Organizational Hierarchies in the Slovenian Manufacturing Sector

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Abstract

We study organizational hierarchies in a transition country. Using employer-employee matched data for a set of Slovenian manufacturing firms, we find strong support for the key hypotheses of the knowledge-based hierarchies proposed by Garicano (2000) and Caliendo and Rossi-Hansberg (2012). According to these theories, firms should organize in consecutively ordered layers with less hours and higher wages in higher layers. Following Caliendo, Monte, and Rossi-Hansberg (2015b), who were the first to test the predictions of knowledge-based theories of organizational hierarchies, we are able to directly compare our results to those obtained for French manufacturing firms. We find that Slovenian firms exhibit lower consistency with consecutive ordering of organizational layers, have on average fewer organizational layers and change them less frequently. We attribute lower organizational depth to the higher wage premia to workers in higher organizational layers, which is an implication of under-investment in human capital during the socialist era.

Keywords: Organizational hierarchies, human capital, wages
JEL classification: D21, D24, J24, J31

1 Introduction

Firms facing decisions regarding organization of production must deal with questions like how many and what kind of workers to hire, and what roles should they play. When facing rising demand, firms must decide whether to replicate their operations to a larger scale or instead reorganize their employees in teams. Similarly, when facing declining demand, they decide

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whether to reduce the number of workers, or change the organization of teams. The theories of knowledge-based hierarchies provide nuanced answers to such questions that often depart from traditional theory of labor demand with homogeneous workers.

In the seminal work Garicano (2000) develops a theory, which predicts that firms should organize their workforce in hierarchical layers, with the less-knowledgeable workers dedicated solely to the most routine tasks, while the more-knowledgeable ones deal only with more complex problems that might appear in production and give directions to the others regarding these harder tasks.[1] Caliendo and Rossi-Hansberg (2012) consider these decisions within the general equilibrium context featuring heterogeneous firms, which allows the authors to derive further theoretical insights that relate firm organization and its characteristics. A firm facing an increase (decrease) in demand or productivity, may add (drop) layers, as having many layers of management with more knowledgeable managers at the top, but much less knowledgeable employees in the bottom layers, allows it to have lower production costs. Changes in the number of layers are expected only when production costs fall with adding or dropping layers. If changes in value added are too small, firms may instead respond by changing the number of working hours.

In this paper we investigate whether the predictions of the theoretical model developed by Caliendo and Rossi-Hansberg (2012) also hold for Slovenian manufacturing firms. We examine the differences between firms with different number of hierarchical layers, and investigate the consequences of adding/dropping layers of management due to expansions/contractions in value added, as opposed to the case when they keep the same hierarchical structure. For this purpose we use a comprehensive annual employer-employee matched data set of Slovenian manufacturing firms covering the period 1997–2011. Using employee-level information on ISCO 88 4-digit occupation code, we map each worker into one of four possible hierarchical layers that each firm can have, thus obtaining a data set that is suitable for testing the implications of the model by Caliendo and Rossi-Hansberg (2012). In our empirical analysis we follow closely the empirical methodology used by Caliendo et al. (2015b), who analyze employer-employee data for French manufacturing firms, which makes many of our results directly comparable to those reported in their paper.

Our findings mostly confirm the theory of Caliendo and Rossi-Hansberg (2012) and are aligned with the results obtained by Caliendo et al. (2015b) for French manufacturing firms. First of all, we observe that Slovenian firms pay higher wages in higher layers; larger firms in terms of value added are also larger in terms of number of layers and hours of work, and pay higher wages. Second, we find that the probability of firms adding layers increases with value added, and that the probability of adding 1 layer is larger than that of adding more than 1 layer. Third, we note that firms adding more layers at a certain transition period tend to grow faster than their counterparts that diminish or preserve the same number of layers. In comparison to French firms, Slovenian firms tend to pay higher wage premia in higher layers and have fewer

[1] At the core of this cost minimization decision is the trade off between increasing returns to specialization (due to economies of scale in the use of knowledge) and matching problems to workers, which gets increasingly difficult with specialization.

organizational layers. We attribute these differences to relative scarcity of skilled workers in Slovenia, a heritage of under-investment in human capital during the socialist era, particularly in tertiary education (Bartolj, Ahčan, Feldin, and Polanec, 2013). Due to higher wage premia, Slovenian firms have weaker incentives to add organizational layers and are thus less likely to adjust them.

More to the point, we also explore firm dynamics in terms of hours of work and wages when firms grow in size, both with and without changing their number of layers. When firms grow in value added and keep the same number of layers, we observe that they hire more hours of work and increase wages in all layers. However, according to our estimated elasticities and compared to French firms in Caliendo et al. (2015b), we note that Slovenian firms tend to adjust more in terms of hours of work rather than in wages. Now, when firms grow by changing their organizational structure, the patterns we find also coincide with those observed for French firms in Caliendo et al. (2015b): firms that add (drop) a layer of management increase (decrease) hours of work, but decrease (increase) average wages in pre-existing layers. This is fully consistent with the theoretical prediction by Caliendo and Rossi-Hansberg (2012), as firms that decide to add (drop) a layer of management must be, at the same time, transferring knowledge upward (downward) by reducing (increasing) it in all layers that pre-date the corresponding transition. Again, our estimates suggest that Slovenian firms rely relatively more heavily on hours of work than on wages to perform said adjustments when compared to French firms.

Finally, we employ worker education and experience as more direct measures of knowledge, in the same manner as Caliendo et al. (2015b), in order to explore how firms redistribute those resources as they change their layer structure. Our results show that the theory holds well in Slovenian firms: in the vast majority of cases, when undergoing transitions that add (drop) layers of management, Slovenian firms decrease (increase) either average education or average experience in all pre-existing layers, as they transfer knowledge to (from) the newly added (dropped) top layers. In fact, Slovenian firms seem to transfer knowledge across layers via worker education and experience more than average wages reveal.

The structure of the paper is as follows. Section 2 contains a brief review of the most relevant literature on organizational hierarchies. Section 3 describes the sources of data and variables we use in our empirical estimations and Section 4 contains summary statistics. We present our key empirical findings in Section 5. Section 6 concludes.

2 Literature Review on Organizational Hierarchies

The study of organizations has been present in economics literature for a long time, with early works aiming mostly to explain the distribution of pay and firm size. One of the earliest investigations studies how managers monitor their subordinates using hierarchies (Calvo and Wellisz, 1978). This and several subsequent studies, however, feature neither an equilibrium approach for firms and the economy nor do they involve labor heterogeneity. Equilibrium analysis was initially introduced in a model developed by Garicano (2000), which represents a cornerstone in the theory of knowledge-based hierarchies. In his model, firms minimize the costs of producing output by organizing their employees in teams, with the less-knowledgeable workers dedicated solely to the most routine tasks, while the more-knowledgeable ones deal with more complex problems that might appear in production processes. Thus, knowledge-based hierarchies arise in the firm, with labor specialization leading to a more efficient allocation of working time, and the organizational problem lies in determining the proper quantities and distribution of knowledge, as well as the ways of communication within hierarchies. However, one of the simplifying assumptions made by Garicano (2000) is that all workers have the same learning and communication abilities. This assumption is relaxed in the models developed by Garicano and Rossi-Hansberg (2006, 2012), which assume ex-ante heterogeneity of workers embedded in a dynamic framework. This allows them to study the effects of communication and information technologies on economic growth through their impact on firm organization and innovation. Caliendo and Rossi-Hansberg (2012) use the same model of knowledge-based hierarchies, this time allowing heterogeneity in the demand that firms face, to analyze the effect of international trade on firm organization. By calibrating the model to U.S. data and running simulations, they find that due to bilateral trade liberalization exporting firms will increase the number of management layers. Hence, the theory of knowledge-based hierarchies allows researchers to gain a better understanding of how firms organize internally, using layers of management in order to solve the problems that emerge in the production processes. More recently, Chen (2017) builds an industry equilibrium model in which firms use hierarchies as a means to gain efficiency in monitoring employees in the production process. Ke, Li, and Powell (2018) use a theoretical model based on Shapiro and Stiglitz (1984) to examine the impact of various internal policy decisions by firms aimed at increasing worker motivation within their ranks. One of the implications of their model is that firms tend to increase turnover rates at top layers and create more top positions in order to keep strong promotion incentives among workers.

In terms of empirical research, the study of organizational hierarchies in firms has been gaining momentum, especially after the development of theories featuring worker and firm heterogeneity (Garicano and Rossi-Hansberg, 2006, 2012; Caliendo and Rossi-Hansberg, 2012).[2] As mentioned, this new research focuses on the effects of demand shocks, especially of foreign demand shocks, foreign acquisitions, competitiveness programs, information and communication technologies, and trade costs, on organizational hierarchies; it also studies the effects of changes in organizational hierarchies on firm performance, like productivity and entrepreneurship.[3]

[2]Meagher (2001), using surveys of Australian employees, was one of the first to document wage premia for higher hierarchical positions.

[3]Our review of empirical literature is by no means comprehensive. Bastos, Monteiro, and Straume (2018) examine the impact of foreign acquisitions on organizational structures of Portuguese firms. Tåg, Åstebro, and Thompson (2016) analyze the relation between Swedish firms' hierarchical structure and the likelihood of their former employees becoming entrepreneurs. Caliendo, Mion, Opromolla, and Rossi-Hansberg (2015a) study the effects of firm reorganizations caused by expansions on the productivity of firms. Cruz, Bussolo, and Iacovone (2018) investigate the impact of competitiveness enhancing program for small and medium enterprises in Brazil on firms' internal organization. Bloom, Garicano, Sadun, and Van Reenen (2014) examine the impact of information technologies and communication technologies on the organizational structure of firms, whereas Gumpert (2018) studies how changes in communication costs affect their organizational structure.

A few studies analyze the relation between organizational structures, demand shocks and wages, in order to test the theoretical predictions by Caliendo and Rossi-Hansberg (2012). As our work is tightly related to them, we start our survey with these studies. Tåg (2013) uses linked employer-employee data from the Swedish manufacturing sector to find that firms with more organizational layers tend to be larger in terms of number of workers and value added, exhibit higher wages, and when they add a new top layer of management, bottom layers experience a decrease in average wages, whereas the opposite happens when firms drop said top layer. Caliendo et al. (2015b) provide similar results using a comprehensive employer-employee data set for French manufacturing firms. They provide a vast set of empirical tests that relate organizational structure, in terms of total number of organizational layers, to firm size, in terms of value added and working hours, and wages. For example, they compare the adjustment of wages and hours of work in firms that change their number of layers (i.e. adding or dropping one or more layers), as opposed to firms that keep the same number of layers across periods. They find that firms that grow in terms of value added without changing their hierarchical structure tend to increase wages in all layers, while firms that expand by adding one layer of management tend to decrease average wages in pre-existing layers. As our work closely follows theirs, we discuss their results along with ours below in order to avoid repetition.

Several recent empirical studies of organizational hierarchies exploit possibly exogenous variation in either trade costs or foreign demand. Guadalupe and Wulf (2010) analyze the impact of increased product market competition brought by the 1989 Canada-United States Free Trade Agreement on the depth of hierarchies and span of control in a set of large US manufacturing firms. They find that, for a firm with average tariffs before 1989, trade liberalization induced an increase in CEO span of control and a reduction in the number of management levels. Spanos (2016), also using French employer-employee data for the manufacturing sector combined with firm-transaction-level trade data, studies the relation between export performance and the organizational structure of firms. He finds a positive relationship between the total number of organizational layers and export performance: firms with more hierarchical layers tend to sell a greater value on average, to more destinations, and comprising a wider variety of products. Caliendo, Monte, and Rossi-Hansberg (2017) further examine how French firms' decisions of becoming exporters affect their organizational structure in terms of hierarchies. These authors find that, relative to non-exporters, exporter firms are larger, hire more hours of work, pay higher wages and exhibit more layers of management, and, in addition, new exporters are more likely to add new layers than non-exporters. Davidson, Heyman, Matusz, Sjöholm, and Zhu (2017) also examine the relation between the degree of global engagement (i.e. international commercial relations) of firms and the skill mix of the workforce they employ. Using employer-employee data on Swedish firms, the authors find that an increase in export shares in firms has the effect of shifting their labor structure towards more skilled personnel (i.e. professionals in finance, sales, computing and engineering).

