The Internal Spatial Organization of Firms: Evidence from Denmark*

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Abstract

We study the location and occupational composition of establishments within firms during the last 36 years. Using Danish administrative employer-employee data, we document four interesting results regarding the internal spatial organization of firms. We show that the average number of establishments per firm increased by 36% between 1981 and 2016. Moreover, the average distance of establishments and workers to their headquarters increased by more than 200%. These changes are mainly driven by a decentralization of production and business service workers, and a higher use of the latter. Finally, we show that the ratio of managers to production and clerical workers has been increasing, in particular in establishments located in the largest urban municipalities. These facts imply that firms are not simply becoming more spatially dispersed; instead, some activities such as managerial activities are increasingly concentrating around firms' central offices.

JEL: L22, L23, R00, R30.

Keywords: spatial organization, agglomeration, multi-establishment firms, firm fragmentation, occupational composition.

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1 Introduction

In 1890, Alfred Marshall documented that cities or regions often specialize by sector. The mechanisms he proposed are intuitive: labor market pooling, input sharing, and knowledge spillovers lead to this specialization and to the rise of agglomeration economies (Marshall, 1890).[1] More recently, Duranton and Puga (2005) argued that the patterns of specialization are shifting from sectoral to functional. Specifically, they show that larger cities increasingly specialize in headquarter activities, whereas other cities specialize in business services or production activities. The spatial organization of activity within firms plays an important role shaping these patterns, influencing regional differences and local economic dynamics. Therefore, understanding the internal spatial organization of firms is essential to understand the position of a city or a region in production networks.

In this paper, we study the internal spatial organization of firms. In particular, we study how the location and labor composition of different establishments within firms have changed in the last three decades. Understanding these facts is relevant given the importance of multi-establishment firms in the aggregate economy. For instance, in 2016 approximately 7% of all private firms in Denmark had more than one establishment. This share increased from around 3% in 1981. Moreover, multi-establishment firms account for around 47% of all private sector employment, 54% of total output revenue, and have lower exit rates. Studying these changes is a necessary first step before addressing questions concerning the causes and consequences of such organizational structures.

We study the organizational patterns using Danish register data between 1981 and 2016. These data contains all matches between employees and establishments every year, and therefore, we are able to follow every worker through every job they have had since 1981. Moreover, since the data has unique firm and establishment identifiers, we can determine whether the firm has one or multiple establishments, and observe the location of each establishment. In addition, we can observe the characteristics of the workers in each establishment, and its changes over time.

Using these data, we lay out four facts that describe the spatial organization of firms. Some of these facts are, to the best of our knowledge, new in the literature and represent the main contribution of this paper. First, we show that the average number of establishments within a firm increased by 36% between 1981 and 2016. Our evidence also suggests that multi-establishment firms are opening establishments at a faster rate than the rate at which they close. We refer to this phenomenon as an increase in firm fragmentation. Moreover, this increase holds for all four aggregate sectors in our sample: manufacturing, finance, insurance and real estate, business service, and transportation. The increase in the number of establishments per firm in the manufacturing sector has happened despite of the de-industrialization that has taken place in Denmark during the last decades (Bernard et al., 2017).

[1] See Combes and Gobillon (2015) for a recent survey on the literature studying the patterns of specialization and agglomeration economies.

Second, we document an increase of more than 200% in the average distance between firms' establishments and their headquarters (HQ). This fact implies that the degree of spatial decentralization has been increasing over time. Specifically, it also implies that firms are either replacing establishments that are closer to their HQ for establishments farther away, or opening new ones farther from the HQ. This increase holds when we weight each establishment by the number of workers they employ, suggesting that firms are not only opening establishments farther away, but also placing workers farther from the HQ. Perhaps more importantly, it suggests that even if a multi-establishment firm does not open or close establishments during our sample period, it can be reallocating some of its jobs out of the HQ.

Third, the increase in the average distance of workers to their HQ is driven mainly by increases in the average distance of production and business service workers, together with an increase in the use of the latter. Moreover, the increase in the average distance to the HQ of high-skilled occupations, such as managers or engineers, has been relatively small. This could be pointing towards the existence of strong within-firm agglomeration economies for some of the occupations. Fourth, we show that the ratio of managers to production and clerical workers within firms has increased. The increase has been particularly large in establishments located in the metropolitan area of Copenhagen and in Aarhus. Finally, we show that the increase in functional specialization observed in the data is partially driven by location and labor demand decisions of multi-establishment firms, as suggested by Duranton and Puga (2005).

All of these facts suggest that the "death of distance" (Cairncross, 1997) and the "flattening of the world" (Friedman, 2005) are much more complicated than imagined. In particular, while firms' geographic span of control has become broader, the degree of decentralization is not the same across all of the firm's activities. Instead of observing a general decentralization of all of the firm's activities, this decentralization seems to be happening mostly for production and business services activities. On the other hand, there seems to be an increasing relative concentration of managerial and other high-skilled activities around the firms' central offices. These facts imply that firms, and the world itself, are not becoming flat, but rather segregated by functions.

This paper relates to the literature that studies the location decisions of multi-establishment firms and the agglomeration of headquarters (Aarland et al., 2007; Davis and Henderson, 2008; Henderson and Ono, 2008; Strauss-Kahn and Vives, 2009; Mota and Brandão, 2013; Alcácer and Delgado, 2016).[2] In particular, Henderson and Ono (2008) suggest that it is very costly for firms to send their first stand-alone HQ away from their production facilities, given the existence of communication and coordination costs. Thus, the new location has to offer something beneficial for the firm, such as, a larger variety of business services. More recently, Bartelme and Ziv (2017) document geographic location and growth patterns for firms in the United States. Among their facts, the authors document that the size of the establishments decreases with a larger distance to their HQ. Our analysis is also guided by a few theoretical articles that study the firm's fragmentation decision and the location of the firm's multiple establishments (Ota and Fujita,

[2]Firm location has been widely studied, but usually treating one establishment as a whole firm. See Gaubert (2018) for a recent article on this issue.

1993; Duranton and Puga, 2005; Rossi-Hansberg et al., 2009; Gokan et al., 2019). Most of the empirical studies in this literature focus on comparing firms' location choices and some of its determinants, by comparing firms in the cross-section. Our paper contributes to this literature by being the first one to study changes in firm fragmentation and spatial decentralization over time.

Our paper also relates to articles studying the labor composition across different establishments within firms, keeping the number of establishments fixed (Charnoz et al., 2018; Cestone et al., 2018; Antoni et al., 2019). On the theoretical side, Duranton and Puga (2005) present aggregate evidence showing a decrease in sectoral specialization across US cities, but an increase in the relative concentration of managers in larger cities. To understand these findings, the authors develop a model in which a decrease in communication costs leads to firm fragmentation and to larger cities specializing in HQ activities, whereas smaller cities specialize in business services or production activities. To our knowledge, our paper is the first to empirically study changes in the internal spatial organization of firms along two equally important margins: the extensive margin on whether to have multiple establishments and their locations, and the intensive margin studying the distribution of workers within firms. This allows us to understand the structure of firms and their possible effects on local economies in a more holistic way. Moreover, we show that changes in the spatial organization of firms can be behind the increases in functional specialization, as suggested by Duranton and Puga (2005).

The location of establishments and firms has been studied in other fields within economics. First, there have been large advances in the international trade literature regarding the study of multinational enterprises (Markusen, 2002; Antràs and Yeaple, 2014). We consider the decision of a firm to become multinational to be a specific case of the firm fragmentation process. Second, there has been theoretical and empirical advances in the study of models of market entry in the industrial organization literature (Holmes, 2011; Aguirregabiria and Suzuki, 2016). Moreover, this literature has also studied vertical integration and outsourcing decisions across firms (e.g., Atalay et al. (2014)). Even though we consider these to be important margins of firm fragmentation, given our current data we take the boundaries of the firm as given throughout our analysis, and focus on organizational changes within firms. Finally, this paper also contributes to the organizational economics literature studying firm organization and its relation to communication costs (Becker and Murphy, 1992; Garicano, 2000; Bloom et al., 2014). Our paper adds to this literature by highlighting the importance of geography in determining firm organization and labor demand decisions, in line with Antràs et al. (2006) and Antoni et al. (2019).

The rest of the paper proceeds as follows. Section 2 describes our data. In section 3 we present our facts regarding the internal spatial organization of firms in Denmark. Section 4 discusses possible causes underlying the facts and concludes.

