τ} over time, relative to $t-1$, and 95% confidence bands. The results show that the coefficients are statistically insignificant in the lead years, prior to the "On the Spot Firm", confirming that there are no anticipatory effects and supporting our identification strategy. The coefficients become positive and statistically significant in the years after the adoption of the policy and they also increase over time, with an increase in firm entry in affected municipalities.

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[13]This confirms our finding in previous work (Fernandes et al., 2014, 2018). Consistent results on increased firm entry following deregulation are reported by Bruhn (2011) for a similar reform in Mexico.

[14]Our setup is a staggered adoption design (see Athey and Imbens, 2018), but we use the term event study as is common in the applied literature.

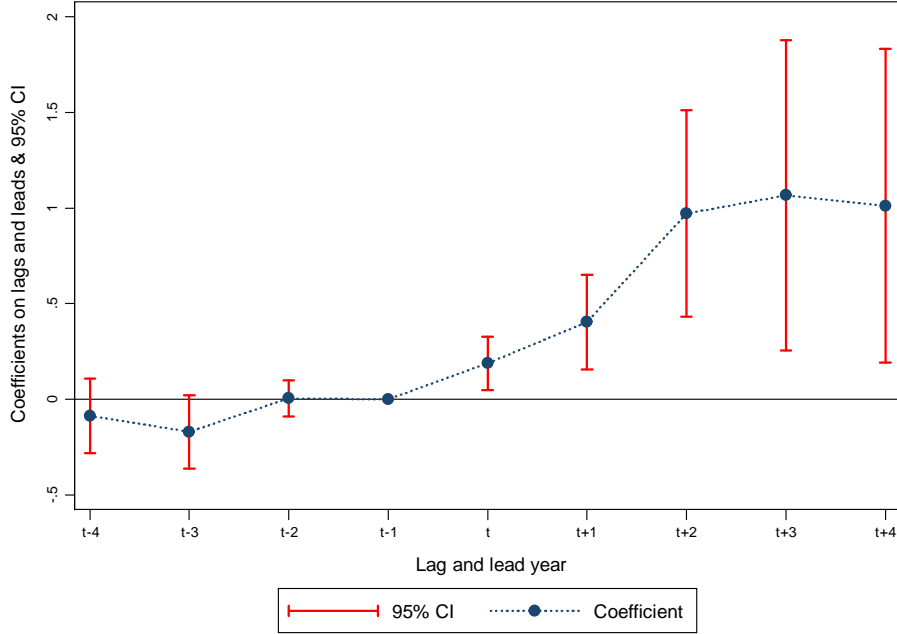[15]We group all the leads prior to $t-4$ in a single one, labelled $t-4$.

Figure 3: Effect of the "On the Spot Firm" program on firm entry over time

6.2 Firm production scale and the "On the Spot Firm" Program

We have documented stylized facts in section 4 of a positive correlation between firm scale and hierarchy and between hierarchical structure and inequality. In this section, we investigate the effects of increased entry following the "On the Spot Firm" reform on firm production scale, as a motivation for the subsequent analysis that establishes a causal link between competition and firm reorganization and wage inequality. We assess whether the competition shock affected firm production scale, thereby inducing firms to reorganize, and in turn changing inequality, as predicted by the theory.

We use the "On the Spot Firm" program as a natural experiment and estimate Equation (3) for the (ln) of sales, employment and output of incumbent firms as the dependent variables. Table 5 presents the results. We find that increased firm entry following the reform is associated with a significant reduction in sales, output and employment within firms (odd-number columns), as well as across firms in an industry and municipality (even-number columns). These findings are consistent with theoretical results that lowering entry barriers leads to a fall in firm-level output and sales, with the entry of new firms.

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Table 5: Competition and firm size

Dependent variable:	ln(sales)		ln(employment)		ln(output)	
	(1)	(2)	(3)	(4)	(5)	(6)
$OTSF$ reform	-0.027***	-0.116***	-0.032***	-0.107***	-0.024***	-0.105***
	(0.008)	(0.013)	(0.003)	(0.010)	(0.008)	(0.015)
Firm fixed effects	yes		yes		yes	
Municipality fixed effects		yes		yes		yes
Industry fixed effects		yes		yes		yes
Year fixed effects	yes	yes	yes	yes	yes	yes
R^2	0.016	0.371	0.037	0.342	0.013	0.400
No. obs.	1,214,951	1,214,951	1,214,951	1,214,951	680,012	680,012

The dependent variable is the natural log of firm sales volume in real terms in columns (1)-(2), the natural log firm employment in columns (3)-(4), and the naural log of output in columns (5)-(6). The $OTSF$ variable is lagged one year. Odd-numbered columns include firm and year fixed effects while even-numbered columns include industry, municipality and year fixed effects. Other covariates include whether the firm is an exporter, whether multi-establishment, ownership, and age. Robust standard errors, clustered by municipality, are reported in parentheses. Observations are at the firm-year level. * p<0.10; ** p<0.05; *** p<0.01.

In sum, this section shows that following the reform, firm sales and output decrease. The reduction in production scale may be a channel inducing firms to drop hierarchy layers, as predicted by knowledge-based hierarchy theories. In the next section, we investigate how the reform affects firms' hierarchies and pay inequality.