3 Data Sources and Description of Variables

3.1 Data Sources

Our empirical analysis of organizational hierarchies is conducted using data for Slovenian manufacturing firms that operated during the period 1997—2011. We use three distinct data sets to construct a matched employer-employee data set, using unique firm and individual identifiers. Our main source of data, maintained and provided by the Slovenian Statistical Office, is the Slovenian Employment Registry (henceforth SER), which contains information on all registered employment contracts between employers and employees.[4] The former is obliged to report initiation and termination dates of contracts, which allows us to identify the matches between firms and workers, and to determine job tenure. Employers are also obliged to report detailed information on occupation (4-digit ISCO 88 and ISCO 08 occupational codes), educational attainment (ISCED codes), gender, hours worked, and type of employment contract (definite vs. indefinite) for all initiated contracts and any changes to these characteristics. From the events in the registry we construct annual data of employment spells. The most important information for studying organizational hierarchies is the occupation of employees, which is used to allocate workers to different organizational layers, as described in the next subsection.

The second source of data is the Slovenian Financial Authority (henceforth SFA), which collects personal-income tax filings and also contains information on labor incomes. Unlike typical personal-income tax data reported by employees, which lack information on the identity of employers paying wages, we use SFA data that is reported by employers.[5] Hence, the data on gross wages used in our empirical analysis contains both personal and firm identifiers that can be matched to employment spells. Incomes combined with employment spells allow us to calculate the hourly gross wages that were paid to employees by individual employers.

The last source of data is the Agency of the Republic of Slovenia for Public Legal Records and Related Services (henceforth AJPES). All registered firms are obliged to report annual balance sheets and income statements to AJPES, from which we extract information on annual sales, costs of material inputs and services, and total hours worked by all employees. These allow us to calculate the measures of firm-level demand/size — value added and total hours worked.

3.2 Description of Variables

The main focus of this paper is to study how firms organize their labor into different organizational layers and how these organizations change when firms expand or contract. Hence, it is essential to map workers with different occupations into organizational layers. We follow

[4]Employment contracts are registered with the Health Insurance Institute of Slovenia. The employment registry is maintained by the Statistical Office based on these records.

[5]Personal incomes reported by payees (firms, government entities etc.) were originally used for tax-inspection purposes, that is, to identify potential misreporting of personal incomes by individuals. More recently, these data have become the main source of individuals' personal incomes, while individuals are no longer obliged to file personal income statements.

Caliendo et al. (2015b) and map 4-digit ISCO 88 or ISCO 08 codes into four occupational layers $l \in L = \{1, 2, 3, 4\}$, where workers in the bottom layer (layer 1) perform the ordinary tasks in production, while higher layers deal with problems of increasing complexity. In particular, we distinguish between:

- Occupational layer 1: blue-collar qualified and nonqualified workers (assemblers, machine operators, drivers, laborers, office clerks, etc).
- Occupational layer 2: professionals and technicians at the supervisory level (engineers, safety and quality inspectors, technical supervisors, etc).
- Occupational layer 3: senior staff (production and operations department managers, chief financial officers, etc).
- Occupational layer 4: Firm owners, directors and chief executives (CEOs and general managers).[6]

The mapping from occupational codes to layers is, however, not unique and depends on the total number of occupations within a firm. For example, if a firm in a given year has employees with occupational codes 2 and 4, then the total number of layers is $L = 2$, and employees with occupational code 2 (4) belong to layer $l = 1$ ($l = 2$). So, as in Caliendo et al. (2015b) all firms have at least 1 layer and can take the decision of adding layers, up to a maximum of 4.

Aside from the organizational layer each employee belongs to and the total number of layers in each firm and year, the main variables we use throughout our empirical analysis are: firm-level measures of demand/size—value added and number of working hours, and hourly gross wage for each worker.[7] Using employer and employee identifiers, we are able to construct firm-level totals and averages per year, which we use in our empirical analysis. For the final exercise in this paper, we also use years of formal education for each worker and use them to construct a measure of potential experience.[8]

Our analysis is conducted on a sample of firms from the manufacturing sector. Namely, for the period 1997–2008 we include firms that reported main economic activity within 2-digit industry code 15–37, according to NACE Rev.1.[9] As firms' income statements were reported in Slovenian Tolars prior to 2007, we convert those to Euros using a fixed exchange rate of 239.64 Tolars per Euro. In order to calculate real wages and value added, we deflate nominal

[6]We identify firm owners who are actually employed as managing directors using information on basis for social insurance.

[7]Note that our entire empirical analysis relies on gross wages as these are specified in employment contracts. For brevity we refer to these as wages.

[8]Potential years of experience (X) is calculated as $X = A - T - 6$, where A is age of individual, T is the number of years spent in formal education and 6 is the statutory school entry age in Slovenia. The number of years of schooling is calculated using ISCED codes of the highest completed level of education. Namely, primary school is given 8 years of schooling, high school is attributed 12 years of schooling, bachelor's degree is given 16 years of schooling and PhD degree corresponds to 20 years of schooling.

[9]During the period 2009–2011 firms reported industry codes according to NACE Rev.2 codes. We used a concordance between the two classifications for firms entering the sample after 2008, and the NACE Rev.1 code reported in 2008 for continuing firms.

Table 1: Summary statistics for the sample of Slovenian manufacturing firms, 1997–2011

Variable	Firm-worker-year Observations	Firm-year Observations	Mean	S.d.
Wage	3'302,751	71,730	5.05	2,69
Total Hours	3'302,751	71,730	82,488	337,089
Total Layers	3'302,751	71,730	2.28	1.01
Value Added	3'302,751	71,730	1,011	6,399
Experience	2'975,299	66,535	23.22	10.19
Education	3'151,241	71,275	10.49	2.66

Note: This table presents the total number of firm-worker-year and firm-year observations for each variable. Means and standard deviations are calculated from firm-level values. Firm-level values for variables that are observed at the level of individual workers (i.e. wage, experience and education) are averages calculated at the level of firms. Value added is reported in thousands of 2004 Euros, whereas hourly wage is reported in 2004 Euros.

values using the consumer price index with base in 2004 (the year in which the exchange rate was fixed).

We restrict our sample to employer-year observations that reported positive sales, total labor costs and costs of materials and services, which are used to calculate value added. Due to our focus on organizational hierarchies, we restrict the sample to firms with at least one employee. For this set of firm-year observations we only preserve employer-employee-year observations for which we have information on annual gross wage paid by employer to employee. The final sample used in our empirical analysis is described in Table 1. In our main analysis we use 3.3 million firm-worker-year observations for almost 72 thousand firms. On average, these firms paid a wage around 5 EUR (in 2004 prices), hired around 82 thousand hours of work, had on average 2.3 total organizational layers, and produced around 1 million EUR in real value added. The samples of observations for the two direct measures of knowledge (years of education and potential years of experience) are slightly smaller due to missing values. Average years of schooling and work experience for workers with available information are 10.5 and 23 years, respectively.

4 Summary Statistics on Layers and Other Key Variables

The basic prediction of the theories of knowledge hierarchies (see Garicano (2000), Garicano and Rossi-Hansberg (2006, 2012), and Caliendo and Rossi-Hansberg (2012)) states that in order to minimize production costs, firms position their workers within hierarchies based on their level of knowledge. Assuming that wages reflect the level of knowledge associated with employees' occupations, we should observe that workers in higher layers earn higher average wages. Table 2 compares average hourly wages and selected percentiles of wage distributions across layers. Evidently, higher layers are indeed associated with higher average wages and wages in all percentiles of wage distributions. This finding is consistent with the evidence reported by Caliendo et al. (2015b) for French manufacturing firms. Due to differences in average productivity between Slovenian and French firms, direct comparisons of wages are not meaningful.[10] Instead, we compare the wage premia associated with layers in the two countries. To calculate wage premia for French firms, we use wages reported in Table 1 in Caliendo et al. (2015b).[11] We find that the employees of Slovenian (French) firms in the fourth layer earn wages 89 (70) percent higher, on average, than the employees in the third layer. Similarly, Slovene (French) employees in the third layer earn hourly wages 99 (80) percent higher, on average, than those in the second layer, whereas the premium in the second layer in comparison to the first layer is 40 (35) percent in Slovene (French) firms. These premia are significant in both countries, although employees in Slovenian firms in the top-two layers earn significantly higher premia than workers in French firms. In summary, wage inequality in French firms seems to be lower than that observed in Slovenian firms, which may also affect motivation for adding organizational layers.

Table 2: Hourly Wage Distribution by Layers

Layer	Average Hourly Wage	p.5	p.10	p.25	p.50	p.75	p.90	p.95
1	4.54	2.39	2.76	3.35	4.17	5.27	6.61	7.69
2	6.14	2.65	3.05	4.00	5.52	7.48	9.67	11.55
3	11.65	3.44	4.07	6.05	9.68	14.78	20.99	26.27
4	22.05	4.71	6.33	10.63	18.85	29.27	41.38	49.95

Source: Own calculations based on data from SER, SFA and AJPES.

Notes: This table presents average hourly wage and hourly wage in the corresponding percentile (in 2004 Euros), by layer. We use firm-level average values as units of observation. The mean hourly wage and percentiles in every layer are calculated for the sample of all firms and across all years of observations within our sample.

Table 3 shows the dynamics of the number of firms and the average values of the main variables of interest. The number of firms had been increasing until the onset of the economic crisis of late 2008. Regarding hierarchies, the average number of layers was between 2.20 and 2.35 over this entire period, which is slightly lower than the values reported by Caliendo et al. (2015b) for French firms (2.51–2.60). This comparison suggests that Slovenian firms are less hierarchically organized. This is somewhat surprising as the average number of working hours in French firms (69–78 thousand hours) is slightly lower than that in Slovenian firms. It is also interesting to observe that the average number of layers in Slovenia declined during the economic crisis, falling from 2.32 in 2007 to 2.20 in 2011.

One of the main predictions of theoretical models on knowledge-based hierarchies is that larger firms should find it optimal to choose more layers and pay higher average wages. Both of these features are evident in our sample of firms. In Table 4 are shown averages of value added, total hours of work and hourly wage, as well as median hourly wage, calculated separately for

[10] The average hourly wage of Slovenian firms is roughly one quarter of that paid by French firms.

[11] Although Caliendo et al. (2015b) do not report wages by layers, we used average wages of five groups of occupations, which correspond to four layers, assuming consecutively ordered layers.

Table 3: Dynamics of Main Variables by Year

		Average			
Year	Active firms	Number of Layers	Hourly Wage	Value Added	Total Hours
1997	4,007	2.27	4.09	1,056	101,685
1998	4,166	2.24	4.17	987	96,529
1999	4,206	2.25	4.32	1,034	97,079
2000	4,404	2.27	4.39	1,052	95,329
2001	4,518	2.29	4.61	1,066	90,975
2002	4,674	2.33	4.73	1,070	90,548
2003	4,738	2.33	4.85	1,075	87,633
2004	4,823	2.35	4.88	1,026	85,231
2005	4,986	2.33	5.05	1,005	81,865
2006	5,138	2.32	5.26	1,049	78,548
2007	5,289	2.32	5.56	1,061	74,943
2008	5,443	2.30	5.70	979	73,382
2009	5,378	2.24	5.58	890	67,196
2010	5,222	2.21	5.80	875	64,594
2011	4,738	2.20	6.01	979	65,923

Source: Own calculations based on data from SER, SFA and AJPES.

Notes: The average values are calculated from the firm-level values for our sample of firms. Average value added is reported in thousand (2004) Euros and average hourly wage is given in 2004 Euros. Total hours are calculated as the sum of hours for all employees in a firm in a given year.

Table 4: Description of Main Variables by Total Number of Layers

Number of Layers	Firm-Years	Median Hourly Wage	Average		
			Hourly Wage	Value Added	Total Hours
1	19,140	3.88	4.39	41.30	3,552
2	22,872	4.35	4.84	182.57	17,131
3	19,853	5.03	5.44	855.53	80,899
4	9,865	5.65	6.05	5,125.46	390,363

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents the number of observations (firm-years) and the average values for the referenced variables by total number of layers. Median and average hourly wage are given in 2004 Euros, whereas average value added is reported in thousands of 2004 Euros.