2 Data

We use Danish administrative register data containing the full population of employers and employees for the period 1981-2016. We use the establishment records from the Integrated Database for Labor Market Research (IDA), which contains all the matches between the employees and their workplaces every year. Therefore, we are able to follow every worker through every job they have had during their working life. Equivalently, we can observe the worker composition of each establishment inside the country through time.

Statistics Denmark defines a firm as an administrative unit that is subject to registration on the Danish Customs and Tax Agency, regardless of their level of activity Statistics Denmark (2016). This means that there are around 180,000 firms observed each year. Given that the smallest firms often have irregular activity and missing accounting records, we exclude firms that at some point in the period between 1981 and 2016 have fewer than five employees, similar to Malchow-Møller et al. (2017).

We match these data with firm records from the General Firm Statistics and the Accounting Statistics.[3] Since the data has unique firm and establishment identifiers, we can determine whether the firm has one or multiple establishments. An establishment is an individual local business unit, which is an organizationally defined part of a firm and is located at a given address (Statistics Denmark, 1991). In addition, we observe the location (at the municipality level) of each establishment, as well as the location reported by the firm in its accounting records. We define an establishment as the unique triplet between the establishment's identifier, its municipality and its firm identifier. Due to confidentially agreements, we cannot observe the exact addresses of the establishments, nor can we compute the exact distances between them. Therefore, we compute distances between establishments as the distance between (the centroids of) the municipalities in which they are located.[4]

We limit our analysis to firms in the private sector. In Denmark, the public sector accounts for around 30-35% of all full-time employees, and this share is roughly constant across municipalities. Further, we restrict the sample to firms in manufacturing, transportation, business services, and finance, insurance and real estate (FIRE). We thereby exclude firms in farming, fishing, raw material extraction, energy/water supply, disposal, construction, wholesale, retail, hotels, restaurants and culture and leisure.[5]

Moreover, we link these registers with data on the workers' occupation from the Labor Classification Module (AKM). For the occupation, we use the PSTILL variable, which defines the primary job for each worker in terms of their position, and the 4-digit DISCO88 code from the Labor Classification Module. DISCO is the Danish version of the International Standard

[3]The General Firm Statistics and Accounting Statistics are only available after 1995.

[4]In 2007, there was a structural reform in the Danish public sector. With this reform, the number of municipalities went from 275 to 98. We account for this by tracking the present municipality boundaries back and using the 98 municipalities for the entire period.

[5]The definition of sectors change several times during the years. To make the sectors comparable across time, we apply an aggregated sector format, divided into 36 groups (2-digit NACE codes), to all the years in the analysis.

Classification of Occupations (ISCO) and is only available from 1991.[6] For most of the analysis, we aggregate the 4-digit DISCO codes into 6 categories: managers, business service workers, engineers and scientists, clerical workers, production workers, and other workers.[7] Since workers could have several jobs in one year, we keep each employees' main job, which is defined by Statistics Denmark based on their main source of income. In addition, we drop workers younger than 15 years old and older than 80 years old. These registers imply that, for a multi-establishment firm we can observe, not only the location of its establishments, but also their composition in terms of occupations and other characteristics.

Furthermore, to avoid outliers, we drop those that have more than 100 establishments and firms that exhibit large jumps in the total number of establishments across years. These sample restrictions mean that, each year we have on average 8,600 firms and 13,250 establishments, which contain around 507,000 workers (around 30% of all the private labor force). In total for the entire period, we have 314,203 firm-year observations, 481,024 establishments-year observations, and 18,251,870 worker-year observations.

Since Statistics Denmark does not provide information on which of the establishments of a multi-establishment firm is the headquarters establishment, we define it following an iterative process. First, we select the establishments that are located in the same municipality as the one reported by the firm in the General Firm Statistics, and that had at least five employees. If more than two-establishments satisfy these conditions, we take their labor composition into consideration by choosing the establishment with the largest i) number of managers, ii) number of high wage earners, iii) number of workers with long cycle education, iv) number of workers with short and medium cycle education.

In 2016, approximately 5.7 million people lived in Denmark. According to Statistics Denmark, out of these 5.7 million people, 53% were part of the labor force and there was an unemployment rate of 4.1%. Moreover, the geographic distribution of population and employment across Danish municipalities is uneven. Economic growth and job creation is concentrated in the Copenhagen metropolitan area and in the second largest city (Aarhus), which is located in Eastern Jutland. Economic growth in these large cities is mainly based on knowledge intensive industries, such as the medical industry. Moreover, the rise of services and welfare economies have lead to a strong growth in the demand for high-skilled jobs (Hansen and Winther, 2012). Thus, for some of the analysis, we separate firms with HQ in either Copenhagen or Aarhus to see whether the dynamics of these firms differ from those in the rest of the country.

[6]The DISCO classification changes in the registers between 2009 and 2010 from DISCO88 to DISCO08. Information on the crosswalk used is available upon request.

[7]In the Other category there are mainly three types of workers. First, workers with a missing occupational category. Second, workers who did not have a specific enough occupational code to be put in one of the five categories, like "Other associate professionals". Third, workers whose occupation did not clearly belong to any of the five categories, like "Primary education teaching professionals" or "Authors, journalists and other writers", among others. See Appendix B for a detailed list of occupations within each of the categories.

3 The Internal Spatial Organization of Firms

In this section, we present our findings regarding the internal organization of multi-establishment firms in Denmark. We present our results as four connected facts that describe the internal geography of firms and its changes during the last 26 to 36 years. Most of these facts are, to the best of our knowledge, new to the literature. One contribution of this paper is to show that most of these firm fragmentation patterns are a result of changes within firms. This has been largely theorized in the literature, but has not been shown formally until now.

3.1 Firm Fragmentation

Around half of the employment generated by firms in our sample is held by multi-establishment firms that both open and close at least one establishment between 1981 and 2016. On average, these firms represent 4% of the total number of firms.[8] Furthermore, every year only around 5.5% of all the firms either open or close an establishment, but these firms generate approximately 25% of all the employment. The fact that the firms that both open and close establishments are the largest ones is very intuitive, especially if we consider that there are large fixed costs associated with opening and closing establishments. These fixed costs are usually capital costs associated with renting or building new office space and equipment, or getting rid of an older office when the establishment closes. Moreover, when a firm wants to move an establishment to a municipality farther away, the fixed costs could take the form of contractual costs often associated with the short run stickiness of capital and labor, even in a country with flexible labor policies like Denmark.

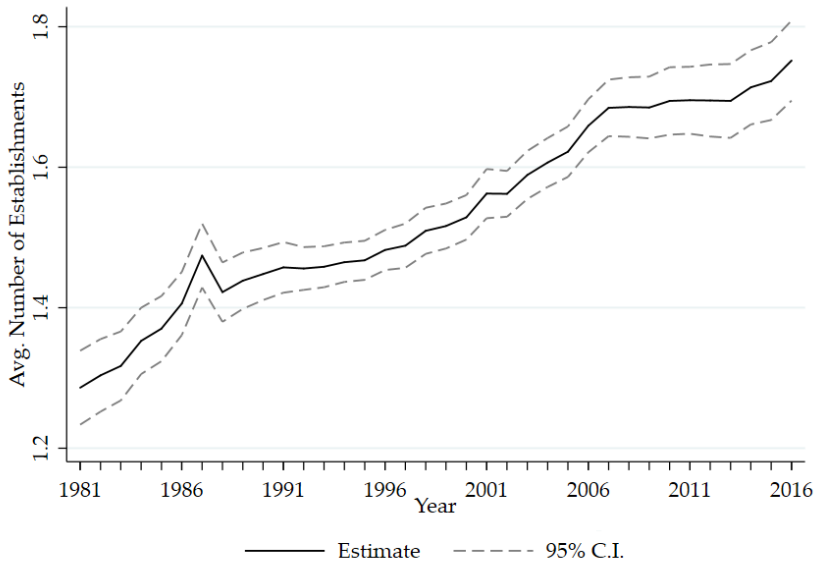
In order to know whether firms are opening more establishments relative to the ones they are closing (positive net expansion), or if they are just replacing them (zero net expansion), we explore the evolution of the average number of establishments per firm. We do so by regressing each firm's total number of establishments on firm and year fixed effects. In Figure 1, we plot the year fixed effects of this regression. The details of this and all other regressions can be found in Appendix C.

Figure 1 shows that the average number of establishments per firm increased from 1.3 to 1.75 establishments (36%) during our period. Since we include firm fixed effects, identification for this trend comes from firms that either open and/or close establishments. Firm fixed effects are also controlling for variables that do not vary over time at the firm level. By including year fixed effects, we are controlling for yearly shocks that affect all the firms similarly. When we look only those firms that have multiple establishments at some point in our period, we observe a more pronounce rise in the number of establishments: From 2.1 to 3.3 establishments (Figure A1). We summarize this result as:

FACT 1: *The average number of establishments per firm increased by 36% between 1981*

[8] Moreover, around 11% of the firms only added establishments during our sample period. On the other hand, 30% of each year's total employment is generated by 70% of firms that had one establishment during the whole period.