6.3 The "On the Spot Firm" reform, firm hierarchies and wage inequality

In this section we present the main results of the paper, on the effects of increased entry and competition following the "On the Spot Firm" policy on firms' internal organization and wage structure, particularly pay inequality between the top and the bottom layers of the hierarchy.

In Table 6, we start by investigating the effect of the entry deregulation on the depth of the hierarchy, measured as the number of hierarchy layers in the firm. We estimate Equation (3), with the number of layers (columns 1 and 2), or the log number of layers (columns 3 and 4), as the dependent variable. This analysis excludes firms with just one layer prior to the reform, since it is not possible to measure spans of control and inequality across layers, in subsequent sections. The top panel of Table 6 uses the full sample of firms. We include firm and year fixed effects in columns (1) and (3), thus estimating the effects accounting for firms' unobserved idiosyncractic characteristics that may affect the hierarchy, as well as for aggregate trends. The estimated coefficients on the reform dummy variable, $OTSF_{m,t-1}$, show that the increased competition led to a significant reduction in the number of layers within firms in affected municipalities, by 0.08 or 5%, relative to other firms. The effects are larger when municipality and industry fixed effects are included, corresponding to a 10% reduction in layers (columns 2 and 4). These findings provide evidence that the entry reform induced firms to flatten their hierarchies.

Table 6: Competition and the number of hierarchical layers

Dependent variable:	No. of Layers		ln(No. of Layers)	
	(1)	(2)	(3)	(4)
All firms				
$OTSF$ reform	-0.080***	-0.163***	-0.053***	-0.102***
	(0.008)	(0.013)	(0.004)	(0.008)
R^2	0.010	0.252	0.010	0.223
No. obs.	1,386,328	1,386,328	1,386,328	1,386,328
Layers pre-reform = 2				
$OTSF$ reform	-0.059***	-0.047***	-0.072***	-0.065***
	(0.005)	(0.005)	(0.003)	(0.003)
R^2	0.007	0.029	0.014	0.027
No. obs.	375,224	375,224	375,224	375,224
Layers pre-reform = 3				
$OTSF$ reform	-0.271***	-0.265***	-0.138***	-0.135***
	(0.012)	(0.012)	(0.006)	(0.006)
R^2	0.044	0.079	0.052	0.077
No. obs.	162,126	162,126	162,126	162,126
Layers pre-reform = 4				
$OTSF$ reform	-0.351***	-0.351***	-0.119***	-0.118***
	(0.018)	(0.018)	(0.007)	(0.006)
R^2	0.081	0.139	0.071	0.122
No. obs.	77,896	77,896	77,896	77,896

The dependent variable is the number of hierarchical layers in columns (1)-(2) and the natural log of the number of layers in columns (3)-(4). The $OTSF$ variable is lagged one year. Columns (1) and (3) include firm and year fixed effects and columns (2) and (4) include industry, municipality and year fixed effects. Other covariates include whether the firm is an exporter, whether it is multi-establishment, ownership, and age. Robust standard errors, clustered by municipality, are reported in parentheses. Observations are at the firm-year level. * p<0.10; ** p<0.05; *** p<0.01.

In the top panel of Table 6, we estimate average treatment effects for the post-reform period, relative to the pre-reform period. We now present event study evidence of the effects of the reform on firms' delayering. We estimate a specification similar to Equation (6) above, for the number of layers at the firm-year level as the dependent variable. Figure 4 plots the point estimates of the coefficients β_τ over time, relative to the year prior to the policy in each municipality, as the reference year, and 95% confidence bands. The event graph shows a structural break after the introduction of the "On the Spot Firm" policy, with a significant reduction in the number of layers for firms in affected municipalities, from period $t+1$ onwards. The coefficients are insignificant prior to the reform, showing that there are no pretrends, and supporting the identification assumption that the policy was unanticipated. Markedly, comparing the results in Figure 4 with those in Figure 3 above, for firm entry, the timing of

the drop in the number of hierarchy layers is consistent with that for the increase in firm entry after the policy change.
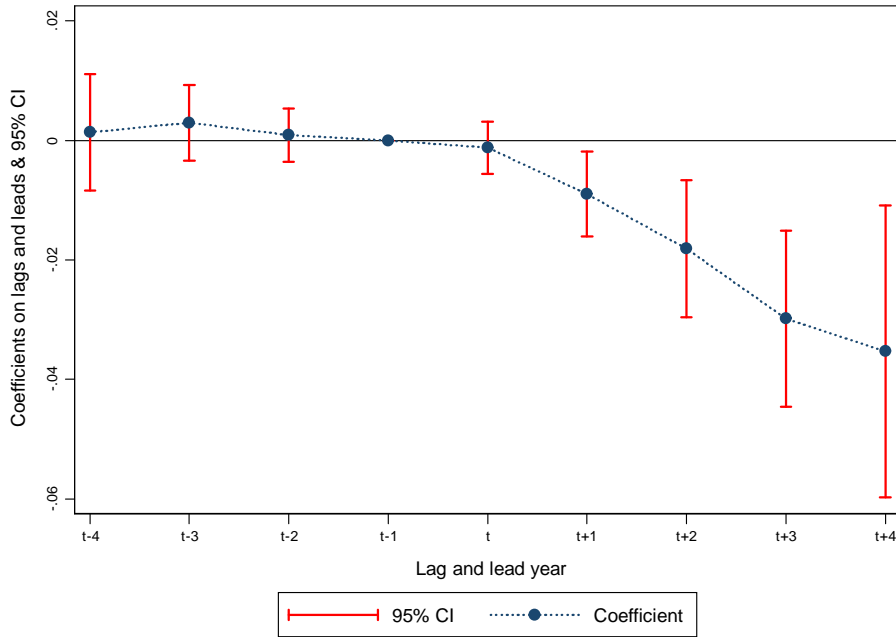