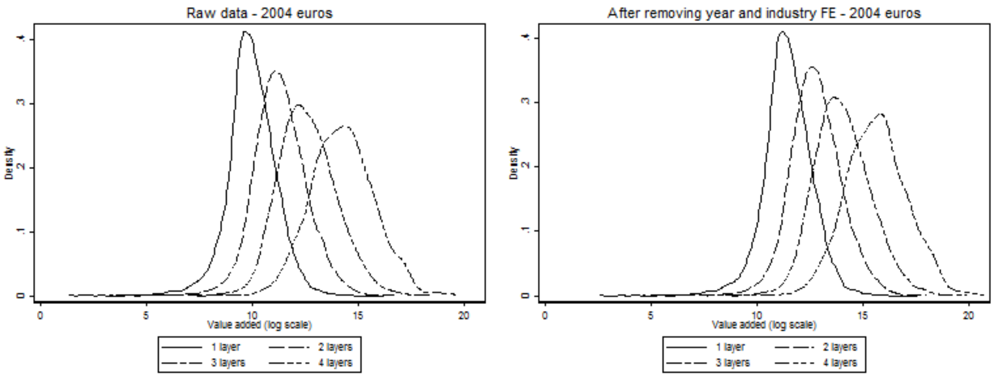
firm-year observations with different total number of layers. While main patterns are broadly consistent with those documented for French firms, there are some important differences. Average hourly wages in Slovenian firms monotonically increase with total number of layers, while this is not the case for French firms.[12] Namely, average hourly wage increases with total number of layers by roughly 10 percent for Slovenian firms, whereas in France, it is the highest for firms with only one layer, and increases modestly between firms with 2–4 layers. We attribute this difference to the higher wage premia for higher layers, which we have discussed above, and is related to the relative scarcity of college educated persons who are the predominant group of workers in the third and fourth layers.[13]

Figures 1, 2 and 3 present kernel density plots of the distributions for value added, total hours of work and average hourly wage (all in logs), for 1-, 2-, 3- and 4-layered firms. We follow the same procedure as Caliendo et al. (2015b), and report densities for both raw data and transformed variables after removing year and industry fixed effects. In Figure 1 we again see how firms with more layers of management are also larger in terms of value added, even after controlling for year and industry fixed effects. In addition, Figure 2 shows that firms with more layers also tend to hire more hours of work. The relation between average hourly wage and number of layers in the firm, as presented in Figure 3, appears less striking, although more layers are clearly related to higher wages. These distributions for Slovenian firms exhibit qualitatively similar patterns for French firms in measures of firm size (value added and total hours), while the distributions for average hourly wages bear some important differences. Wage distributions in Slovenian firms are less skewed and feature thinner upper tails than in French firms. French one-layered firms exhibit particularly a thick upper tail, which may explain the non-monotonic ranking of average hourly wages in France.

[12]The rankings of median hourly wage, however, hold also for French firms.

[13]Bartolj et al. (2013) show that Slovenia had relatively poor educational attainment at the start of the economic transition from socialist to market economy, which leads to relatively high returns to college degrees during the period 1994–2008, a period that partly overlaps with our sample.

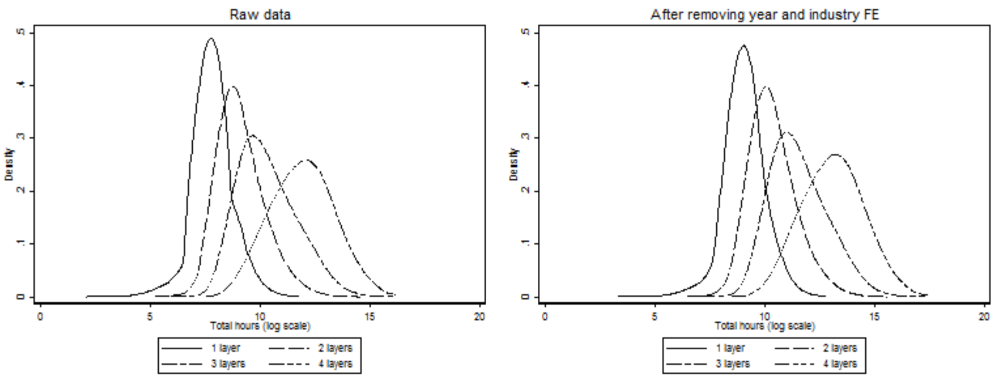
Figure 1: Distribution of Value Added by Total Number of Layers.



Source: Own calculations based on data from SER, SFA and AJPES.

Notes: This figure depicts the distribution of logarithm of value added by total number of layers. The left panel uses raw data in order to estimate kernel densities by groups of firm-year observations with the same number of layers. The right panel shows the distributions of value added after we remove year and industry fixed effects. To do so, we run a linear regression of the logaritm of value added on indicator variables for the number of layers in the firm, the two-digit NACE industry codes, and the year. We take firms with 1 layer of management in Food and Beverage Production (2-digit code 15) in the year 1997 as the base group. Then, we use the residuals of the previous regression, the median value added for the base group and the estimated coefficients for the number of layer dummies in order to estimate the log value added free of industry and year fixed effects. Finally, we compute the kernel-density estimates for the distribution of our log value added estimates, using the number of layers of each firm as the grouping variable.

Figure 2: Distribution of Working Hours by Total Number of Layers.



Source: Own calculations based on data from SER, SFA and AJPES.

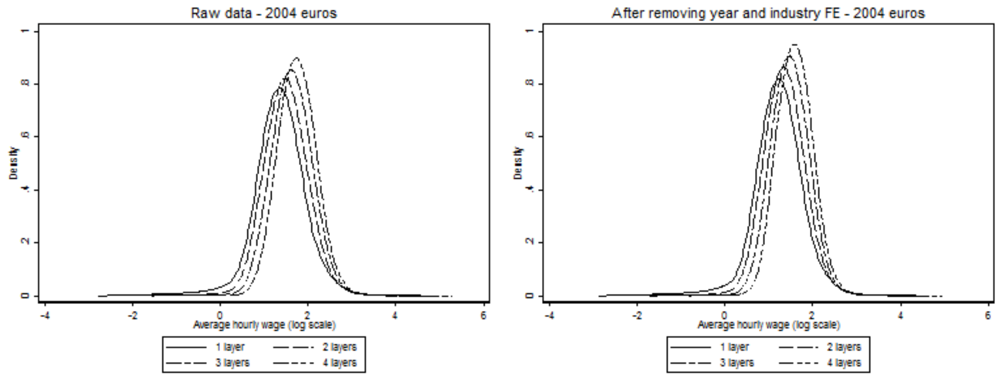
Notes: This figure presents kernel density estimates of the distribution of (log) working hours by total number of layers. The left panel uses raw data, whereas the right panel uses hours after removing industry and year fixed effects. To build it we use the same methodology as in Figure 1, after computing total working hours used in each firm-year.

5 The Empirics of Organizational Hierarchies in Slovenia

5.1 Consecutively Ordered Layers and Hierarchical Behavior

Next, we analyze layer management in Slovenian manufacturing firms. Specifically, we test whether firms' behavior is consistent with theoretical predictions by Caliendo and Rossi-Hansberg (2012) regarding the choices of number of hours in different layers, and how wages and working hours change when firms choose to add layers. The first prediction states that hours in layers

Figure 3: Distribution of Average Wage by Total Number of Layers.



Source: Own calculations based on data from SER, SFA and AJPES.
Notes: This figure presents kernel density estimates of the distribution of firm-level (average) hourly wage (in logarithm) by total number of layers. The left panel uses raw data, whilst the right panel removes industry and year fixed effects. To build it we use the same methodology as in Figure 1, after computing average hourly wage for each firm-year.

are *consecutively ordered*. Algebraically, $n_L^1 \geq \ldots \geq n_L^l \geq \ldots \geq n_L^L$ for all L, where n_L^l is the number of working hours at layer l in a firm with L total layers, where $l, L = 1, 2, 3, 4$ and $l \leq L$. This means that firms are hierarchical in the way they manage working hours, using more hours of work at the bottom layer, and employing less labor as we climb to higher layers. The second hypothesis states that, given the level of demand a firm faces, w_L^l (i.e. hourly wage at layer l in a firm with L total layers) should decrease and n_L^l should increase, at all l, if L increases. This means that as firms add layers of management, we should find that wages in pre-existing layers decrease, while the number of working hours increases in such layers, given that the tasks of solving more demanding problems get transferred to the new top layer. We examine whether this behavior, observed in French firms (Caliendo et al., 2015b), also holds in our sample of firms.

We first investigate whether Slovenian firms choose to organize in layers that are consecutively ordered. According to Caliendo et al. (2015b) a firm has such ordering if it has the proper types of occupations in each of its layers. Namely, if a firm has only 1 layer, then its employees must belong to occupation 1; if a firm has 2 layers, its employees must belong to occupation 1 and 2; if it has 3 layers, its employees must belong to occupations 1, 2 and 3; and if a firm has all 4 layers, then it must include all 4 types of occupation. Table 5 presents the percentages of firm-year observations fulfilling this feature, separately by the total number of layers. Taking all observations in our sample into account, we find that 55.36 percent of them fulfill the condition of having consecutively ordered layers, which is quite high. The degree of fulfillment further increases above 90 percent once we weight firms by value added or hours of work. However, when compared to French firms these proportions are significantly lower, since the corresponding unweighted and weighted proportions of consecutively ordered firms in French firms are 82 percent and 96 percent, respectively. The proportions of consecutively ordered firms in Slovenia are lower in all but 4-layered firms, which suggests that discrepancies are quite common. This finding is consistent with the fact that French firms have on average more layers, which are more likely to be consecutively organized, but nevertheless somewhat surprising in the light of the Slovenian socialist heritage, which featured large hierarchies.[14] It suggests that particularly new firms tend to deviate from the hypothesized consecutive ordering. Further inspection of the data shows that main departures are primarily related to the classification of managers/executives in small firms, who may be the only employee in firms (and often perform multiple tasks), or may directly manage employees in the first layer. These may be considered as misclassified, as the tasks of such managers may not correspond to those in the top layer.[15]

Table 5: Firm-Year Observations with Consecutively Ordered Layers

	Firm-Year Observations With				
	1 Layer	2 Layers	3 Layers	4 Layers	All obs.
Unweighted	49.27	56.18	38.12	100	55.36
Weighted by Value Added	62.17	79.27	72.62	100	91.98
Weighted by Hours of Work	68.30	80.84	72.66	100	90.95

Source: Own calculations based on data from SER, SFA and AJPES.

Notes: This table presents the percentages of firm-year observations that fulfill the condition of having consecutively ordered layers, where observations were grouped by number of layers. We also present the percentages of fulfillment, weighted by value added and by total hours of work hired.

Next, we examine whether firms exhibit hierarchical behavior with respect to the total hours of work they hire. According to the aforementioned theory, a firm with L total layers satisfies a hierarchy in hours between layers l and $l+1$, with $l = 1, \ldots, L-1$, if the number of working hours employed in layer l is larger or equal than the hours of work hired in layer $l+1$. For instance, a firm with 4 layers satisfies all hierarchies in hours of work if it hires more hours of work in the bottom layer than in the second layer, more hours of work in the second layer than in the third one, and more hours of work in the third layer than in the top layer.

Table 6 shows that the majority of firms in our sample satisfy hierarchical behavior with respect to hours of work. For instance, more than 71% of firms with 4 layers of management satisfy hierarchical order in all of their layers.[16] Slovenian firms with 3 and 4 layers—in comparison to French firms (Caliendo et al., 2015b)—tend to exhibit higher shares of firms with consistent ranking (based on all layers) by 8 and 14 percentage points, respectively, whereas in firms with only 2 layers the percentage is lower by 5 points. These numbers suggest that larger firms in particular tend to strongly comply with hierarchical patterns for hours.

Regarding hierarchical patterns for wages — according to Caliendo et al. (2015b) — a firm with total number of layers L satisfies a hierarchy in wages between layers l and $l+1$, if the average wage in layer $l+1$ is higher than or equal to the average wage in layer l. The results in Table 7 suggest that firms do exhibit such hierarchies regarding wages, albeit the percentage of

[14]We also investigated a subsample of firms with socialist heritage, defined as those that existed already prior to 1988—a year of deregulation of entry of privately-owned firms—and find them to be larger, to have four layers and thus to fully comply with the consecutive ordering of layers. The share of such firms (including their spin offs) is, however, relatively small in comparison to post-1988 entrants.