Figure 1: Evolution of the Total Number of Establishments



This figure shows the estimated year fixed effects from a regression of each firm's total number of establishments on year and firm fixed effects.

and 2016.

This result also persists after controlling for age of the firm, suggesting that the increase in the number of establishments is not driven only due to the firm life cycle patterns, as in Bartelme and Ziv (2017). Furthermore, our results also hold if we exclude all the firms with HQ in the Copenhagen metropolitan area and in Aarhus. This implies that increasing competition for land and workers in the urban centers is not the only force driving the firm fragmentation processes, as suggested by Rossi-Hansberg et al. (2009).

Figure 1 also indicates important trends in the Danish economic cycle that seem to influence the firms' average number of establishments. First, we see a positive jump in the number of establishments early in our period. This jump could be partially caused by the overheating of the Danish economy in the end of the 1980's, the subsequent reforms and deceleration of the economy. Second, the global financial crisis in 2008 is visible in the graph, with a stagnation in the growth of the number of establishments from 2008 to 2013, and a recovery starting in 2013.

In figure A3, we look at this trend by sector. This figure shows that the increase in the average number of establishments is mainly driven by an increase in the number of establishments of business service firms (from 1.1 to 1.8), manufacturing sector (from 1.2 to 1.4) and transportation sector (from 1.25 to 1.8). We also observe an increase in the number of establishments in the finance, insurance and real estate (FIRE) sector, although less precisely estimated. Each of these trends are possibly being driven by different factors. In particular, note that the increase in the number of establishments per firm in the manufacturing sector is happening despite the de-industrialization that has been taking place in Denmark during the last decades (Bernard

et al., 2017). Though somewhat puzzling, this upward trend could be explained in part by the exit of small single-establishment firms. The business service sector has seen the largest increase in the average number of establishments per firm. This trend could be explained by the growth of single establishment firms and the large expansion of business services in the aggregate economy Eckert (2019). In fact, this sector has seen the largest increase in the total number of firms over our sample period. Moreover, it could also be explained by firms switching from manufacturing to service sectors, as documented in Bernard et al. (2017).

To further explore this fact, we run logistic regressions on the probability of opening or closing an establishment on indicator variables that equal 1 if the firm closed or opened an establishment in the current or in the previous two years. We also include firm and year fixed effects. Table 1 shows the marginal effects of the coefficients of these regressions. Since we include firm fixed effects, the effects come from firms that actually opened or closed establishments. Column 2 shows that closing an establishment in $t-1$ is associated with an increase in the probability of opening an establishment in t of 7 percentage points. Although small, this effect is statistically significant. Moreover, if the firm opens an establishment in either $t-1$ or in $t-2$, it is less likely to open a second one in t. The results in the flip-side regression from Column 4 are larger: opening an establishment in $t-1$ and $t-2$ is associated with an increase in the probability of closing an establishment in t of 35 and 20 percentage points, respectively. These results, together with Figure 1 suggest that, even if firms are constantly opening and closing establishments, on average they are opening at a higher rate.

3.2 Spatial Decentralization

Location is probably one of the first and most important decisions a firm has to make when opening a new establihsment. If it locates the new establishment–and thus some workers– farther away, the firm has to incur in higher communication costs due to the need of monitoring and communicating ideas between people, or higher shipping costs if it has to send intermediate inputs across establishments. However, if the firm's HQ is located in a very populated metropolitan area, by sending workers farther away, it could save on labor and land costs.[9]

Therefore, we investigate the evolution of the average distance between firms' establishments and their HQ. We do so by running a regression of each firm's average distance between its establishments and HQ on year and firm fixed effects. Recall that, since we only observe the establishments' location at the municipality level, our distance measure corresponds to the distance between municipality centroids. Therefore, the effects we show correspond to movements across municipalities. The left panel of Figure 2 plots the year fixed effects of this

[9] Around 30% of multi-establishment firms in our sample have their HQ either in Copenhagen or in its suburbs. When weighted by the size of the establishment, this share goes up to 47%, meaning that HQ located in the capital region are larger than the ones in the rest of Denmark. This difference could be driven by productivity advantages of big cities, or by the selection of more productive establishments into larger urban areas. Additionally, we observe that the size of the establishments belonging to multi-establishment firms depends positively on the population size of the municipality at which it locates. This is, multi-establishment firms tend to have bigger establishments in more populated municipalities. Suggesting that the patterns presented by Gaubert (2018) could be driven by the internal geography of firms.

Table 1: Probability of Opening or Closing an Establishment

	(1) Open$_t$	(2) Open$_t$	(3) Close$_t$	(4) Close$_t$
Open establishment$_t$			0.042***	0.042***
			(0.008)	(0.008)
Open establishment$_{t-1}$		-0.011		0.345***
		(0.007)		(0.007)
Open establishment$_{t-2}$		-0.079***		0.200***
		(0.008)		(0.008)
Close establishment$_t$	0.042***	0.053		
	(0.008)	(0.009)		
Close establishment$_{t-1}$		0.069***		-0.050***
		(0.009)		(0.009)
Close establishment$_{t-2}$		-0.013		-0.036***
		(0.010)		(0.009)
Observations	94,254	94,254	68,689	68,689
Number of Firms	6,424	6,424	4,112	4,112

This table shows the marginal effects of different logit regressions on the probability of opening or closing an establishment on indicator variables that equal 1 if the firm closed or opened an establishment in the current or in the previous two years. All regressions include firm and year fixed effects. Robust standard errors in parentheses, *** p <0.01, ** p <0.05, * p <0.1

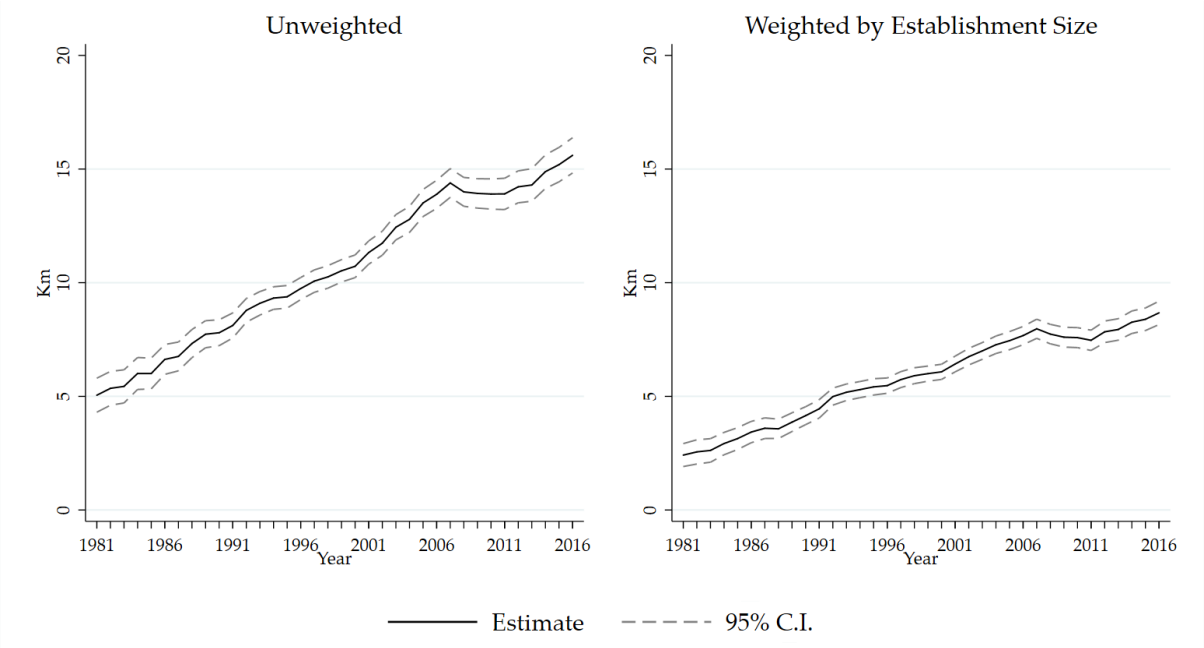
regression.