Figure 4: Effect of the "On the Spot Firm" program on the number of layers over time

The results in the top panel of Table 6, discussed above, are for the full sample, whilst in subsequent panels, we estimate the effects separately according to firms' initial number of layers, in the year prior to the reform. For all samples, we find that firms in affected municipalities reduce the number of hierarchy layers after the reform. The effects are larger for firms with initially three or four layers, with a significant 0.27 and 0.35 reduction in layers within firms, respectively, representing a 10% decrease relative to the sample averages. The results remain similar with municipality and industry fixed effects.

Having discussed the effects on the depth of the hierarchy, proxied by layers, we now consider the width of the hierarchy, the second variable that defines the hierarchy's structure, measured by the span of control of managers. We define the span of control in each layer as the employment ratio between two adjacent layers. Specifically, the span of control of managers is defined as the number of employees in the layer below per manager. In Table 7, we present results for the effects of the policy on the span of control of each layer. Columns (1) and (2) report the effect for top managers' span of control (layer 3 of the hierarchy); columns (3) and (4) present the effects on the span of control of middle managers (layer 2), and columns (5) and (6) for workers in layer 1. We include different sets of fixed effects, as above. The top panel is for the sample of all firms, and shows that firms increased the span of control of top managers in response to the reform, by a significant 0.036, implying an average increase of around 2% within firms, relative to the sample mean.

Table 7: Competition and average span of control

Dependent variable:				average span of control		
Layer:	Top managers (Layer 3)		Middle managers (Layer 2)		Higher-skilled (Layer 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
All firms						
OTSF reform	0.036**	0.044**	0.039	0.155***	0.036	0.104*
	(0.016)	(0.018)	(0.046)	(0.042)	(0.050)	(0.060)
R^2	0.000	0.044	0.001	0.027	0.004	0.145
No. obs.	639,439	639,439	342,325	342,325	330,902	330,902
Layers pre-reform = 2						
OTSF reform	-0.310***	-0.231***	-0.239***	-0.056	-0.063	0.501***
	(0.026)	(0.030)	(0.048)	(0.051)	(0.056)	(0.089)
R^2	0.005	0.079	0.006	0.131	0.002	0.089
No. obs.	216,281	216,281	80,636	80,636	63,261	63,261
Layers pre-reform = 3						
OTSF reform	0.383***	0.434***	-0.194***	-0.007	0.091	0.464***
	(0.047)	(0.050)	(0.069)	(0.079)	(0.059)	(0.102)
R^2	0.005	0.029	0.004	0.088	0.006	0.168
No. obs.	114,104	114,104	74,376	74,376	91,935	91,935
Layers pre-reform = 4						
OTSF reform	0.275***	0.263***	0.436***	0.467***	0.041	0.020
	(0.050)	(0.048)	(0.079)	(0.080)	(0.116)	(0.132)
R^2	0.001	0.042	0.003	0.037	0.006	0.153
No. obs.	69,936	69,936	67,293	67,293	67,867	67,867

The dependent variable is the average span of control of each layer in the firm, defined as the number of employees in the layer below per employee in a layer, e.g. the span of control of top managers (layer 3) is the number of employees in the layer below per top manager. The *OTSF* variable is lagged one year. Odd-number columns include firm and year fixed effects and even-number columns include industry, municipality and year fixed effects. Other covariates include whether the firm is an exporter, whether it is multi-establishment, ownership, and age. Observations are at the firm-year level. Robust standard errors, clustered by municipality, are reported in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

The pooled difference-in-differences results in Table 7 report average estimates after the policy change. In Figures 5 and 6, we present event studies for the effect of the policy on the span of control of top managers and middle managers, respectively. As above, the figures plot the estimated coefficients over time, relative to $t-1$ as the reference year, and 95% confidence bands. The effect on the span of control of top managers (Figure 5) is insignificant prior to the reform, confirming that there are no pretends, and it becomes positive and statistically significant after the policy change. The coefficients also increase over time, with the duration of the program and the increase in firm entry. Importantly, the timing is also consistent with the effects on firm entry and the number of hierarchy layers, reported in Figures 3 and 4 above. The event study evidence for middle managers' span of control, presented in Figure 6, is similar,