[15]Note that employers can select only one occupation in the registration forms for each employee, which may not fully correspond to the actual job description.

[16]The numbers are even higher when the percentages are weighted by firm value added. These are omitted for brevity, but available upon request.

Table 6: Firm-Year Observations with Hierarchies in Terms of Hours

Number of Layers	$N_L^l \geq N_L^{l+1}$ For all l	$N_L^1 \geq N_L^2$	$N_L^2 \geq N_L^3$	$N_L^3 \geq N_L^4$
2	81.72	81.72	...	...
3	72.23	84.40	87.06	...
4	71.24	88.71	96.26	82.94

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents the percentages of firms that fulfill the condition of having hierarchies in terms of working hours. A firm satisfies a hierarchy in hours between layers l and $l+1$ if the number of working hours in layer l is at least as large as the number of working hours in layer $l+1$. The second column reports the percentage of firms that satisfy hierarchies in hours at all layers at once, while columns 3 to 5 report this only at layer $l = 1, 2, 3$. The percentages are presented according to the number of layers in the firm, as the first column indicates.

4-layered firms satisfying this condition in all layers is not as high as it is regarding hierarchies in hours of work. In comparison to French firms these numbers tend to be similar in 3-layered firms, but higher (lower) in 4 (2)-layered firms.

Table 7: Firm-Year Observations with Hierarchies in Terms of Wages

Number of Layers	$w_L^{l+1} \geq w_L^l$ For all l	$w_L^2 \geq w_L^1$	$w_L^3 \geq w_L^2$	$w_L^4 \geq w_L^3$
2	73.68	73.68	...	...
3	62.61	75.15	85.40	...
4	64.34	91.52	88.15	80.84

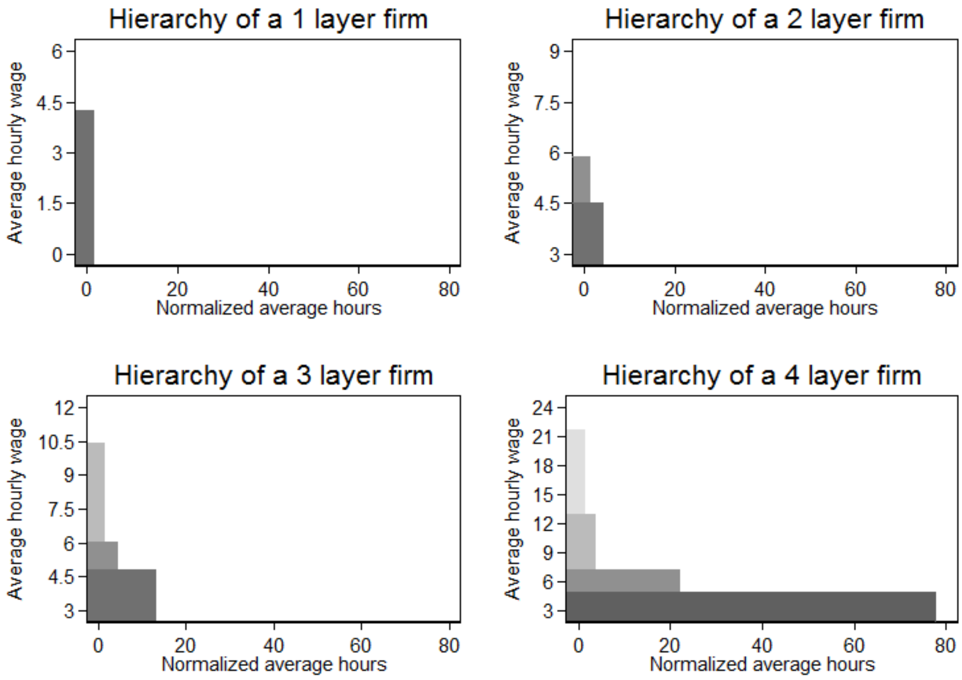
Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents the percentages of firms that fulfill the condition of having hierarchies in wages. A firm satisfies a hierarchy in wages between layers $l+1$ and l if the average wage in layer $l+1$ is at least as large as the average wage in layer l. The second column reports the percentage of firms that satisfy hierarchies in wages at all layers simultaneously, while columns 3 to 5 report this only at layer $l = 1, 2, 3$. The percentages are presented according to the number of layers in the firm, as the first column indicates.

The hierarchical organization within firms can also be presented graphically. Figure 4 presents a clearer view of the hierarchies of 1-, 2-, 3- and 4-layered firms in terms of normalized average hours of work (normalized by total hours in the top layer) and average wages. We can infer that firms use more hours of work in lower layers and pay lower average wages. As we move upward in the hierarchy, firms use less hours of work and pay higher average wages.

The fact that firms organize employees with different levels of knowledge into different hierarchies, as described above, should also be reflected in wage inequality across layers within firms. Namely, it should increase as they add new layers of management (see Garicano and Rossi-Hansberg (2006)). To investigate that, we follow the method used by Caliendo et al. (2015b). We regress the log-hourly wage of workers in each firm-year on a constant and dummy variables for all layers (excluding layer 1), extract the R^2, and compute the mean across all firms,

Figure 4: Firm Hierarchies Normalized by Hours in the Top Layer



Source: Own calculations based on data from SER, SFA and AJPES.
Note: This figure presents hierarchies of the average firm with $L = 1, 2, 3, 4$ layers. Following Caliendo et al. (2015b), we only use data for the middle tercile of firm-year observations according to value added, and for each group of firms with $L = 1, 2, 3, 4$ layers we compute average hours of work and average wage at every layer. We normalize average number of hours by dividing them by their value at the top layer. The x-axis measures normalized average hours of work in the L-layered firm at layer $l = 1, ..., L$, while the y-axis measures average hourly wage (in 2004 Euros) at each layer.

grouping firms by number of total layers. Hence, for each firm-year $i = 1, \ldots, N$ we estimate:

$$\log w_{i,j} = \alpha_i + \sum_{l=2}^{L} \beta_{i,l} D_{i,j,l} + \epsilon_{i,j} \qquad (1)$$

where log$w_{i,j}$ is the log hourly wage of employee j in firm-year i, and $D_{i,j,l}$ is a dummy variable for employee j in firm-year i in layer l, which takes the value of 1 if the employee in a given firm-year pair belongs to layer l, and zero otherwise. We also compute the mean R^2 using hours of work and value added as weights of observations with different numbers of layers.

Our results, reported in Table 8, show that cross-layer wage variation explains almost 43% of mean wage variation in Slovenian firms. When weighing these proportions of variations by hours hired or value added, the share of mean wage variation explained by cross-layer variation falls to around 30%, which suggests there is a negative relation between firm size (captured by hours of work and value added) and variance of wages due to layer variation. These percentages are lower in comparison to French firms, for which Caliendo et al. (2015b) report that cross-layer variation explains around 50% of unweighted and weighted mean wage variation.

Table 8: Average Share of Wage Variation Explained by Layer Variation

	Firm-Years	Unweighted	Weighted by Hours of Work	Weighted by Value Added
All Firms	58,700	42.86	29.12	30.21
Firms with More than 1 Layer	52,052	48.33	29.34	30.42
Firms with 1 Layer	6,648	0.00	0.00	0.00
Firms with 2 Layers	22,361	51.85	26.62	28.83
Firms with 3 Layers	19,826	48.17	29.59	31.17
Firms with 4 Layers	9,865	40.68	29.52	30.29

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents the mean R^2, across all firms and grouped by total number of layers, resulting from the regression $\log w_{i,j} = \alpha_i + \sum_{l=2}^{L} \beta_{i,l} D_{i,j,l} + \epsilon_{i,j}$, for each firm-year $i = 1, \ldots, N$, where $\log w_{i,j}$ is the log hourly wage of employee j in firm-year i, and $D_{i,j,l}$ is a dummy variable for employee j in firm-year i in layer l, which takes the value of 1 if said employee in said firm-year belongs to layer l, and zero otherwise. Thus, R^2 is a measure of wage variation due only to layer variation within firms. We also compute the weighted mean R^2 across firm-years, using hours of work and value added as weights. We should note that, for firms with 1 layer, there is no wage variation across layers since there is only one of them.

5.2 Firm Size and Layer Transitions

In this section we investigate firms' transitions in terms of number of layers. Using the method employed by Caliendo et al. (2015b), we compute the share of firms that, conditioned on having L layers in a certain year, add/drop, keep the same number of layers, or exit the sample in the next year.

According to Table 9, the majority of Slovenian firms—between 76 and 83 percent of them—in any given year tend to keep their number of layers unaltered until the next year, which means their hierarchical structure is slightly more rigid than that of their French counterparts, for which values around 62–71 percent were reported (Caliendo et al., 2015b). While lower transition probabilities may be partly related to higher exit rates among French firms, a higher rigidity of layers in Slovenia is still observed even when we consider transition probabilities for surviving firms alone. Table 9 also reveals that, similar to French firms, the exit rates for Slovenian firms also decline with total number of layers, which is consistent with the commonly observed fact that exit rates decline with firm size. Finally, Table 9 shows that when Slovenian firms decide to expand or contract their size in terms of layers, they do so by adding or dropping only one layer: transitions that add or drop more than one layer are not very likely.

Next we investigate how the probability of adding/dropping layers varies with firm size, measured in terms of value added. The theory by Caliendo and Rossi-Hansberg (2012) states that some firms will add new layers of management when receiving positive demand shocks and/or productivity improvements, and the probability of this happening is higher for firms with higher value added. Hence, a positive relation between value added and the probability of adding layers should be observed. To provide descriptive evidence that supports this prediction, Figure 5 presents a lowess smoothing interpolation of the fraction of firms that change their number of layers as a function of their value added, conditioned on the initial number of layers of the

Table 9: Layer Transition Matrix

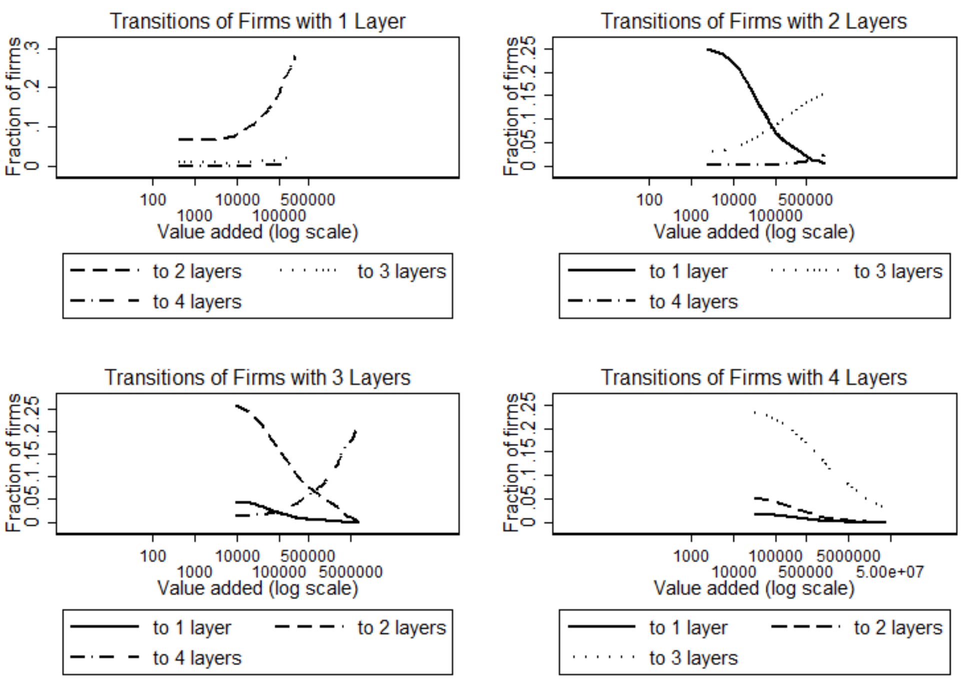
Number of Layers at t	Number of Layers at $t+1$					
	Exit	1	2	3	4	Total
1	10.43	77.06	11.40	1.05	0.06	100
2	6.34	8.37	75.95	8.94	0.39	100
3	4.75	0.95	9.66	78.73	5.91	100
4	4.19	0.28	1.03	11.43	83.08	100

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents the proportion of firms, among all firm-years, that conditioned on having $L = 1, 2, 3, 4$ layers in year t, decide to change/keep their hierarchical structure or exit the market in year $t + 1$.

firm, following the same method used by Caliendo et al. (2015b). Supporting the theory by Caliendo and Rossi-Hansberg (2012), Figure 5 shows that the probability of adding layers for Slovenian firms increases with value added, and that the probability of adding only one layer is always greater than that of adding more than one. At the same time, the probability of dropping layers decreases with value added. A visual inspection suggests that the behavior of Slovenian and French firms is very similar (Caliendo et al., 2015b).