Figure shows a sustained increase in the average distance between a firm's establishments and its HQ. This increase slowed down during the recent global financial crisis but seems to have gone back to the previous trend. In particular, this average distance increased by around 11 kilometers between 1981 and 2016: A 220% increase relative to the 1981 mean (5 kilometers). The scope of this change could mean that a lot of the expansion within firms is taking place within commuting zones, in line with recent evidence for US firms presented by Bartelme and Ziv (2017).

To explore this possibility, we decompose the evolution of the total number of establishments per firm–presented in Figure 1–between establishments located in the same municipality as their HQ, in the same commuting area (excluding the HQ municipality), and the rest of the country.[10] We show the result of this decomposition in Figure 3. This figure shows that, even though there has been increases in the average number of establishments in both the same municipality and the same commuting area as the firm's HQ (15% and 18% of the total change, respectively), these changes are small compared to the change in the number of establishments outside the HQ's commuting area (67% of the total change). Figure A2 in the appendix presents this

[10]We use the commuting areas defined by Nielsen (2005) based on 20047 commuting flows across municipalities.

Figure 2: Average Distance between Establishments and Headquarters



This figure shows the estimated year fixed effects from a regression of each firm's average distance between its establishments and headquarters on year and firm fixed effects. In the left panel, we use an unweighted average distance, while in the right panel, we weight by the total number of workers in the establishment.

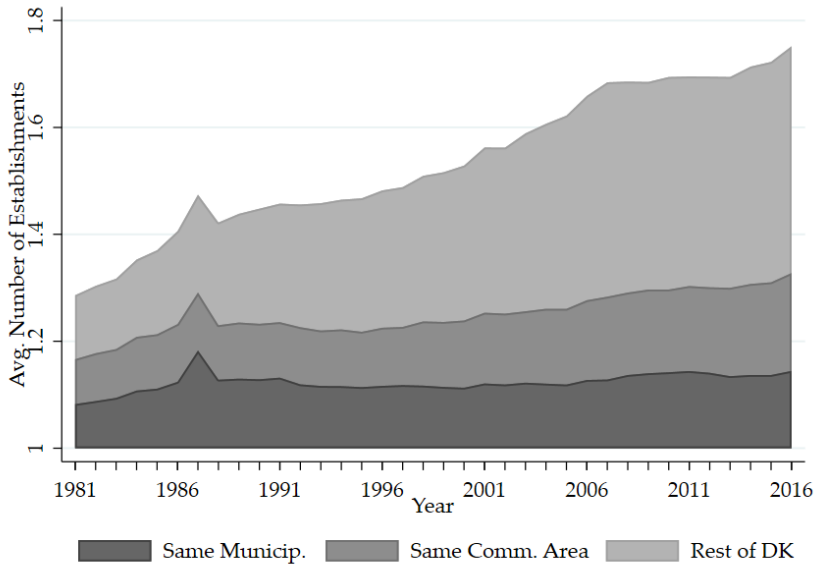
figure using only those firms that had multiple establishments at some point during the period. Since these estimates are identified from firms that open and/or close establishments during the period, the results are almost equivalent.

Identification of the changes presented in Figure 2 comes from firms that opened and/or closed establishments. However, given the high fixed costs involved in these actions, a firm could still decentralize its labor by sending some of its workers to satellite establishments or by hiring more in these locations. Therefore, we run the same regression as before, but weighting each establishment by its total number of workers. Thus, this regression shows the average distance between the firm's workers and its HQ. The right panel of Figure 2 shows the estimated year fixed effects. The increase in the average distance is lower in this case: only 5.5 kilometers. This is consistent with the fact that the HQ and the establishments relatively closer to them, tend to be a firm's largest establishments.[11] This change corresponds to a 220% increase relative to the 1981 value of 2.5 kilometers, and indicates that even if a firm does not open new establishments, it could be reallocating some of its labor force out of the HQ. When we only look at firms that had multiple establishments at some point in our period (Figure A4), the average distance of the establishments and workers to the HQ goes from 21 to 48 kilometers (a 129% increase) and from 10 to 27 kilometers (a 170% increase), respectively.

These trends lead us to our second fact:

[11]The average multi-establishment firm in our sample holds 65% of their employees at the firm's HQ. This distribution is skewed to the left. We will discuss the evolution of the HQ employment below.

Figure 3: Decomposition of the Total Number of Establishments



This figure shows the evolution of the total number of establishments from a regression of each firm's total number of establishments on year and firm fixed effects, separating between those establishments located in the same municipality as their HQ, same commuting area, rest of the country.

FACT 2: *The average distance between the establishments and their HQ has more than doubled during the last 36 years. These changes are mainly driven by the creation of establishments outside the HQ's labor market area.*

The average distance is influenced equally by establishments close and far from the HQ. For example, if a firm has a satellite establishment located 40 km from the HQ and opens a third one 8 km away from the HQ, the average distance would go from 20 to 16 km. In this case, there would be an increase in firm fragmentation (more establishments), but a possible decrease in spatial decentralization (less average distance). Therefore as a robustness check, we look at the evolution of the distance to the establishment farthest away from the HQ. Figure A5 shows that when we consider this maximum distance as measure of spatial decentralization, it increased from 10 to 32 km (a 220% increase) for all the firms, and from 42 to 100 km (138% increase) for firms that had multiple establishments.

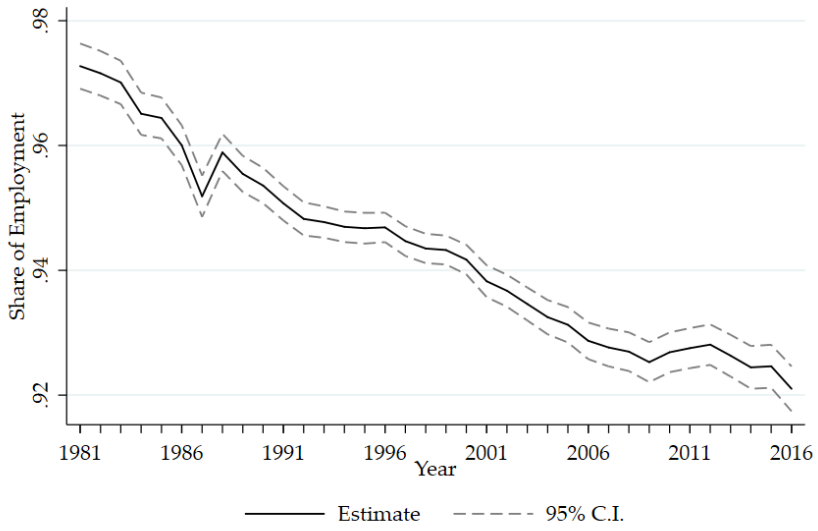
Figure A6 and A7 in the appendix show the results by firm sector. All the sectors experience an increase in the average distance between establishments and HQ: the business service and transportation sectors by 17 km (increase of 567% and 340%, respectively), the manufacturing by 6 km (133%), and the FIRE sector by 7 km (75%), this last one is less precisely estimated. The relatively small increase in the manufacturing sector is consistent with this sector facing higher fixed and fragmentation costs (communication and shipping). When we weight by the size of the establishments, we see an increase of 3.5 km for manufacturing (153%), 9 km for transportation (304%), 10.5 km for business services (117%), and 3.5 km for FIRE (70%). The small changes in the FIRE sector could be explained by high within firm agglomeration forces,

or by the outsourcing of business services.

We believe that Fact 1 and 2 could be behind the increase in the share of establishments and workers belonging to multi-establishment firms in Denmark between 1981 and 2016. We show the change in these shares for each municipality in Figure A8. The maps show that the share of establishments belonging to multi-establishment firms has increased in most of the country. The same goes for the workers, except for some municipalities in the southern part of the country.

Finally, we show in Figure 4 that the increase in the average distance of workers to their HQ has been accompanied by a decrease in the share of workers employed at the firms' HQ. The figure shows a significant reduction of 5 percentage points in the share of employment at the HQ. This reduction is similar, when looking at our four aggregated sectors.[12] Even though a reduction of 5 percentage points might seem small, recall that firms with multiple establishments are usually large firms and even a small change in this share could mean that a considerable amount of jobs are being reallocated. Figure A9 in the appendix shows the same figure, using only those firms that had multiple establishments at some point in our sample period. For this group of firms, there is a reduction of 13 percentage points, going from 89% to 76%.

Figure 4: Concentration of Employment at the HQ



This figure shows the estimated year fixed effects of a regression of each firm's share of employment at their HQ on year and firm fixed effects.