with the coefficients turning positive and significant after the policy change.
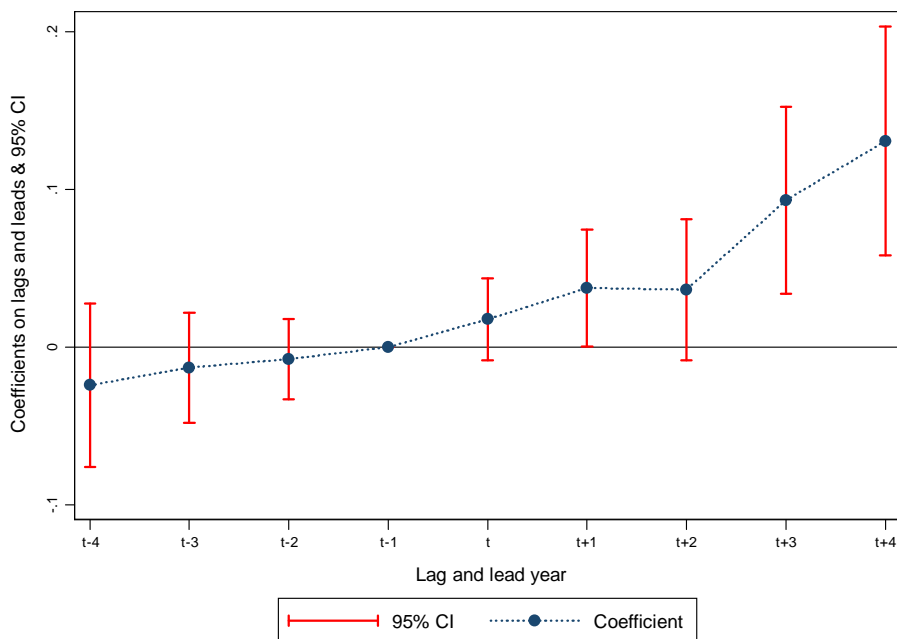
Figure 5: Effect of the "On the Spot Firm" program on top managers' span of control over time
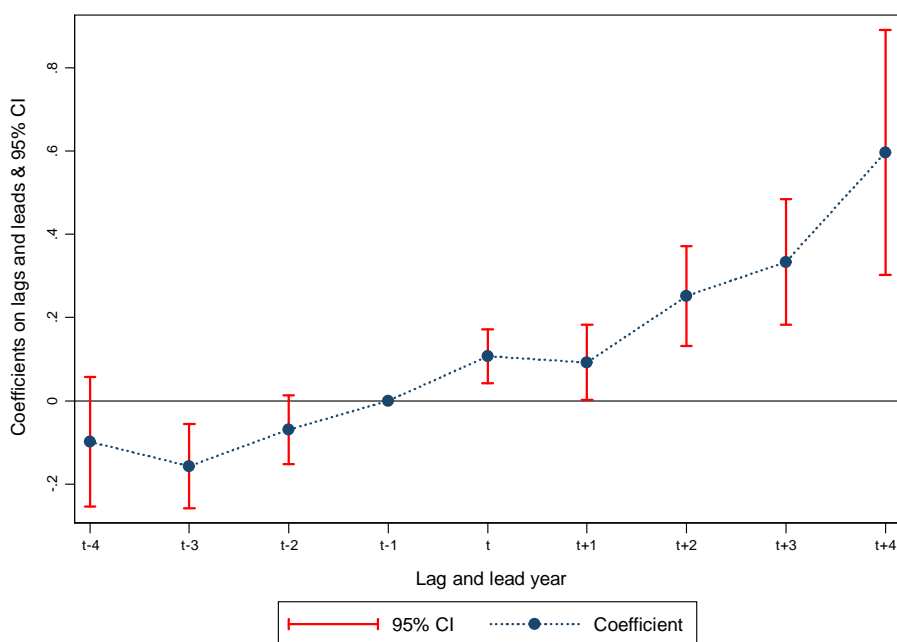

Figure 6: Effect of the "On the Spot Firm" program on middle managers' span of control over time

The subsequent three panels of Table 7 present results for samples of firms according to the initial number of layers. We find that firms with three and four layers prior to the reform are the ones that increase the span of control of managers in response to the increase in firm

entry, consistent with the results for the number of layers. In particular, the estimates imply an increase of 18% and 12% in the span of control of top managers, for firms with three and four layers, respectively, relative to average span in the samples. We find that firms with initially four layers also increase the span of control of middle managers, but the coefficient is negative for the other samples.

In sum, the results above show that in response to the competition shock, firms change the structure of their hierarchy, reducing its depth and increasing the span of control of experts, relative to firms in municipalities unaffected by the policy.