Figure 5: Transitions Between Layers and Value Added



Source: Own calculations based on data from SER, SFA and AJPES.
Note: This figure presents lowess smoothing interpolations of the fraction of firms that change their number of layers as a function of their value added, conditional on the initial number of layers of the firm. The x-axis measures value added (in 2004 Euros), while the y-axis measures the fraction of firms with $L = 1, 2, 3, 4$ layers engaging in the respective layer transitions in the next year. We follow Caliendo et al. (2015b) in allocating groups of firm-years (by their total number of layers L) into 100 bins, according to their value added. Then, we compute in each bin the share of firm-years that engage in each type of layer transition in the next year. Finally, we graph the lowess plot of the fraction of firm-years in each type of transition against the average value added in each bin, for all bins.

5.3 Firm Dynamics before Transitions

In this part of our empirical analysis we test an implication of a frictionless extension of the static model of organizational hierarchies to a dynamic setting, as developed by Caliendo and Rossi-Hansberg (2012). According to their theory, firms that are subjected to demand and/or productivity shocks change their number of layers when the cumulative change in value added —since the last change in the total number of layers—is large enough. These premises imply that, conditional on their initial value added, firms that will add layers in period t should, on average, grow faster in terms of value added in comparison to other firms that will not make any layer transition. On the other hand, firms that will drop layers in period t should grow slower in the previous couple of periods than those that will not.

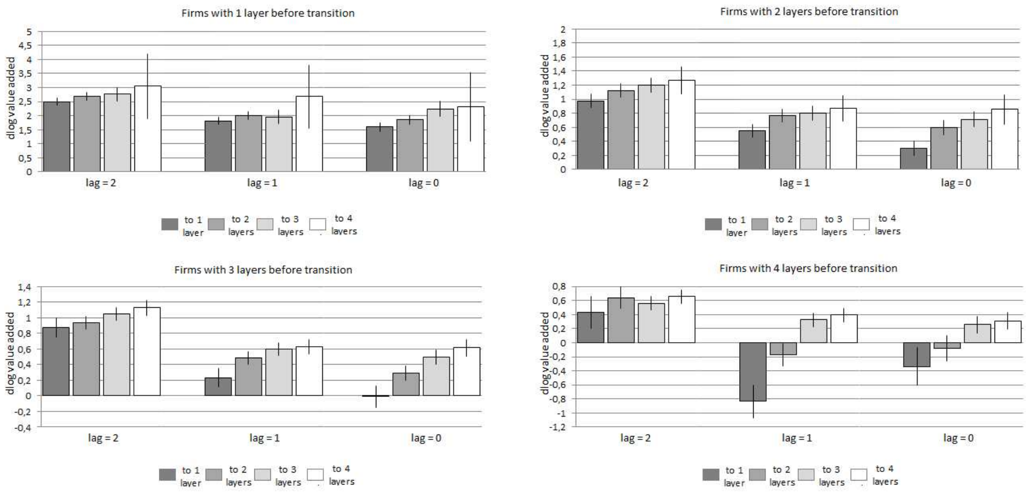
Our empirical test again follows Caliendo et al. (2015b), who estimate a dynamic model for value added and include indicator variables for layer switching as additional regressors. The sample is constructed using data on all firms with the layer sequence (L, L, L, L') over time for any L, where $L' = 1, 2, 3, 4$; that is, firms that keep the same hierarchical organization for 3 years in a row, and in the 4th year either make a transition, or maintain the previous number of layers. For these firms we run the following regression, with varying number of time lags, $k = 0, 1, 2$:

$$\mathrm{dlog}\widetilde{VA}_{i,t-k} = \sum_{L'=1}^{4} \gamma^1_{LL',t-k} D_{LL'} + \gamma^2_{L,t-k} \log VA_{i,t-k} + \epsilon_{i,t-k}. \tag{2}$$

where $\mathrm{dlog}\widetilde{VA}_{i,t-k}$ corresponds to the log difference in detrended real value added between periods $t-k$ and t for firm i. To detrend variables we use aggregate trends and, following Caliendo et al. (2015b), divide the original variables by their yearly average among firms belonging to the same group, e.g. $\widetilde{VA}_{i,t-k} = \frac{VA_{i,t-k}}{\overline{VA}_{t-k}}$. $D_{LL'}$ is an indicator variable that assumes a value of 1 if a firm with L total layers in period $t-k$ ends up with L' total layers at the end of the sequence and a value of 0 otherwise. $\gamma^1_{LL',t-k}$ is the corresponding regression coefficient that measures the effect of transitioning from L to L' total layers on the mean growth rate of detrended value added, $k = 0, 1, 2$ periods before the transition occurs, conditioned on the firm's value added at the same period; the effect of initial value added on the detrended growth rate in value added is captured by the regression coefficient $\gamma^2_{L,t-k}$. Finally, $\epsilon_{i,t-k}$ denotes the error term, assumed to be normally distributed with mean zero and variance σ^2_k.

Figure 6 shows our estimates for $\gamma^1_{LL',t-k}$, as well as the corresponding 95 percent confidence interval, two periods before, one period before, and for the period of transition, conditioned on the respectively lagged log value added. We can see that firms that add layers at the transition period $k = 0$ grew faster in the preceding periods than firms that kept (or reduced) their number of layers at the transition period. In general, the more layers they add/drop in the transition period, the larger/smaller is their growth in value added in the preceding years, although these differences may not always be statistically significant. We take this evidence as support for the hypothesis that firms need to pass a certain firm-specific threshold regarding their size in order to decide to change their hierarchical structure. It is interesting to note that almost all of our estimated effects for Slovenian firms tend to be significantly higher than those reported by Caliendo et al. (2015b) for French firms. In order to illustrate this point, consider firms with 3 layers before transition and lag 0 in both countries. Slovenian firms that shifted to 2 (4) layers had a productivity growth 20 (10) percentage points lower (higher) than those that kept 3 layers, whereas the corresponding French firms that shifted to 2 (4) layers had a less than 10 (less than 5) percentage points lower (higher) value added growth than those that kept 3 layers. This comparison suggests that Slovenian firms require a greater (relative) change in value added in order to adjust their total number of layers, which is consistent with the fact that Slovenian firms tend to have flatter organizations with a smaller average number of organizational layers.

Figure 6: Growth in Value Added before and at Transition Period



Source: Own calculations based on data from SER, SFA and AJPES.
Notes: This figure displays the estimates of regression coefficients $\gamma^1_{LL',t-k}$ (and their 95 percent confidence interval in each case) corresponding to indicator variables for various layer transitions (from $L = 1, 2, 3, 4$ to $L' = 1, 2, 3, 4$ number of layers). These coefficients are obtained from a dynamic equation for real value added: $d\log\widetilde{VA}_{i,t-k} = \sum_{L'=1}^{4} \gamma^1_{LL',t-k} D_{LL'} + \gamma^2_{L,t-k} \log VA_{i,t-k} + \epsilon_{i,t-k}$. The coefficient estimates are reported for $k = 0, 1, 2$ periods before layer transition for each group of firms, according to their number of layers before the transition.

5.4 Changes in Hours and Wages as Firms Expand or Contract

One of the theoretical implications of the model by Caliendo and Rossi-Hansberg (2012) is that, for firms that do not change their hierarchical structure, demand and productivity shocks increasing (decreasing) their revenues should increase (decrease) their hours of work and wages in all layers. Hence, in this section we analyze the changes that occur within different layers of management in firms as they expand or contract in terms of firm size. We first investigate the relation between real value added and normalized hours (normalized with respect to the number of hours employed in the top layer), for those firms that keep the same number of layers for two consecutive years. Specifically, we estimate the following equation

$$\mathrm{dlog}\widetilde{n}^l_{Li,t} = \beta^l_L \mathrm{dlog}\widetilde{VA}_{i,t} + \epsilon_{i,t}, \tag{3}$$

Table 10: Elasticities of Normalized Working Hours With Respect to Value Added, for Firms that Keep L Layers in Two Consecutive Years

Number of Layers	Layer	β_L^l	Standard Error	p-Value	Observations
2	1	0.108	0.009	0.000	15,925
3	1	0.139	0.008	0.000	14,525
3	2	0.129	0.010	0.000	14,525
4	1	0.152	0.013	0.000	7,666
4	2	0.135	0.014	0.000	7,666
4	3	0.107	0.016	0.000	7,666

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table shows our estimates of the elasticity of working hours to value added, β_L^l. These estimates are obtained from the equation $\text{dlog}\tilde{n}_{Li,t}^l = \beta_L^l \text{dlog}\widetilde{VA}_{i,t} + \epsilon_{i,t}$, where $\text{dlog}\tilde{n}_{Li,t}^l$ is the yearly log difference in detrended normalized hours of work, in layer l and total number of layers L, and $\text{d}\log\widetilde{VA}_{i,t}$ is the yearly log difference in detrended value added, both for firm i in year t.

Here $\text{dlog}\widetilde{n}_{Li,t}^l$ denotes log difference of detrended normalized hours of work in layer l for firm i and period t, keeping L total layers, whereas $\text{dlog}\widetilde{VA}_{i,t}$ denotes log difference in detrended real value added for the same firm-year observation. β_L^l denotes the elasticity of normalized hours of work in layer l for firms with L layers, with respect to value added, for firms that do not change layers in 2 consecutive years. Detrended normalized hours and value added are defined as: $\widetilde{n}_{Li,t}^l = \frac{n_{Li,t}^l}{\overline{n}_t}$ and $\widetilde{VA}_{i,t} = \frac{VA_{i,t}}{\overline{VA}_t}$, where $\overline{n}_t$ and $\overline{VA}_t$ are yearly average hours and value added, respectively.

Our estimates for the elasticity of hours of work with respect to value added, β_L^l, are shown in Table 10. We can see that, when firms grow in value added, they hire more hours of work in all layers, i.e. our estimates of β_L^l are all positive and significant in all cases. We also find that, given the total number of layers in the firm, the increase in hours of work hired is higher in lower layers. Our estimates of β_L^l also satisfy that $\beta_L^l > \beta_L^{l'}$ for $l < l'$, so that as firms grow in value added, they become flatter, employing proportionally more hours of work in the bottom layers. Comparing our results to those for French firms (Caliendo et al., 2015b), we observe that the elasticities for Slovenian firms tend to be significantly higher. Namely, the range of these elasticities for French firms is between 0.013 and 0.107, while the corresponding elasticities for Slovenian firms are between 0.107 and 0.152. This finding seems expected given our previous result that Slovenian firms are less inclined to change their organizational layers in response to changes in value added. Moreover, a comparison of the range of estimated elasticities between the two countries also suggests important differences in the adjustment of the number of hours across layers, as Slovenian firms exhibit a weaker flattening of organizational hierarchies.

Next, we use a similar estimation equation, only this time to estimate the elasticity of average wages to value added for firms keeping the same number of layers in two consecutive years. We estimate

$$\text{dlog}\widetilde{w}_{Li,t}^l = \gamma_L^l \text{dlog}\widetilde{VA}_{i,t} + \epsilon_{i,t}, \tag{4}$$

Table 11: Elasticities of Wages with Respect to Value Added, for Firms that Keep L Layers in Two Consecutive Years

Number of Layers	Layer	γ_L^l	Standard Error	p-Value	Observations
1	1	0.065	0.005	0.000	13,045
2	1	0.051	0.004	0.000	15,925
2	2	0.068	0.005	0.000	15,925
3	1	0.039	0.004	0.000	14,525
3	2	0.043	0.005	0.000	14,525
3	3	0.058	0.005	0.000	14,525
4	1	0.019	0.004	0.000	7,666
4	2	0.022	0.005	0.000	7,666
4	3	0.039	0.008	0.000	7,666
4	4	0.052	0.009	0.000	7,666

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents our estimates of the elasticity of average wage to value added, γ_L^l, for firms that do not change layers in 2 consecutive years. The estimates are obtained from the regression $\mathrm{dlog}\widetilde{w}_{Li,t}^l = \gamma_L^l \mathrm{dlog}\widetilde{VA}_{i,t} + \epsilon_{i,t}$, where $d\mathrm{log}\widetilde{w}_{Li,t}^l$ is the yearly log difference in detrended normalized average wage in layer l for firm i keeping L total layers for 2 consecutive years, and $\mathrm{d}\log \tilde{VA}_{i,t}$ is the yearly log difference in detrended value added for firm i at year t.

where $\mathrm{dlog}\widetilde{w}_{Li,t}^l$ denotes the yearly log difference in detrended average wage in layer l for firm i keeping L total layers for two consecutive years, and $\log \widetilde{VA}_{i,t}$ is the yearly log difference in detrended value added for firm i at year t. γ_L^l denotes the elasticity of average wage in layer l for firms with L layers with respect to value added, for firms that do not change layers in 2 consecutive years.