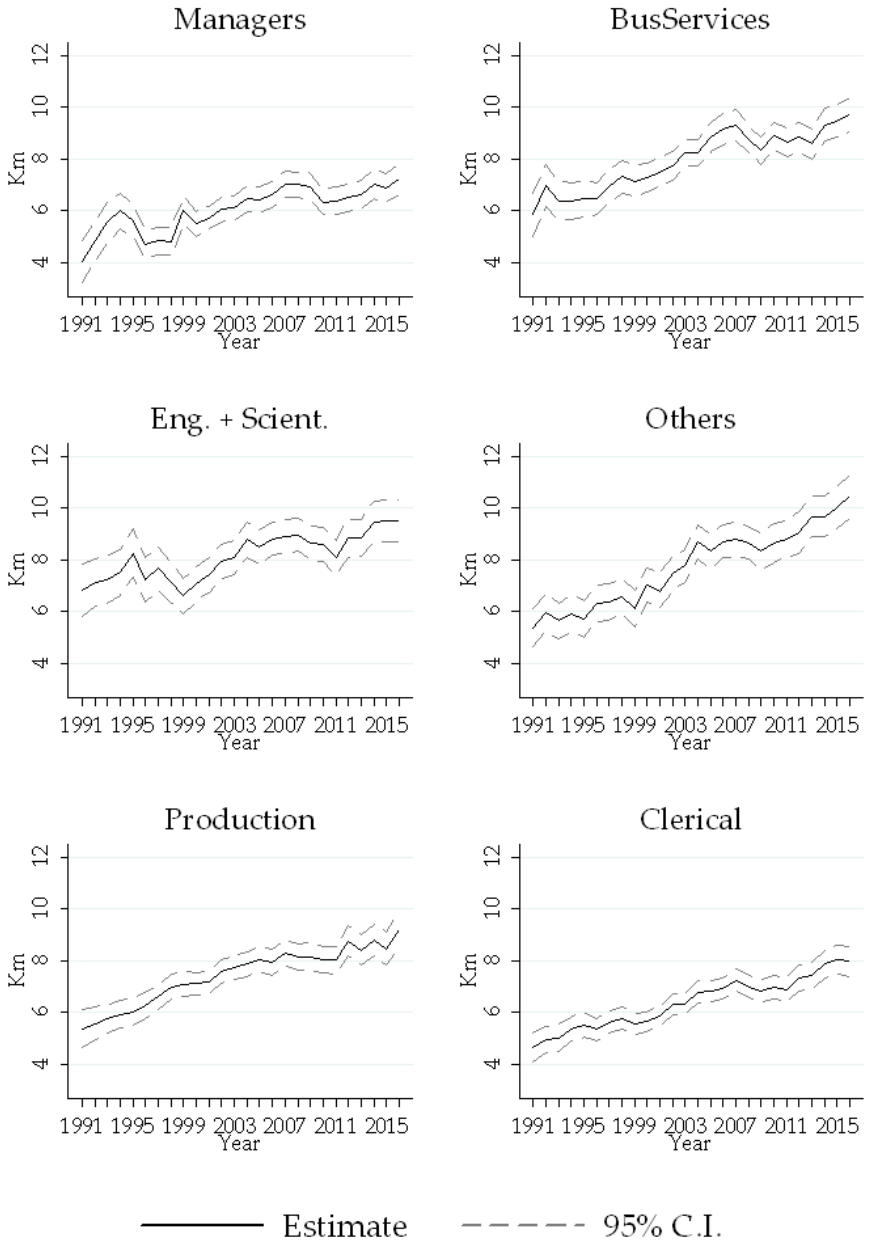
3.3 Functional Specialization

If a large number of jobs is be being moved away from the HQ, the distribution of different types of workers within a firm could change. Thus, we investigate if the changes from Figures 2

[12]The levels of the figure might seem high. However, note that the entry and exit of firms in our sample, together with the fact that single establishment firms have higher entry and exit rates, could shift upward the level of this trend.

and 4 are driven by a particular occupation, or if it is a general phenomenon for all the workers regardless of their occupation. Figure 5 shows the evolution of the average distance to the HQ of workers within a particular occupational group, by plotting the estimated year fixed effects from similar regressions as the ones described for Fact 2. These figures start in 1991, which is the first year for which we have the DISCO occupational classification.

Figure 5: Average Distance to the HQ by Occupation



This figure shows the estimated year fixed effects of a regression of each firm's average distance of the establishments to their HQ (weighted by the establishment's relative number of employees within each occupation category) on year and firm fixed effects.

Note that all groups experience an increase in their average distance to HQ. Workers in

lower-skilled occupations, such as clerical and production workers, experienced an increase of approximately 4 km in the average distance to their HQ (82% and 80%, respectively). Business service workers and managers also experience an increase in their average distance of respectively 67% and 75% over the same period. Engineers and scientists experience the lowest increase: 36%. When we explore the evolution of the share of firm's employment at HQ for each of the occupational categories, the pattern is similar: Lower-skilled occupational groups experience the largest decrease, while the decrease for high-skilled occupations is less sharp. Figure A10 shows these results.

These results could point to the existence of strong within firm agglomeration economies, in particular regarding high-skilled workers. Specifically, firms might realize that there could be productivity gains by putting workers of particular occupations together, e.g., concentrating managers at the HQ could lead to an increase in knowledge spillovers. Decreases in communication costs brought by the broadband expansion in the first half of the 2000s–and documented by Henten and Falch (2011)–could contribute to these patterns. If communication between establishments is relatively easier, the firm could afford to send some occupations farther from the HQ, leaving at the HQ occupations that benefit the most from agglomeration economies and Face-to-Face communication (Storper and Venables, 2004).

To explore each occupation's contribution to the changes from Figure 2, we write the firm's f average distance of the workers to their HQ at time t ($\bar{D}_{HQ,t}$) as a weighted sum of the average distance for each occupation o, $\bar{D}^o_{HQ,t}$:

$$\bar{D}_{HQ,t} = \sum_o \left(\frac{L_{of}}{L_f}\right)_t \bar{D}^o_{HQ,t} = \sum_o \left(\frac{L_{of}}{L_f}\right)_t \left[\sum_j dist_j \left(\frac{L_{oj}}{L_{of}}\right)_t\right] \tag{1}$$

where $\left(\frac{L_{of}}{L_f}\right)_t$ is the share of workers of occupation o within firm f at time t, and $\left(\frac{L_{oj}}{L_{of}}\right)_t$ the share of workers of occupation o at establishment j relative to the total amount of workers in that same occupation in the firm f at time t. Using equation (1), we can investigate the yearly contribution of each occupational category to the average distance of the workers to their HQ. Moreover, we can decompose the contribution into two parts: the relative use of occupation o inside the firm, and the average distance of workers from this occupation to their HQ. We show the results in Table 2. Technical details of the decomposition can be found in Appendix C.

The decomposition shows that workers in production and in business service occupations contribute by 35% and 29.8% to the overall change in the average distance of workers to their HQ. Engineers and scientists contribute by 22.4% to this change, while managers and clerical by around 7% and 10% each. Further decomposing each occupation's contribution into their changes in relative use and changes in average distance to HQ, we observe that the contribution of each occupation comes from different sources. For managers, 60% of their contribution comes from an increase in their use at the firm level. In fact, between 1991 and 2016 managers went from being 4% of the total number of workers within firms to being around 7%.

For clerical workers, we observe that changes in the use of these occupations contribute

Table 2: Changes in Average Distance of Workers to HQ, 1991-2016

Value 1991	**Value 2016**	**Change**
4.41 km	8.29 km	88.07%
Managers		6.89%
Change in Use		4.11%
Change in Dist		2.78%
Production		34.99%
Change in Use		2.43%
Change in Dist		32.56%
Business Services		29.78%
Change in Use		15.02%
Change in Dist		14.76%
Engineers & Scientists		22.37%
Change in Use		4.65%
Change in Dist		17.71%
Clerical		9.88%
Change in Use		-5.70%
Change in Dist		15.58%
Others		-3.92%
Change in Use		-10.29%
Change in Dist		6.38%

This table shows the decomposition of the total change in the distance of firm's workers to their HQ into changes in the use and in the average distance of six occupational categories. This decomposition is described in Equation (1). The percentages add up to 100%, and not to the total change (88.07%).

negatively to the total change, but the increases in these occupations' average distance to their HQ contribute positively. Furthermore, we observe that increases in the distance of production workers to their HQ contribute by a third of the observed total change. This is consistent with a decrease in the use of workers in these occupations at the firm's HQ (Figure A10) and an increase in their average distance to the HQ (Figure 5). For engineers and workers in science professions, most of their contribution comes from changes in their average distance to the HQ. Moreover, increases in the average distance of engineers and scientists to their HQ happened in two waves: the first one at the beginning of 2000s, and a recent second one starting around 2011.