Table 8: Competition and top-bottom-layer pay inequality

Dependent variable:	Top-bottom-layer pay ratio					
Sample:	All firms		Reduce layers		Do not reduce layers	
	(1)	(2)	(3)	(4)	(5)	(6)
All Firms						
$OTSF$ reform	-0.033**	-0.105***	-0.156***	-0.181***	0.079***	-0.036***
	(0.015)	(0.018)	(0.036)	(0.033)	(0.019)	(0.012)
R^2	0.000	0.076	0.001	0.020	0.002	0.132
No. obs.	759,990	759,990	111,668	111,668	648,322	648,322
Layers pre-reform = 2						
$OTSF$ reform	-0.084***	-0.116***	-0.190***	-0.192***	0.025	0.013
	(0.024)	(0.021)	(0.040)	(0.035)	(0.032)	(0.029)
R^2	0.000	0.012	0.001	0.018	0.003	0.030
No. obs.	150,265	150,265	57,871	57,871	92,394	92,394
Layers pre-reform = 3						
$OTSF$ reform	-0.031	-0.072***	-0.058	-0.113***	0.028	0.033
	(0.027)	(0.022)	(0.043)	(0.036)	(0.044)	(0.040)
r2	0.001	0.044	0.004	0.043	0.003	0.047
No. obs.	78,114	78,114	34,025	34,025	44,089	44,089
Layers pre-reform = 4						
$OTSF$ reform	-0.099***	-0.151***	-0.231**	-0.295***	0.005	-0.019
	(0.037)	(0.043)	(0.095)	(0.096)	(0.040)	(0.058)
R^2	0.002	0.069	0.004	0.048	0.004	0.079
No. obs.	56,142	56,142	19,772	19,772	36,370	36,370

The dependent variable is the ratio of average hourly pay in the top layer in the firm to average pay in the bottom layer. The $OTSF$ variable is lagged one year. Columns (1)-(2) are for all firms, columns (3)-(4) are for the sample of firms which drop layers after the reform, while columns (5)-(6) are for the sample of firms which do not drop layers. Odd-number columns include firm and year fixed effects and even-number columns include industry, municipality and year fixed effects. Other covariates include whether the firm is an exporter, whether it is multi-establishment, ownership, and age. Observations are at the firm-year level. Robust standard errors, clustered by municipality, are reported in parentheses. * p<0.10; ** p<0.05; *** p<0.01.

Next, we investigate the effects of the reform on wage inequality. We estimate Equation (3) for measures of wage inequality as dependent variables. To construct a measure of pay

inequality at the firm-level, which is closely linked to the theory, we focus on "top-bottom" pay ratios, comparing average pay in the highest hierarchy level of the firm with average pay in the lowest level (see also Mueller et al., 2017 and Friedrich, 2020). We also use the standard deviation of hourly pay as a measure of dispersion, as well as the 90-10 and 90-50 hourly pay percentile ratios, to measure changes in the pay distribution.

Table 8 presents the results for the top-bottom layer pay inequality measure. Columns (1) and (2) use the full sample of firms. We find that the reform is associated with a decrease in the gap between average pay in the top and the bottom layer within firms in affected municipalities (column 1) as well as across firms in an industry, controlling for municipalities' unobserved heterogeneity (column 2). The effects are negative and statistically significant for the full sample, in the top panel, as well as for samples according to firms' initial number of layers, in subsequent panels. The estimates for the full sample imply a 2% to 7% reduction in the top-bottom pay ratio, relative to the mean in the sample. This finding shows that the delayering following the competition shock, discussed above, is accompanied by a significant reduction in within-firm wage inequality. For example, eliminating a top-management layer could reduce the wage gap between managers and workers. The firm can also change the number of production workers. Thus, compositional changes are important in explaining changes in inequality.

To confirm whether the reduction in wage inequality arises through changes in organizational structure induced by the policy, we estimate the effects separately for firms that reduce and for those that do not reduce the number of layers. Columns (3) and (4) of Table 8 report results for the sample of firms that drop layers after the reform, while columns (5) and (6) report results for firms that do not drop layers. We find that the reduction in pay inequality within firms is observed only for firms that reduce the number of layers. The coefficient on the reform variable is negative and highly significant for the sample of all firms, as well as by initial layers. In particular, firms that reduce hierarchical layers experience a 10 to 12% average decrease in the top-bottom pay ratio after the reform (top panel). This effect is of a larger magnitude than the estimates in columns (1) and (2), for all firms. The effects are insignificant for firms that do not reduce the number of layers, with an exception for the sample of all firms, but only when firm fixed effects are not included. These findings suggest that the reduction in inequality arises through firm restructuring, induced by the reform, as predicted by the theory, rather than as a direct effect of the deregulation.

Table 9: Competition and pay inequality measures

	sd(hourly pay)		90-10 pay ratio		90-50 pay ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
All firms						
$OTSF$ reform	-0.255***	-0.303***	-0.154***	-0.183***	-0.078***	-0.097***
	(0.083)	(0.072)	(0.034)	(0.035)	(0.020)	(0.018)
r2	0.000	0.023	0.000	0.015	0.000	0.011
N	96,189	96,189	111,668	111,668	111,668	111,668
Layers pre-reform = 2						
$OTSF$ reform	-0.342**	-0.319***	-0.197***	-0.205***	-0.118***	-0.124***
	(0.142)	(0.091)	(0.048)	(0.048)	(0.035)	(0.031)
r2	0.000	0.026	0.001	0.019	0.000	0.017
N	44,306	44,306	57,871	57,871	57,871	57,871
Layers pre-reform = 3						
$OTSF$ reform	-0.060	-0.173**	-0.070	-0.137***	-0.022	-0.060*
	(0.096)	(0.081)	(0.058)	(0.044)	(0.043)	(0.034)
r2	0.003	0.062	0.002	0.030	0.002	0.021
N	32,399	32,399	34,025	34,025	34,025	34,025
Layers pre-reform = 4						
$OTSF$ reform	-0.412	-0.632**	-0.172	-0.239	-0.057	-0.099**
	(0.316)	(0.273)	(0.156)	(0.148)	(0.048)	(0.047)
r2	0.001	0.040	0.001	0.011	0.002	0.021
N	19,484	19,484	19,772	19,772	19,772	19,772

The $OTSF$ variable is lagged one year. The regressions are for the sample of firms that drop layers after the reform. Odd-number columns include firm and year fixed effects and even-number columns include industry, municipality and year fixed effects. Other covariates include whether the firm is an exporter, whether it is multi-establishment, ownership, and age. Observations are at the firm-year level. Robust standard errors, clustered by municipality, are reported in parentheses. * p<0.10; ** p<0.05; *** p<0.01.