Table 11 presents our estimates for the elasticity of wages with respect to value added, γ_L^l. These results are again in line with the theory by Caliendo and Rossi-Hansberg (2012), as all of our estimates are significant, positive, and satisfy that $\gamma_L^l < \gamma_L^{l'}$ for $l < l'$. This means that, as firms grow in value added without adding layers, they increase wages in all their existing layers, although the increases are proportionally larger at higher layers. Comparing these results with those obtained for French firms (Caliendo et al., 2015b), we again observe important differences. Wage elasticities for Slovenian firms are relatively small, ranging between 0.019 and 0.068, whereas the corresponding elasticities for French firms are significantly higher, between 0.077 and 0.217. Interpreting these results jointly with our results on the elasticities of hours, we can deduce that among firms that keep layers unchanged, Slovenian firms tend to primarily adjust hours, whereas French firms mainly adjust wages.

Next, we consider the adjustment of firms depending on whether they decrease, increase, or keep the same number of layers of management over consecutive years. The implications of the theory by Caliendo and Rossi-Hansberg (2012) are now different than in the previous case. Firms that grow by adding a new top layer of management should hire more hours of work, but at the same time decrease wages in all pre-existing layers. Table 12 presents our estimates for the average differences in log of total hours of work, normalized total hours of work, value added and average firm wage, both including and excluding wages in the newly added/dropped layer, if so. It shows that, over consecutive years, and even after removing time trends in the variables, firms tend to increase their number of working hours, value added and wages when adding layers. This general pattern is consistent with that documented by Caliendo et al. (2015b) for French firms.

The same pattern is evident with respect to working hours and value added even when considering only firms that increase or do not change their number of layers. However, we find that on average firms that increase their number of layers also tend to increase their wages, whilst the theory implies that firms that add a layer of management should decrease wages in bottom layers, since they are reducing knowledge in all pre-existing layers and adding a new top layer in order to deal with uncommon problems. That is the reason why we also compute the average log change in wages only for common layers, i.e. those which firms had both before and after the change. The negative and significant estimates for firms that increase their total layers show that, in accordance with the theory, wages in all pre-existing layers tend to decrease once a firm adds a new top layer. On the contrary, when firms do not change layers or drop a top layer, wages in all pre-existing layers tend to increase. Once again it is necessary to point out the difference in adjustment of wages and hours between Slovenian and French firms. The former exhibit larger changes in total hours in response to changes in the number of layers[17], whereas the latter tend to make greater wage adjustments. A case in point are firms that expand layers. For these firms we observe that (i) the average growth rate of detrended total hours is 0.336 for Slovenian firms and only 0.04 for French firms and (ii) the wage growth rate in common layers is -0.059 for Slovenian firms, while the corresponding value for French firms is -0.101.

Next, we investigate a theoretical prediction stating that firms adding layers should increase their hours of work in all pre-existing layers and decrease wages in all pre-existing layers. This is done in Table 13, which shows the average changes in log hours of work and wages for firms that make a transition from L to L' total layers (for $L \neq L'$), layer by layer. We focus on firms that experience a layer transition as described by the first two columns, and we calculate the average log change in detrended normalized hours and wages in the (common) layer (stated in the third column). Focusing first on working hours, we confirm the theory as all our estimates are statistically significant, and for transitions with an increase (decrease) in the total number of layers the change is positive (negative). In comparison to French firms, we find that most (but not all) of the absolute values of the changes we observe are lower, which is exactly what we observed in Table 12 in the case of normalized working hours.

Regarding the adjustment of average wages to layer transitions, we note that the estimated coefficients are not all significant as in the case of working hours. Namely, out of 20 estimates, 12 are statistically significant (at the 1% level). More importantly, among the significant coefficients 11 out of 12 have the sign that is in line with the theory: in firms that add layers, wages tend to decrease in every pre-existing layer, and in firms that drop layers, wages should

[17]Note that the adjustment of normalized hours is smaller in Slovenia, which may be due to smaller absolute change in the top layer.

Table 12: Firm-Level Outcomes Conditioned on Layer Management

	All	Increase in L	No Change in L	Decrease in L
dlog Total Hours	0.045**	0.387**	0.043**	-0.299**
Detrended	-	0.336**	-0.003	-0.344**
dlog Normalized Hours	0.012**	1.078**	0.003	-1.046**
Detrended	-	1.066**	-0.009**	-1.058**
dlog Valued Added	0.020**	0.242**	0.012**	-0.136**
Detrended	-	0.222**	-0.008*	-0.116**
dlog Average Wage	0.021**	0.034***	0.020**	0.020**
Detrended	-	0.013**	-0.001	0.000
Common layers	0.021**	-0.037**	0.020**	0.088**
Detrended	-	-0.059**	0.000	0.067**
% of Firms	100.00	8.34	84.01	7.66
% Value Added Change	100.00	15.78	96.28	-12.06

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table reports changes in various firm outcomes, grouping firms according to the type of transition they experience between two years: increase in their total number of layers L, decrease in L, no change in L, and altogether. For changes in the average wage in common layers, we compute average wage only taking into account the layers that existed both before and after the referenced transition. To detrend variables, we again use aggregate trends following Caliendo et al. (2015b), as we explained above. In the last two rows, % of firms shows the percentage of firms engaging in each type of transition, and % value added change shows the share of total change in value added for the whole data set explained by firms in each type of transition. ***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively.

increase in every pre-existing layer. In comparison to French firms, for which Caliendo et al. (2015b) find all coefficients correctly signed and statistically significant, Slovenian firms again exhibit lower responsiveness of wages to layer transitions.

Continuing with the analysis of layers and wages, we follow Caliendo et al. (2015b) to decompose firm-level the log-change in detrended average wage in the firm:

$$\text{dlog}\bar{w}_{Li,t} = \log \bar{w}_{L'i,t+1} - \log \bar{w}_{Li,t} = \log \left[\left(\frac{\bar{w}^{l\leq L}_{L'i,t+1}}{\bar{w}_{Li,t}} \right) s + \left(\frac{\bar{w}^{L'}_{L'i,t+1}}{\bar{w}_{Li,t}} \right) (1-s) \right]. \tag{5}$$

Here $\bar{w}^{l\leq L}_{L'i,t+1}$ denotes the average detrended wage in all pre-existing layers in the firm after the transition from L to L' total layers, where $L' > L$. $\bar{w}^{L'}_{L'i,t+1}$ is the average wage in the newly added layer, $\bar{w}_{Li,t}$ is the average wage in the firm before the transition for all layers, and s is the share of working hours in pre-existing layers.

In Table 14 we report estimates for each component, separately by layer transitions. The upper left and right cells show average ratios that compare wages after and before transitions in common organizational layers. For example, for firms expanding from 1 layer to 2 layers, this ratio is 0.987 for workers that stayed in layer 1, which implies a modest reduction of average wage in common layers, as predicted by the theory of organizational hierarchies. Similarly, all reorganizations that add one layer also exhibit a decrease in the average wage. However, additions of more than one layer lead to growth in wages even in the common layers. These

Table 13: Average Change in Log-Hours and Log-Wages in Layer l, Conditioned on Transition Type

Total Layers Before	Total Layers After	Layer	$\text{dlog}\tilde{n}^l_{Li,t}$	S.E.	$\text{dlog}\tilde{w}^l_{Li,t}$	S.E.	Observations
1	2	1	0.515***	0.039	-0.080***	0.011	1904
1	3	1	0.833***	0.137	-0.044	0.049	165
1	4	1	2.621***	0.522	0.496	0.384	9
2	1	1	-0.610***	0.037	0.083***	0.013	1632
2	3	1	0.645***	0.038	-0.026***	0.007	1848
2	3	2	0.383***	0.041	-0.208***	0.012	1848
2	4	1	1.442***	0.235	0.050	0.051	77
2	4	2	1.581***	0.183	-0.054	0.065	77
3	1	1	-0.964***	0.120	0.118**	0.049	150
3	2	1	-0.629***	0.035	0.037***	0.009	1742
3	2	2	-0.523***	0.037	0.252***	0.014	1742
3	4	1	0.770***	0.039	0.002	0.006	1074
3	4	2	0.753***	0.042	-0.047***	0.010	1074
3	4	3	0.449***	0.048	-0.213***	0.019	1074
4	1	1	-1.846***	0.432	-0.074	0.270	22
4	2	1	-1.540***	0.209	-0.004	0.048	83
4	2	2	-1.466***	0.186	0.225***	0.081	83
4	3	1	-0.742***	0.038	-0.006	0.008	1033
4	3	2	-0.745***	0.039	0.037***	0.011	1033
4	3	3	-0.417***	0.045	0.275***	0.022	1033

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents the log changes in hours worked and wages in a specific layer, separately by total number of layers before and after transition. In each row are shown the estimates for firms transitioning from L to L' total layers in two consecutive years, where $L \neq L'$. Hours are normalized by hours in the top layer. Both wages and hours are detrended using aggregate trends. ***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively.

positive growth rates are consistent with our previous observations (Table 13), which showed that workers' pay in the first layer did not decline after the layer expansion. This is inconsistent with the theory and evidence provided by Caliendo et al. (2015b) for French firms, which systematically decrease wages in common layers after expanding the total number of layers. Nevertheless, further investigation of changes in the wages of workers in common layers (see Figure 8 below) shows that log-changes are mostly negative, especially for workers in higher percentiles of wage distributions.

The upper right panel shows the ratios between wages of workers in the new layers after the transitions in comparison to wages of workers before the transitions. Consistent with the theory and evidence for French firms (Caliendo et al., 2015b) we observe that the average wage in the newly added layer is far higher than the average wage before said transition. That is, when firms add layers, average wages in those new layers are significantly higher than average wages in pre-existing layers.

The overall effect of transitions on firm wages can be seen in the bottom-right panel, where we report the log change of the average wage. We mostly observe increases in the average wage for firms adding one or more layers, although the estimates are not statistically different from zero in 3 out of the 6 transition types. This result is in stark contrast to French firms, for which Caliendo et al. (2015b) report negative values in 5 out of the 6 transition types, and may be attributed to the fact that Slovenian firms only modestly reduce wages in pre-existing layers when expanding the total number of layers.

In order to complete the analysis of changes in wages in response to layer transitions, we also consider changes in the entire wage distribution. According to the theory by Garicano and Rossi-Hansberg (2006), reorganizations have an impact on wage inequality within firms. Again, we follow Caliendo et al. (2015b) in computing the log difference in wages before and after transitions for each percentile, as well as in building bootstrapped confidence intervals (5th and 95th percentiles of the replications). The plots in Figure 7 show that firms in our data set do exhibit some change in their wage distribution when performing a transition. For instance, when firms transition from 2 layers to 1 layer, the bottom percentiles experience an increase in wages higher than those in the top of the distribution. However, the impact of these transitions contains also the component of the newly added (or dropped) layer in the wage distribution. It may therefore be useful to look at changes in wage distribution by focusing only on the changes in wages in pre-existing layers. Figure 8 presents log changes in wages by percentiles, just as Figure 7, but conditioning on common layers before and after the transition. Here, the picture becomes clearer: wages tend to increase in pre-existing layers when firms drop a layer, especially in higher percentiles; also, when firms add a layer, they tend to decrease wages, especially in higher percentiles. These results are again in line with the theory by Caliendo and Rossi-Hansberg (2012) and the observed patterns in French firms (Caliendo et al., 2015b).