Changes in the location of workers in the business services contribute by 26% to the total change in the average distance of workers to their HQ. For workers in these professions, the increase in their use within firms is almost as important as the increase in their average distance to the HQ. On one hand, both business service firms and business service workers in all types of firms have become more important in the last decades. On the other hand, this has probably

caused more competition for office space and workers, promoting the re-allocation of business service workers to smaller municipalities for cost saving reasons, as argued by Liao (2012). This re-allocation becomes easier under the presence of better communication technology.

Based on these findings, we formulate a third fact:

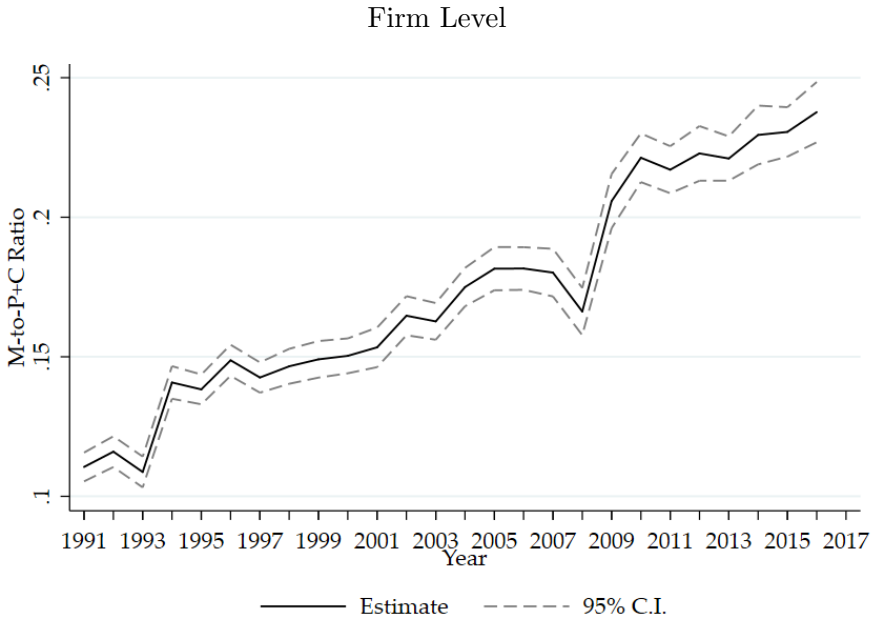
FACT 3: *The increase in the average distance of workers to the firm's HQ is mainly driven by an increase in the average distances of production workers, and engineers and scientists to their HQ, and an increase in the use of business service workers.*

3.4 Small Teams in Big Cities

In the previous decomposition, we showed that there have been significant changes in the use and location of production and clerical workers, and managers at the firm level during the last 26 years. These trends imply that the size of production teams, defined as the ratio of managers to production and clerical workers, might have changed during the same period.

To observe the evolution of this ratio, we compute the ratio of managers to production and clerical workers for each establishment and regressed it on establishment and year fixed effects. Figure 6 shows the estimated year fixed effects. The figure a clear upward trend of this ratio, which means that there has been a systematic reduction in the size of production teams. The ratio went from approximately one manager for every 9-10 production/clerical workers, to around one manager for every four workers in 2016.

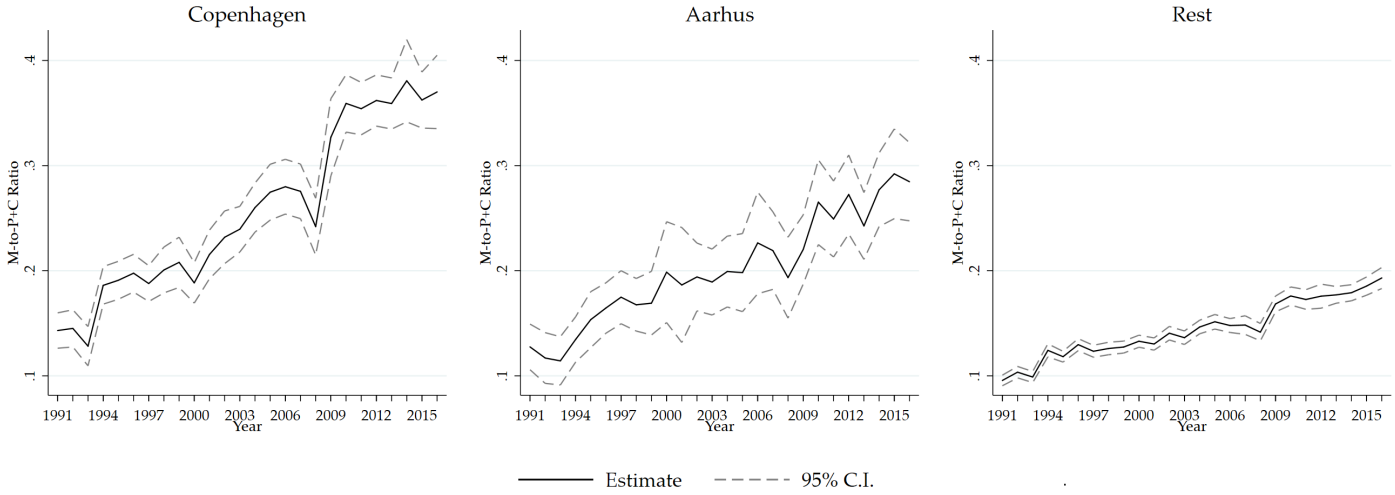
Figure 6: Managers to Production and Clerical Workers



This figure shows the estimated year fixed effects from a regression of each establishment's ratio of managers to production and clerical workers, on year and firm fixed effects.

However, the degree of this reduction in team size is different across different establishment of a firm. In Figure 7, we show that the increase in the managers-to-workers ratio that we observe at the firm level comes mainly from establishments located in the two most populated urban areas: Copenhagen metropolitan area and Aarhus. More specifically, we observe an increase of 164%, 115% and 95% of this ratio for establishments located in Copenhagen, Aarhus and the rest of the country, respectively. We confirm this result by running a regression of the ratio of managers to production and clerical workers on year and firm fixed effects, with an interaction between the year fixed effects and the municipality size of the establishment. Figure A11 in the appendix shows these results. This figure shows an increase in the correlation between this ratio and the size of the municipality, which is consistent with Figure 7, and suggests that production teams are becoming smaller in more populated municipalities. The trend is in line with similar results for the United States presented in Santamaria (2017), who argues that these changes could be generated due to a rise in the complexity of the production process in big cities.

Figure 7: Managers to Production and Clerical Workers by Municipality



This figure shows the estimated year times area fixed effects of a regression of each establishment's ratio of managers to production and clerical workers on firm and year times area fixed effects, where area includes three categories: Copenhagen metropolitan area, Aarhus, and the rest of the country.

Given that Copenhagen and Aarhus contain more than a third of the country's headquarters, the reduction in the size of production teams is consistent with the reduction in the share of employment at the firms' HQ and increasing average distances for some types of workers to their HQ previously described. We summarize these findings in our fourth fact:

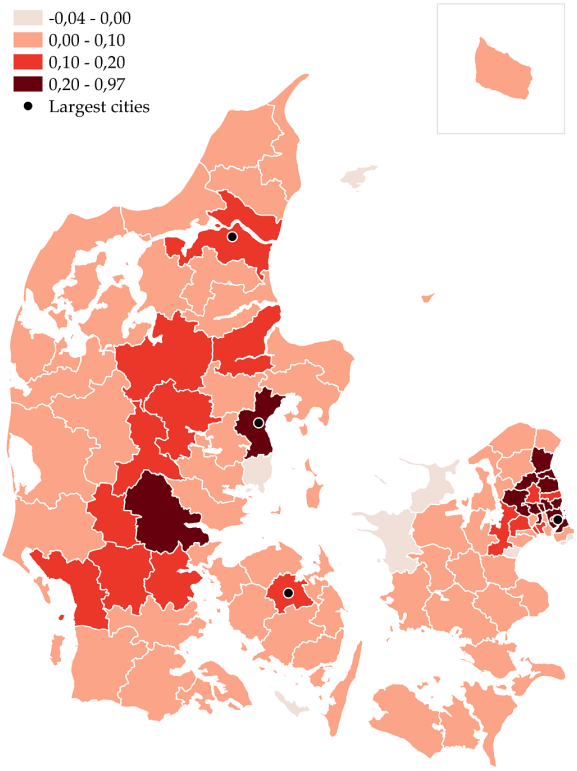
FACT 4: *The ratio of managers to production and clerical workers within firms has been increasing over the last 26 years, mainly driven by establishments located in the most densely populated municipalities.*

Our results partially explain the evolution of the aggregate specialization patterns that Duranton and Puga (2005) describe for the US. In particular, Duranton and Puga argue that increasing firm fragmentation is leading to a decrease in sectoral specialization of US cities,

regardless of their size, and to an increase in functional specialization, measured as the relative concentration of managers to production workers in large cities. In order to briefly explore this last hypothesis, we compute the change in the average ratio of managers to production and clerical workers across establishments for each municipality between 1991 and 2016. Figure 8 shows that this ratio increased during this period for almost every municipality in the country. Figure A12 in the appendix shows the levels of this ratio for 1991 and 2016 separately. These two figures show that at the beginning of the 1990s, all the municipalities were not too different in terms of this measure, but that it increased substantially for Copenhagen, its metropolitan area, and the other main urban areas.