Table 9 uses as alternative measures of pay inequality the standard deviation of real hourly pay as well as the 90-10 and 90-50 percentile ratios of pay. These measures assess whether there are changes in the overall dispersion and in the pay distribution. The table reports results for the sample of firms that reduce the number of layers after the policy change. We find that the standard deviation of hourly pay decreases by 13% after the reform within affected firms, relative to the sample standard deviation (column 1); there is also a reduction across firms in affected municipalities (column 2). The results in columns (3) to (6) show that the reform is also associated with a decrease in the 90-10 and 90-50 pay gaps. The estimate in column (3) implies a 9% drop in the 90-10 percentile pay ratio within firms, similar to the effect estimated above for the top-bottom-layer pay ratio. Delayering is also accompanied by a decrease in the 90-50 gap of 0.078, corresponding to 5.6% of the sample average ratio. The magnitude of the decrease is thus larger for the 90-10 wage gap, suggesting that the drop in inequality is larger between workers at the top and those at the bottom of the firm than between workers at the

top and those in the middle of the distribution.

Table A.2 in the Appendix reports results for the same specifications as Table 9 but for the sample of firms that do not reduce layers. As shown, the coefficients are insignificant for the samples by initial layers, while they are positive and significant for the full sample of firms when firm and year fixed effects are included. Therefore, the reduction in within-firm inequality arises through restructuring following the competition shock, consistent with the previous results.

The evidence presented in this section, that dropping a layer is accompanied by a reduction in inequality within firms, is consistent with knowledge-based and incentive-based hierarchy theories, where reducing the number of layers affects wage inequality due to changing skill requirements and incentives (e.g., Caliendo and Rossi-Hansberg, 2012; Chen, 2017). In particular, knowledge-based theories predict that if firms contract by dropping a management layer, more problems are solved at each layer, since there is less problem-solving assistance from a higher layer. Therefore, the knowledge or skill requirement of each layer increases, reducing pay inequality between managers and workers.

6.4 Worker-level outcomes

The matched employer-employee data that we use allows to also estimate individual-level outcomes. This assesses in more detail how firms reorganize and how reorganization affects workers' pay and career transitions. We estimate the effects on individual wages, as well as the probability of demotion, promotion and exit for workers in firms affected by the policy, according to the layer of the worker in the year prior to the reform.

We start by estimating Equation (4), for the log of real hourly pay at the worker level, as the dependent variable. We control for each worker's observable characteristics: education, age and tenure and their squares, gender, and type of employment contract, and for firm characteristics: size, age, ownership, whether the firm is an exporter or multi-plant. We include sets of fixed effects as described in Section 5; in particular, individual fixed effects control for worker's unobservable skills and ability. The results are presented in Table 10. We find that the pay of individuals in layers 3 and 2 prior to the reform (top and middle managers) in affected municipalities increases following the policy change. In particular, the estimates imply that managerial pay increases on average by 2% (column 1). The results are the same when we include worker-firm match fixed effects, thus estimating the effect of the policy from workers that remain in the same firm after the reform, rather than also from those that move to other firms (column 2).

The increase in managerial pay is consistent with the higher spans of control of managers reported in the previous section; with higher managerial span of control, managers' wages are expected to increase. Increased managerial pay at the individual-level also suggests that the flattening of the firm is accompanied by increased decision-making by managers, consistent with

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evidence of the link between incentive provision and decision-making authority (e.g. Athey and Roberts, 2001; Prendergast, 2002; Rosen, 1982). The pay of production workers, in the lowest hierarchy layer, also increases, consistent with increased problem solving when firms reorganize by dropping a hierarchy layer.

Table 10: Competition and worker-level compensation

Dependent variable:	ln(hourly pay)			
	(1)	(2)	(3)	(4)
$OTSF \times \text{layer}_{pre\text{-}reform}=3$	0.024***	0.024***	0.014***	0.010**
	(0.003)	(0.003)	(0.002)	(0.005)
$OTSF \times \text{layer}_{pre\text{-}reform}=2$	0.022***	0.021***	0.024***	0.024***
	(0.004)	(0.004)	(0.001)	(0.005)
$OTSF \times \text{layer}_{pre\text{-}reform}=1$	0.001	0.001	-0.002**	-0.002
	(0.003)	(0.003)	(0.001)	(0.003)
$OTSF \times \text{layer}_{pre\text{-}reform}=0$	0.004**	0.004**	0.001***	-0.001
	(0.002)	(0.002)	(0.000)	(0.002)
Worker fixed effects	yes			
Match fixed effects		yes		
Municipality Fixed effects	yes			yes
Industry Fixed effects	yes			yes
Firm fixed effects			yes	
Year fixed effects	yes	yes	yes	yes
R^2	0.046	0.044	0.448	0.619
No. obs.	4,920,508	4,920,508	4,920,508	4,920,508