Finally, we use the methodology by Caliendo et al. (2015b) one more time in order to show how hierarchies in firms change in terms of normalized hours of work and wages when they experience transitions. Figures 9, 10 and 11 show how, when adding a layer of management,

Table 14: Decomposition of Log-Change in Average Wages, by Transition Type

	$\frac{\bar{w}^{l\leq L}_{L'i,t+1}}{\bar{w}_{Li,t}}$		
From/To	2	3	4
1	0.987***	1.125***	3.285*
	[1,866]	[163]	[9]
2		0.952***	1.130***
		[1,812]	[77]
3			0.971***
			[1,054]

	$\frac{\bar{w}^{L'}_{L'i,t+1}}{\bar{w}_{Li,t}}$		
From/To	2	3	4
1	1.098***	1.584***	8.726
	[1,866]	[163]	[9]
2		1.519***	2.014***
		[1,812]	[77]
3			2.772***
			[1,054]

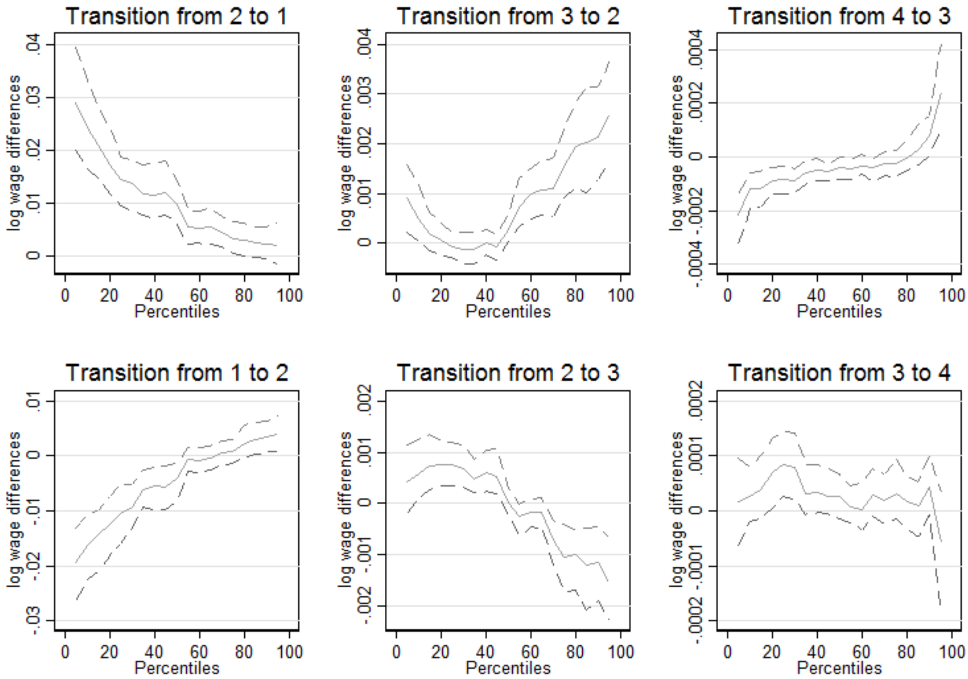
	s		
From/To	2	3	4
1	0.584***	0.488***	0.610***
	[1,866]	[163]	[9]
2		0.821***	0.822***
		[1,812]	[77]
3			0.953***
			[1,054]

	$\text{dlog}\bar{w}_{Li,t}$		
From/To	2	3	4
1	-0.004	0.075*	0.742
	[1,866]	[163]	[9]
2		0.005	0.076*
		[1,812]	[77]
3			0.016***
			[1,054]

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents estimates of the components of decomposition of the total log-change in average wage, by transition type, into average wage change in pre-existing layers, and in the newly added layer, both with respect to average wage before transition. For the top-left panel, we compute $\bar{w}^{l\leq L}_{L'i,t+1}$, which is the average wage in common layers (i.e. pre-existing layers before the transition occurs) after the corresponding transition from L to L' total layers (with $L' > L$), as well as $\bar{w}_{Li,t}$, which is the average wage before transition among all layers; after detrending both measures using again aggregate trends of wages, we compute the average ratio and its standard error. For the top-right panel we follow the same procedure, but this time we compute $\bar{w}^{L'}_{L'i,t+1}$, which is the average wage in the newly added layer after transition, in order to obtain its ratio with the average wage among all layers before transition (detrending both measures), and compute the average ratio. For the bottom-left panel, we calculate total hours of work in common layers (i.e. pre-existing layers before transition) and total hours of work among all layers, for those firms engaging in layer transitions; after detrending both measures, we compute the ratio of the former over the latter and calculate the average. Hence, s is an estimate of the share of hours of work in pre-existing layers. Finally, the bottom-right panel shows the estimates for total log-change in detrended average wage; to do so, we compute average wage both before and after transition, and after detrending both variables, we compute their log-difference, and calculate its average. ***, ** and * denote statistical significance at 1, 5 and 10 percent, respectively.

Figure 7: Change in Wage Distribution by Transition Type



Source: Own calculations based on data from SER, SFA and AJPES.

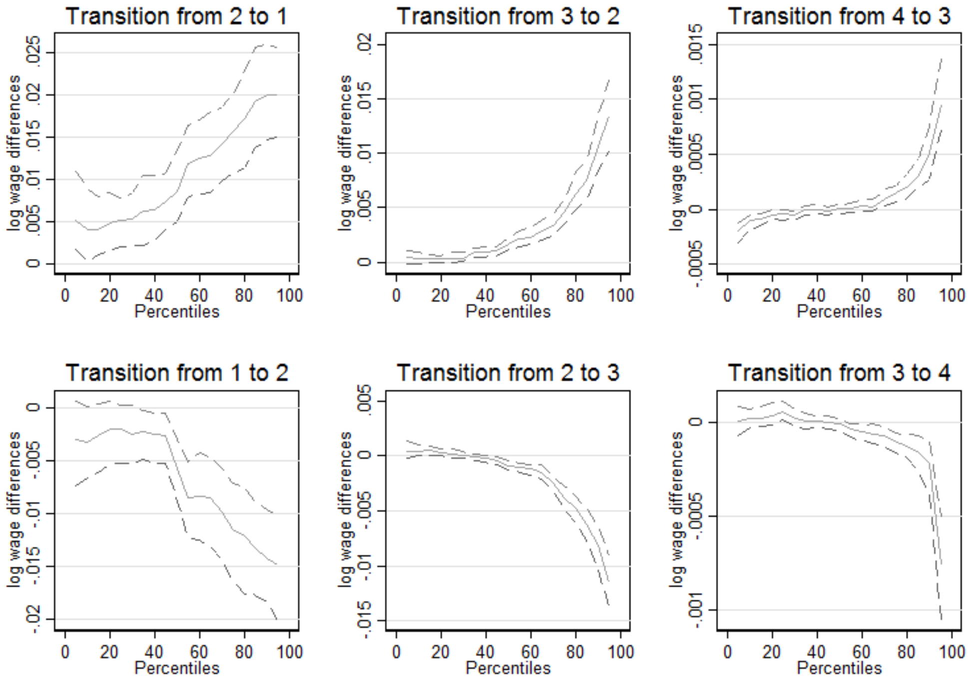
Note: This figure presents differences in log-wages after minus before each transition type, by wage percentile in our sample. Following Caliendo et al. (2015b) we remove firm and year fixed effects from log-hourly wage in the data set. Then, we weight this employee-level "clean" log-wage by the share of yearly working hours of each employee in each firm. After this, we compute the percentile wage distribution for each firm-year, i.e. we obtain 19 values of clean weighted log-wage for each firm-year, corresponding to the pth percentile, with $p = 5, 10, ..., 95$. We then focus on those firms engaging in each 1-layer transition type between 2 years (i.e. from L to L' total layers, with $L, L' = 1, 2, 3, 4$ and $|L - L'| = 1$), and compute the difference in our wage measure at each percentile. Next, using this percentile distribution of log-wage changes we have for each firm-year, we bootstrap its values and confidence intervals (5th and 95th estimated percentiles), with 500 replications and clustering by firm. Hence, we end up with an estimated percentile distribution of log-changes in wages for our whole sample, each estimated percentile with its own confidence interval, for those firms transitioning from L to L' total layers in each panel, with $L, L' = 1, 2, 3, 4$ and $|L - L'| = 1$.

firms tend to decrease average wages and increase the number of hours of work in pre-existing layers, while the newly added layer has, of course, the highest average wage and the lowest total number of hours of work in it. At the same time, when firms decide to drop a layer of management, they tend to increase average wages and decrease the number of hours of work in pre-existing layers.

5.5 Other Variables as *Proxies* of Knowledge

Our last exercise seeks to employ variables other than hourly wage that can also measure the level of knowledge within layers, which is what firms manage whenever there are expansions or contractions that induce them to change their organizational structure in terms of layers. As the model by Garicano (2000) states, firms use hierarchies in order to optimize their organizational structure by allocating workers and supervisors with different levels of knowledge to different layers. Depending on specific conditions, firms may decide to invest in knowledge acquisition for their workers, thus requiring fewer layers of supervisors dealing with more complex problems, or they may decide to reduce the knowledge of bottom layer workers and instead create a

Figure 8: Change in Wage Distribution in Common Layers by Transition Type



Source: Own calculations based on data from SER, SFA and AJPES.

Note: This figure presents differences in log-wages after minus before each transition type, by wage percentile in our sample, using only common layers (i.e. layers existing before and after the transition). We follow the exact same method we use to build Figure 7, but this time using only the pre-existing layers before each transition type in every firm-year to build the wage percentile distribution.

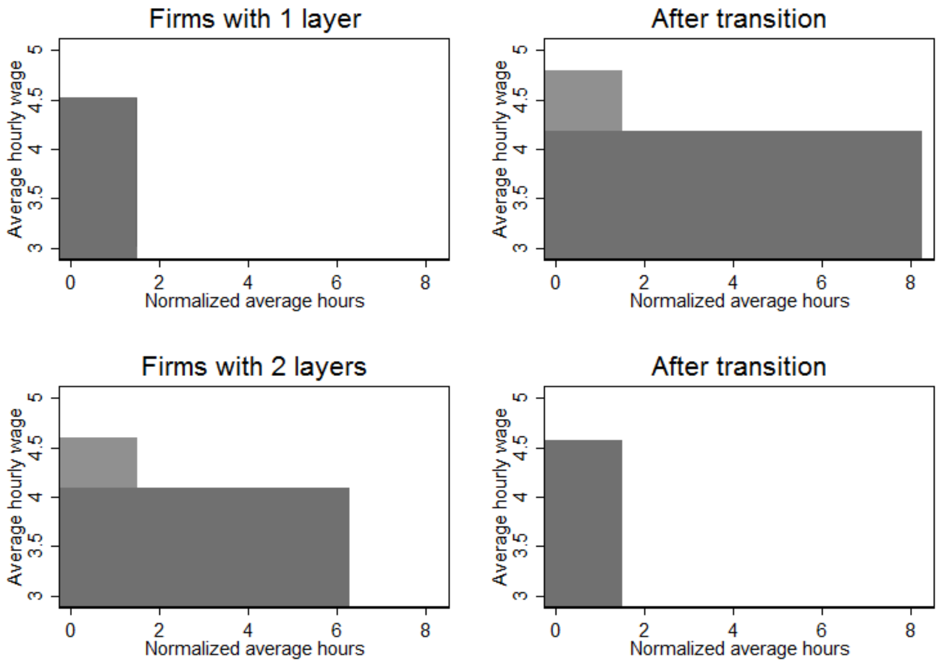
new layer of more knowledgeable problem solvers who will deal with more complex situations whenever they arise.

Thus far we used the variable "hourly wage" as a market-based measure for knowledge. Now, following Caliendo et al. (2015b) we use formal education and experience as more direct measures for the knowledge of employees, and examine how firms manage these as they grow in value added. As we mention earlier, the Slovenian Employment Registry data set contains employee-level information on educational attainment based on the International Standard Classification of Education codes, which we are able to transform into years of formal education.[18] In order to obtain worker experience, we follow Caliendo et al. (2015b) and compute what the authors call "potential experience" for each employee, by taking their age and subtracting their years of formal education from it, and subtracting again 6. Then, we compute average experience and average education by layer in each firm, take logarithms, and after detrending them using aggregate trends, we compute their difference after and before transition. Finally, we regress each of them on a constant for those firms engaging in layer transitions, in order to obtain average changes in experience and education, layer by layer, for firms transitioning from L to L' total layers, with $L, L' = \{1, 2, 3, 4\}$ and $L \neq L'$.