Figure 8: Managers to Production and Clerical Workers Ratio by Municipality

Changes between 1991 and 2016



This figure shows the percentage point difference between 1991 and 2016 of the average ratio of managers to production and clerical workers across establishments for each municipality. The 98 municipalities are divided into quartiles according to the changes in this ratio. The black dots mark the largest municipalities: Copenhagen, Aarhus, Aalborg and Odense.

Furthermore, we decompose these changes between changes in the ratio for single-establishment firms, for establishments belonging to multi-establishment firms, entry of establishments belonging to single-establishment and multi-establishment firms and exit of establishments. We do this decomposition for the whole country and for each municipality. For the whole country, we find that 70% of the nationwide increase in the average ratio of managers to production and clerical workers was driven by increases in the average ratio within multi-establishment firms, while increases in the average ratio within single-establishment firms explained 36% of the total

increase.[13] Second, at the municipality level, we find that increases in the average ratio within multi-establishment firms is the main contributor to the growth in the average ratio of managers to production and clerical workers in 35 out of 98 municipalities. Moreover, the opening of establishments belonging to multi-establishment firms is the main contributor in 15 municipalities. Therefore, in more than half of the country's municipalities (51%) the decrease in the average team size is driven by the growth of the ratio or entry of establishments belonging to multi-establishment firms. This share is even larger in the capital region (*Hovedstaden*) with 19 out of 32 municipalities (60%).

4 Possible Causes and Conclusions

In Denmark around 7% of all private firms have more than one establishment. These firms account for approximately 47% of the private sector employment and 54% of the total output. Given the importance of multi-establishment firms for the aggregate economy, it is crucial to understand the facts regarding their spatial organization.

In this paper, we use highly detailed register data covering the universe of firms between 1981 and 2016 to lay out four stylized facts regarding the internal spatial organization of firms. Some of these facts are, to the best of our knowledge, new in the literature. First, we show that the average number of establishments has increased by 36% during the last 36 years. This increase holds for the four aggregate sectors in our sample: manufacturing, finance, insurance and real estate, business services and transportation. Second, we show that the average distance between the establishments and workers to their headquarters also increased by more than 200% during the same period. This fact suggests that firms are placing both establishments and workers farther away from their HQ.

Third, we show that the increase in the average distance of workers to their HQ is driven mainly by increases in the average distance of production and business service workers. The changes in the average distance of managers to their HQ is small and contributes 6% to the total change. Fourth, we show that the ratio of managers to production and clerical workers within firms has been increasing, going from approximately one manager for every 9-10 workers, to one manager every four workers. This increase has been particularly large in establishments located in the most densely populated municipalities. Finally, we show that these within-firm changes in the ratio of manager to production workers could partially explain increases in aggregate functional specialization, as suggested by Duranton and Puga (2005).

These facts imply that, while firms have become more spatially dispersed and their geographic span of control broader, the degree of decentralization is not the same across all of the firm's activities. In particular, some activities such as managerial activities are increasingly concentrating around firms' central offices. They also suggest that firms, and the world itself, are not becoming flat, but are spatially fragmenting by functions.

[13] This sum to more than 100% since composition changes and net entry explain -4.5% and -2.4%, respectively.

What factors could be causing these changes in the spatial organization within firms? Based on the literature, we highlight six potential causes: i) fragmentation costs, ii) location specific comparative advantages, iii) land and labor costs, iv) agglomeration economies, v) market access, and vi) skilled-biased technical change.[14] We study some of these mechanisms in Acosta and Lyngemark (2019).

First, fragmentation costs can be an important factor since the movement of knowledge, people and/or goods can be very important for different operations within firms. On one hand, in the presence of high communication costs, a firm might choose to have one establishment. However, if communication costs decrease, the firm can decide to open new establishments and change its organizational structure for one that is more profitable (Duranton and Puga, 2005). For instance, if communication across establishments is relatively cheap, it could become more affordable for the firm to send some occupations farther from the HQ. Furthermore, it could choose to leave at the HQ only those workers that benefit more from Face-to-Face communication (Storper and Venables, 2004). On the other hand, transportation costs are also important, especially for manufacturing firms where intermediate inputs have to be shipped between establishments and to the final customers. Improvements in transportation infrastructure, such as the construction of the Great Belt Bridge, can have a similar effect on firm fragmentation and organizational structure, as shown by Charnoz et al. (2018) and Antoni et al. (2019) for the expansion of high-speed rails in France and Germany, respectively.

Second, some municipalities might have comparative advantages in the production of certain goods and services. For instance, larger municipalities, which are usually more skill-intensive, could specialize in skill intensive tasks (Davis and Dingel, 2014). Therefore, once a firm reaches a certain scale it might want to locate part of it in a more advantageous location. Third, higher labor and land costs in certain locations might lead a firm to fragment in order to lower their marginal costs. This has been the case with business service workers in the U.S. (Liao, 2012). These higher input costs could be driven by higher population growth, (Rossi-Hansberg et al., 2009), and/or other factors, such as an inelastic supply of floor space. Fourth, when facing higher input costs in a particular establishment, firms could choose to leave there those tasks that benefit the most from input-output sharing, labor pooling or other types of agglomeration economies at that location (Faggio et al., 2017). For example, a firm might want to locate their R&D facilities in the capital region, even if wages are relatively high there, due to the relatively high concentration of academic and research institutions.

Fifth, a firm could also choose to open a new establishment in a municipality if it believes there is enough local demand for its product. Even though we exclude retail and wholesale firms from our analysis, we still believe that market access can be an important mechanism for the firms in our sample. For instance, a business service firm might want to open an establishment near to manufacturing or service firms in order to be close to (potential) clients. On the other hand, a firm might want to locate in Copenhagen, in another port city, or near the German

[14] Differential tax rates across regions could also be an important mechanism driving firm location decisions (Suárez Serrato and Zidar, 2016). We refrain from discussing this factor, as there are not substantial differences in tax rates across municipalities in Denmark.

border, in order to be more exposed to international markets.

Finally, a large number of articles in the literature (e.g., Autor et al. (2003)) have shown that technology (including communication and information technology) complements highly educated workers engaged in abstract tasks, and substitutes workers performing cognitive and manual tasks. Consequently, increases in the ratio of managers to production and clerical workers could be driven by skill-biased technical change. The fact that this ratio seems to be increasing more in the most densely populated municipalities, could be explained in part by increases in the skill bias of agglomeration economies (Baum-Snow and Pavan, 2013).

Two important caveats of our results are worth mentioning. First, we are not able to observe the establishments that Danish firms have outside Denmark. It is clear that globalization has caused firms to increase offshoring and foreign outsourcing, especially in the manufacturing sector. This is consistent with recent reports by Statistics Denmark showing increases in foreign employment held by Danish firms abroad.[15] Therefore, our results should probably be interpreted as a lower bound of the actual decentralization patterns within firms. Second, there has also been an increase in outsourcing within national boundaries (Goldschmidt and Schmieder, 2017). In consequence, there could be more occupational specialization and spatial decentralization than the one dictated by the boundaries of the firms.

The results of this paper intend to shed light and motivate future research studying different causes and consequences of changes in firms' location and labor demand decisions. For instance, changes in the internal spatial organization of firms could be an important factor explaining largely studied phenomena such as urban wage inequality, residential income segregation, or changes in the patterns of agglomeration and specialization.[16] Finally, more research studying the evolution and organization of firms in the business services sector is needed, as their importance in the aggregate economy has been increasing steadily over the recent decades.

[15]For example, the Statistics Denmark report on Danish Subsidiaries abroad in 2016, available at https://www.dst.dk/da/Statistik/nyt/NytHtml?cid=26775.