The $OTSF$ variable is lagged one year. $\text{layer}_{pre\text{-}reform}$ is the hierarchy layer of the worker in the year prior to the adoption of the reform. The regressions consider all pre-reform years and two post-reform years. Other covariates include, at the worker-level: tenure and its square, education, type of contract of employment, whether part-time worker; at the firm-level: log of size, whether the firm is an exporter, whether it is multi-establishment, ownership, and age. All regresions also include indicators for the workers' layer in the year prior to the reform. Robust standard errors, clustered by firm in parentheses. Observations are at the worker-year level. * p<0.10; ** p<0.05; *** p<0.01.

The worker-level results in this section estimate the effects of the reform controlling for observable and unobservable worker skills; and are therefore not reflective of heterogeneous workers' skill differences. The results in the previous section, of a reduction in pay inequality at the firm-level, on the other hand, capture the role of worker skills, consistent with knowledge-based hierarchy predictions that dropping layers changes skill requirements across layers.

Next, we measure the effect on individuals' probability of demotion, promotion and exit from the firm. Demotion is defined as a move to a lower layer, while promotion is a move to a higher layer. We estimate linear probability models for each of those outcomes, conditional on the layer a worker was in prior to the reform. We control for the same worker and firm observable characteristics as above.

Table 11: Competition and worker-level outcomes

	Pr(exit)	Pr(demotion)		Pr(promotion)	
	(1)	(2)	(3)	(4)	(5)
$OTSF \times \text{layer}_{pre\text{-}reform}=3$	0.012***	0.020***	0.021***	-0.025***	-0.027***
	(0.004)	(0.001)	(0.002)	(0.001)	(0.001)
$OTSF \times \text{layer}_{pre\text{-}reform}=2$	0.013***	-0.036***	-0.037***	-0.048***	-0.047***
	(0.004)	(0.001)	(0.002)	(0.001)	(0.002)
$OTSF \times \text{layer}_{pre\text{-}reform}=1$	0.015***	-0.014***	-0.013***	-0.044***	-0.046***
	(0.005)	(0.001)	(0.002)	(0.001)	(0.002)
$OTSF \times \text{layer}_{pre\text{-}reform}=0$	0.030***	0.001**	-0.000	0.024***	0.022***
	(0.003)	(0.000)	(0.001)	(0.000)	(0.001)
Firm fixed effects		yes		yes	
Municipality Fixed effects	yes		yes		yes
Industry Fixed effects	yes		yes		yes
Year fixed effects	yes	yes	yes	yes	yes
R^2	0.058	0.010	0.022	0.014	0.029
No. obs.	5,119,994	4,490,578	4,490,578	4,490,578	4,490,578

The $OTSF$ variable is lagged one year. $\text{layer}_{pre\text{-}reform}$ is the hierarchy layer of the worker in the year prior to the adoption of the reform. The regressions consider all pre-reform years and two post-reform years. Pr(exit) takes the value of one if the worker is in the firm for the last time in the current period. Demotion (promotion) is defined as a lower (higher) layer than in the previous period. Other covariates include, at the worker-level: tenure and its square, education, type of contract of employment, whether part-time worker; at the firm-level: log of size, whether the firm is an exporter, whether it is multi-establishment, ownership, and age. All regresions also include indicators for the workers' layer in the year prior to the reform. The regressions are are linear probability models. Robust standard errors, clustered by firm in parentheses. Observations are at the worker-year level. * p<0.10; ** p<0.05; *** p<0.01.

The results are reported in Table 11. In column (1), we find that across all layers workers are more likely to exit the affected firms after the reform, by 1 to 3 percentage points, depending on the layer of the worker prior to the reform. Workers in lower layers have a higher probability of exit. Columns (2) and (3) report results for the probability of demotion. The coefficients on the interaction terms between the reform variable and the indicators for the pre-reform layer of the worker show that top managers (layer 3) are more likely to be demoted, e.g. to a position in the middle-manager layer, after the reform. This is observed both within the same firm (column 2) and across firms (column 3). However, workers in layers 2 and 1 have a lower probability of demotion. In columns (5) and (6), we also find that workers are less likely to be promoted after the reform, in the same or in another firm, with the exception of those in layer 0.

The results in this section show that the decision of firms to reorganize following the competition shock affects workers' pay and career trajectories. In particular, workers are more likely to exit the firm and less likely to be promoted, within or across firms. While individuals in top management are also more likely to be demoted. The increased competition and the flattening of firms' hierarchies it induced can therefore have lasting consequences on the career progression of individual workers.

7 Conclusion

This paper investigates the effect of increased domestic product market competition, on firms' internal organization and wage inequality. We investigate the effect of entry deregulation on the structure of a firm's hierarchy, measured by the number of layers and the average span of control of managers. We then study how these changes affect the distribution of wages within the firm and wage inequality. An important contribution of our paper is to identify a causal link between changes in competition in the domestic product market and firms' organizational change and wage inequality. To do that, we exploit the "On the Spot Firm" program, a unique episode of firm entry deregulation, implemented in Portugal from 2005, as a natural experiment. Our identification strategy uses the roll out of the program across municipalities over time as an exogenous source of increased entry and competition. We use uniquely detailed linked employer-employee data for the universe of private sector firms and all of their workers.