According to the model by Garicano (2000), firms that add new layers should exhibit a decrease in knowledge in pre-existing layers, as they hire more knowledgeable superiors in the newly

[18]We recode primary school into 8 years of schooling, attained high school degree to 12 years of schooling, finished 2-and 4-year undergraduate degrees to 14 and 16 years of schooling, respectively, master's degree to 18 years of schooling, and PhD to 20 years of schooling.

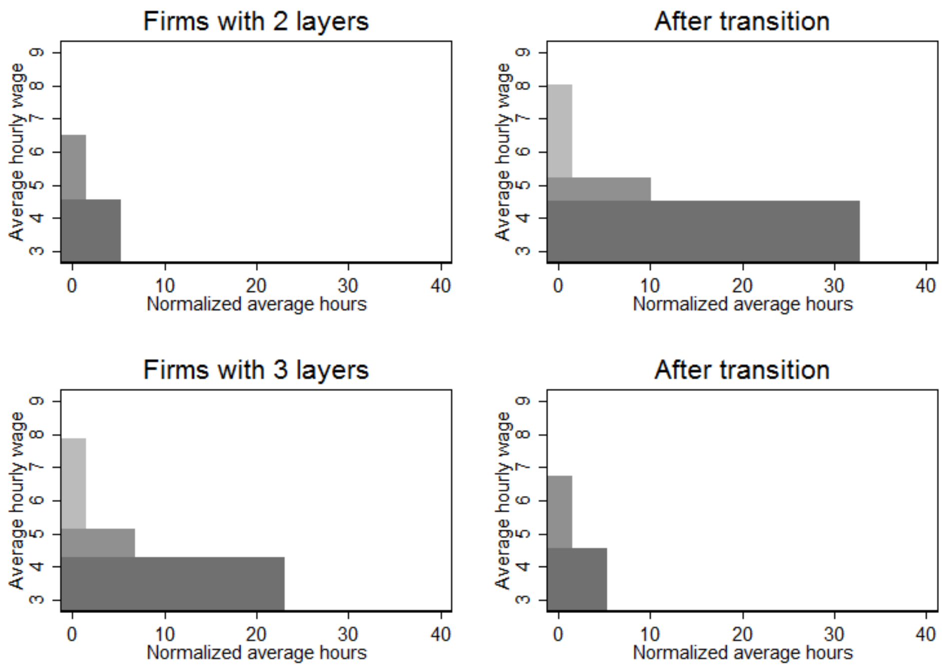
Figure 9: Representation of Transition Between One and Two Layers



Source: Own calculations based on data from SER, SFA and AJPES.

Note: This figure provides a graphical representation of hierarchies in the average firm before and after making the transition from 1 to 2, and from 2 to 1 total layers. To build it, we compute total hours of work in each layer, normalized by total hours of work in the top layer in every firm-year, as well as average wage. Finally, we focus in firms that transition from 1 to 2 total layers in consecutive years and compute the averages in normalized hours of work and mean wage among them, both before and after transitioning. We do the same focusing on firms that transition from 2 to 1 total layers.

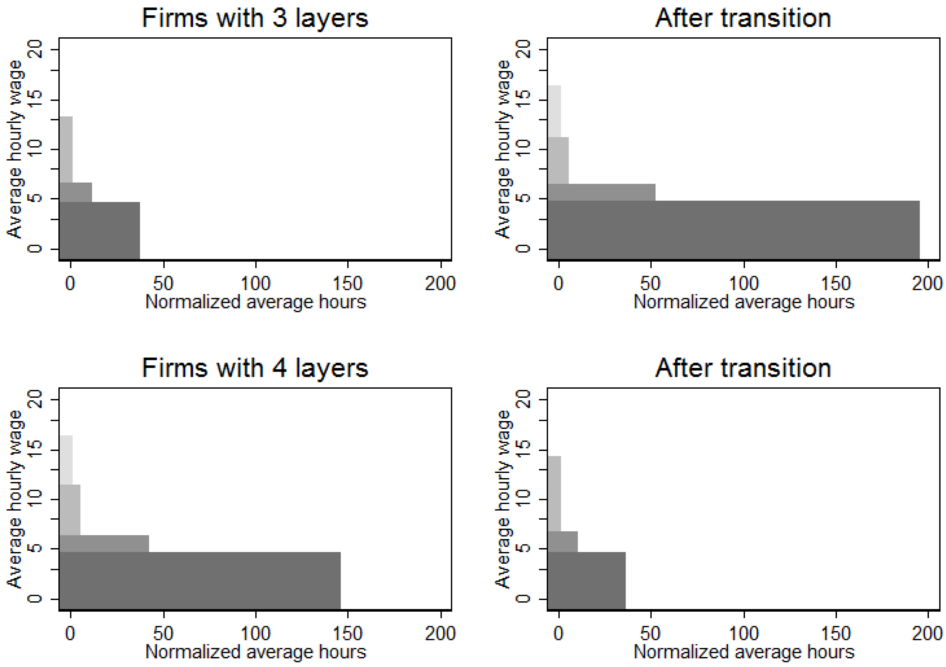
Figure 10: Representation of Transitions Between Two and Three Layers



Source: Own calculations based on data from SER, SFA and AJPES.

Note: This figure provides a graphical representation of hierarchies in the average firm before and after making the transition from 2 to 3, and from 3 to 2 total layers. We follow the same method used to build Figure 9.

Figure 11: Representation of Transition Between Three and Four Layers



Source: Own calculations based on data from SER, SFA and AJPES.
Note: This figure provides a graphical representation of hierarchies in the average firm before and after making the transition from 3 to 4, and from 4 to 3 total layers. We follow the same method used to build Figure 9.

added top layers, whilst firms that reduce their size and drop layers should increase their level of knowledge in pre-existing layers, as they need their bottom-layer workers to be able to solve more complex tasks that their supervisors had to tackle before.

Table 15 shows our estimates for average changes in experience and education by transition type. With respect to average years of formal education, out of the 10 transition types that add layers, 6 estimates are statistically significant (only one of them at the 10% level) and have signs consistent with the theory, i.e. a decrease in average education in pre-existing layers. On the other hand, out of the 10 transition types that drop layers, 8 estimates are significant (only two of them at the 5% level) and show the proper sign, i.e. an increase in average education in pre-existing layers. In comparison to French firms (Caliendo et al., 2015b), which exhibit mostly low and insignificant effects of reorganizations on average education, our results seem to lend more support to the theory.

Regarding experience, only 11 out of the 20 transition types altogether have the expected sign and are statistically significant. However, when considering both variables together, we note that only in 2 transition types are changes in average knowledge not significant, and in a third case it does not have the expected sign. In the remaining transition types in which average change in education is not statistically significant, average change in experience results significant and exhibits the correct sign.

Hence, our results suggest that in the vast majority of layer transitions, Slovenian firms alter average knowledge in pre-existing layers just as the theory predicts. In most cases, these come

Table 15: Average Change in Experience and Education for Firms, Conditioned on Transition Type

Total Layers Before	Total Layers After	Layer	Experience $\beta^l_{L,L'}$	Experience p-Value	Experience Observations	Education $\gamma^l_{L,L'}$	Education p-Value	Education Observations
1	2	1	-0.064	0.000	1,637	-0.046	0.000	1,785
1	3	1	-0.007	0.889	150	-0.117	0.000	160
1	4	1	0.263	0.320	8	-0.142	0.068	8
2	1	1	0.099	0.000	1,355	0.047	0.000	1,564
2	3	1	0.010	0.267	1,696	-0.015	0.000	1,815
2	3	2	-0.192	0.000	1,334	-0.015	0.000	1,451
2	4	1	0.085	0.094	72	-0.032	0.005	75
2	4	2	-0.063	0.281	67	0.006	0.670	71
3	1	1	0.060	0.185	111	0.109	0.000	149
3	2	1	0.027	0.003	1,537	0.019	0.000	1,721
3	2	2	0.175	0.000	1,180	0.014	0.000	1,361
3	4	1	0.018	0.000	1,024	0.004	0.046	1,072
3	4	2	-0.034	0.001	967	0.001	0.617	1,015
3	4	3	-0.089	0.000	1,025	-0.005	0.318	1,071
4	1	1	-0.048	0.836	12	0.133	0.017	20
4	2	1	0.057	0.159	72	0.012	0.569	83
4	2	2	0.118	0.096	69	0.022	0.173	79
4	3	1	0.026	0.000	958	0.009	0.000	1,033
4	3	2	0.048	0.000	916	0.005	0.013	991
4	3	3	0.053	0.000	954	0.024	0.000	1,030

Source: Own calculations based on data from SER, SFA and AJPES.

Note: This table presents our estimates for average changes in experience and educational attainment by layer, according to transition type. Employee-level educational attainment is one of the variables in the Slovenian Employment Registry data set. Following Caliendo et al. (2015b), we compute potential experience as employee's age minus their years of formal education, minus 6. Then, in each row we focus on firms transitioning from L to L' total layers in two consecutive years, with $L \neq L'$, and we compute log average experience and log average education for said firms at layer l (which exists in both years), where $l = 1, ..., min\{L, L'\}$. We again use aggregate trends in order to detrend both variables at layer l. Finally, we regress the detrended log change in experience and the detrended log change in education, each one by separate, on a constant, which yields our estimates for average change in experience ($\beta^l_{L,L'}$) and average change in education ($\gamma^l_{L,L'}$).

in the form of changes in average formal education, which in some cases are complemented with changes in average worker experience. In the couple of cases in which average formal education is not altered when undergoing a transition, it is average experience that firms decide to modify.

According to our results in Table 15, Slovenian firms that decide to add a layer of management hire more knowledgeable (in terms of education or experience) workers and/or promote the more educated/experienced ones into the new top layer, thus decreasing the average level of knowledge in bottom (pre-existing) layers, where they hire employees with a level of knowledge similar to the average. Firms undergoing a contraction such that they decide to drop a layer of management do the exact opposite, by transferring their more knowledgeable employees from the recently dropped top layer into lower layers, which will now have to tackle more complex problems. These dynamics are also consistent with the findings by Caliendo et al. (2015b), which allows us to conclude that wage variation due to layer transitions, as shown in Table 13, is backed up by changes in knowledge across layers. If anything, our results may suggest that, when undergoing layer transitions, wages in Slovenian firms tend to be a bit more rigid than the level of knowledge of their employees across layers.

6 Conclusions

This paper provides the first empirical investigation of knowledge-based organizational hierarchies for one of the Eastern European countries that underwent a process of economic transition. For this purpose we use a large employer-employee data set from the Slovenian manufacturing sector. We provide a set of summary statistics and empirical tests of various theoretical hypothesis (Garicano (2000), Caliendo and Rossi-Hansberg (2012)) regarding the dynamics of layer management by firms. Moreover, wherever possible, we compare our results to those reported in the seminal paper by Caliendo et al. (2015b) for French firms.

We find overwhelming support for the key theoretical predictions of the models with knowledge-based hierarchies. Namely, the firms in our sample also organize workers in layers, where larger firms in terms of value added tend to organize in more layers. This cross-sectional relationship seems to arise from demand or supply side shocks, as firms facing changes in value added are more likely to adjust their total number of layers. Slovenian firms frequently feature consecutively-ordered layers, which implies that firms tend to hire less hours of work and pay higher wages in higher layers. When firms decide to change the number of layers (due to changes in value added), they tend to change both hours and wages, but differently across layers. While workers in the newly added layers tend to receive higher wages, pre-existing layers tend to lose when firms expand the number of layers. In contrast, workers in pre-existing layers tend to gain when firms contract in terms of layers. These patterns are confirmed using not only wages but also direct measures of knowledge (education and experience).

In spite of qualitative similarities between our sample of firms and those reported by Caliendo et al. (2015b) for French firms, we find several differences. The number of organizational layers in Slovenia seems to be smaller, and the wage premia of workers in higher layers are significantly higher. Given the higher wage premia, Slovenian firms also seem to adjust layers less frequently and adjust them when value added exhibits greater variation. Slovenian firms tend instead to adjust more strongly in terms of working hours.

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