We show that the reform significantly increased firm entry within industries and municipalities. The increased firm entry following the policy change is associated with lower firm sales, output and employment within firms. In both knowledge-based and incentive-based hierarchy models, the optimal hierarchical structure is related to firm production scale. Consistent with theoretical results, we find that affected firms respond to the shock by reducing the number of hierarchy layers and increasing the spans of control of managers.

The flattening of the firm following the reform is accompanied by a reduction in pay inequality within firms and across firms. Firms that drop layers experience a significant reduction in inequality between workers in the top and those in the bottom layer of the hierarchy. The magnitude of the effect is estimated at a 10% reduction on average in the top-bottom pay ratio after the reform. We also find that the standard deviation and the 90-10 and 90-50 percentile pay ratios decrease for affected firms. These findings are consistent with knowledge-based and incentive-based hierarchy theories, that reducing the number of layers affects the wage distribution and inequality as workers' skill composition and incentives change.

The matched employer-employee data also allows us to estimate worker-level outcomes. We find that workers are more likely to exit the firm and less likely to be promoted, within or across firms. Top managers are more likely to be demoted, e.g., to a position in the middle-manager layer. The effects of the reform and the flattening of firms' hierarchies, can therefore have lasting consequences on the pay and career progression of individual workers.

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A Appendix

Table A.1: Classification of workers according to skill levels

Level	Tasks	Skills
1. Top executives (top management)	Definition of the firm general policy or consulting on the organization of the firm; strategic planning; creation or adaptation of technical, scientific and administrative methods or processes	Knowledge of management and coordination of firms' fundamental activities; knowledge of management and coordination of the fundamental activities in the field to which the individual is assigned and that requires the study and research of high responsibility and technical level problems
2. Intermediary executives (middle management)	Organization and adaptation of the guidelines established by the superiors and directly linked with the executive work	Technical and professional qualifications directed to executive, research, and management work
3. Supervisors, team leaders	Orientation of teams, as directed by the superiors, but requiring the knowledge of action processes	Complete professional qualification with a specialization
4. Higher-skilled professionals	Tasks requiring a high technical value and defined in general terms by the superiors	Complete professional qualification with a specialization adding to theoretical and applied knowledge
5. Skilled professionals	Complex or delicate tasks, usually not repetitive, and defined by the superiors	Complete professional qualification implying theoretical and applied knowledge
6. Semi-skilled professionals	Well defined tasks, mainly manual or mechanical (no intellectual work) with low complexity, usually routine and sometimes repetitive	Professional qualification in a limited field or practical and elementary professional knowledge
7. Non-skilled professionals	Simple tasks and totally determined	Practical knowledge and easily acquired in a short time
8. Apprentices, interns, trainees	Apprenticeship	

Note: Hierarchical levels defined according to Decreto Lei 121/78 of July 2nd (Source: Lima and Pereira, 2003).

Table A.2: Competition and pay inequality measures, firms that do not drop layers

	sd(hourly pay)		90-10 pay ratio		90-50 pay ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
All firms						
$OTSF$ reform	0.110*	-0.043	0.073**	-0.062***	0.050**	-0.029*
	(0.059)	(0.038)	(0.034)	(0.024)	(0.024)	(0.015)
R^2	0.001	0.053	0.001	0.049	0.001	0.038
No. obs.	437,980	437,980	648,322	648,322	648,322	648,322
Layers pre-reform = 2						
$OTSF$ reform	0.050	0.062	0.026	0.019	0.023	0.013
	(0.102)	(0.083)	(0.075)	(0.066)	(0.055)	(0.048)
R^2	0.002	0.037	0.001	0.015	0.001	0.009
No. obs.	88,359	88,359	92,394	92,394	92,394	92,394
Layers pre-reform = 3						
$OTSF$ reform	0.091	0.118	-0.038	-0.024	-0.032	-0.024
	(0.087)	(0.107)	(0.058)	(0.066)	(0.029)	(0.031)
R^2	0.000	0.028	0.000	0.012	0.000	0.010
No. obs.	43,781	43,781	44,089	44,089	44,089	44,089
Layers pre-reform = 4						
$OTSF$ reform	0.034	0.006	-0.035	-0.033	0.008	0.004
	(0.127)	(0.133)	(0.033)	(0.036)	(0.014)	(0.015)
R^2	0.001	0.027	0.001	0.040	0.004	0.053
No. obs.	36,321	36,321	36,370	36,370	36,370	36,370

The $OTSF$ variable is lagged one year. Regressions are for the sample of firms that drop layers after the reform. Odd-number columns include firm and year fixed effects and even-number columns include industry, municipality and year fixed effects. Other covariates include whether the firm is an exporter, whether it is multi-establishment, ownership, and age. Observations are at the firm-year level. Robust standard errors, clustered by municipality, in parentheses. * $p<0.10$; ** $p<0.05$; *** $p<0.01$.

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