[16]The sorting of high-skilled workers and high-productivity firms into high-wage urban areas has been widely studied by (e.g., Davis and Dingel (2014) or Gaubert (2018)). Combes and Gobillon (2015) and Behrens and Guillain (2017), among others, study agglomeration patterns between industries. The evolution of the urban wage gap for the United States is studied in Baum-Snow and Pavan (2013). Most of these issues have also been studied for Denmark (Hansen and Winther, 2012; Eckert et al., 2019).

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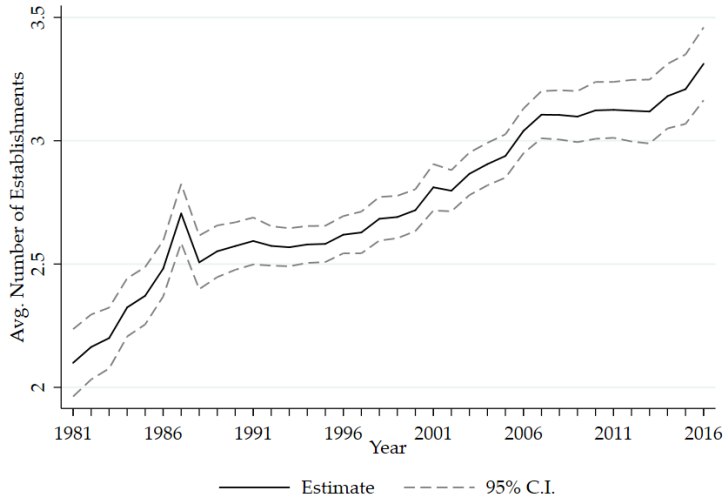
A Extra Tables and Figures

Figure A1: Evolution of the Total Number of Establishments

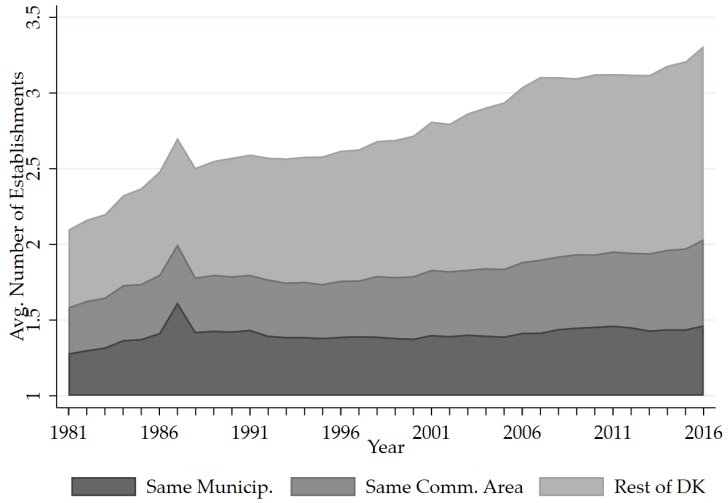
for Multi-establishment Firms



This figure shows the estimated year fixed effects from a regression of each firm's total number of establishments on year and firm fixed effects, using only firms that had a multiple establishment at some point between 1981 and 2016.

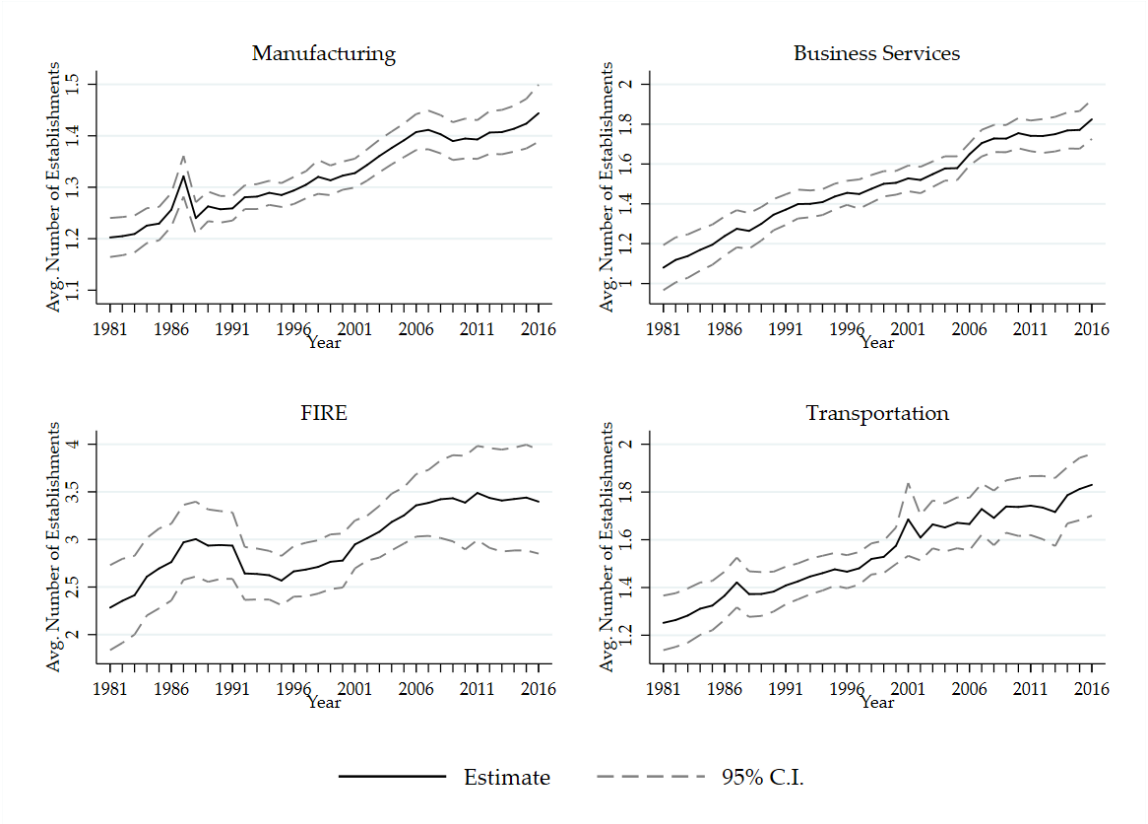
Figure A2: Decomposition of the Total Number of Establishments

for Multi-establishment Firms



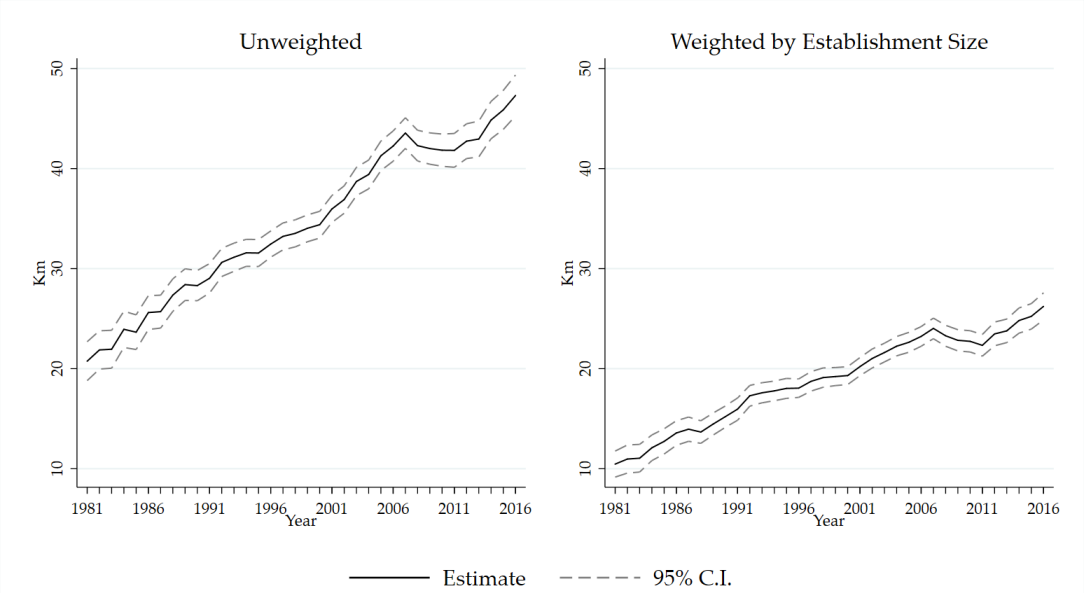
This regression shows the evolution of the total number of establishments from a regression of each firm's total number of establishments on year and firm fixed effects, separating between those establishments located in the same municipality as their HQ, same commuting area, rest of the country, and using only firms that had a multiple establishment at some point between 1981 and 2016.

Figure A3: Evolution of the Total Number of Establishments



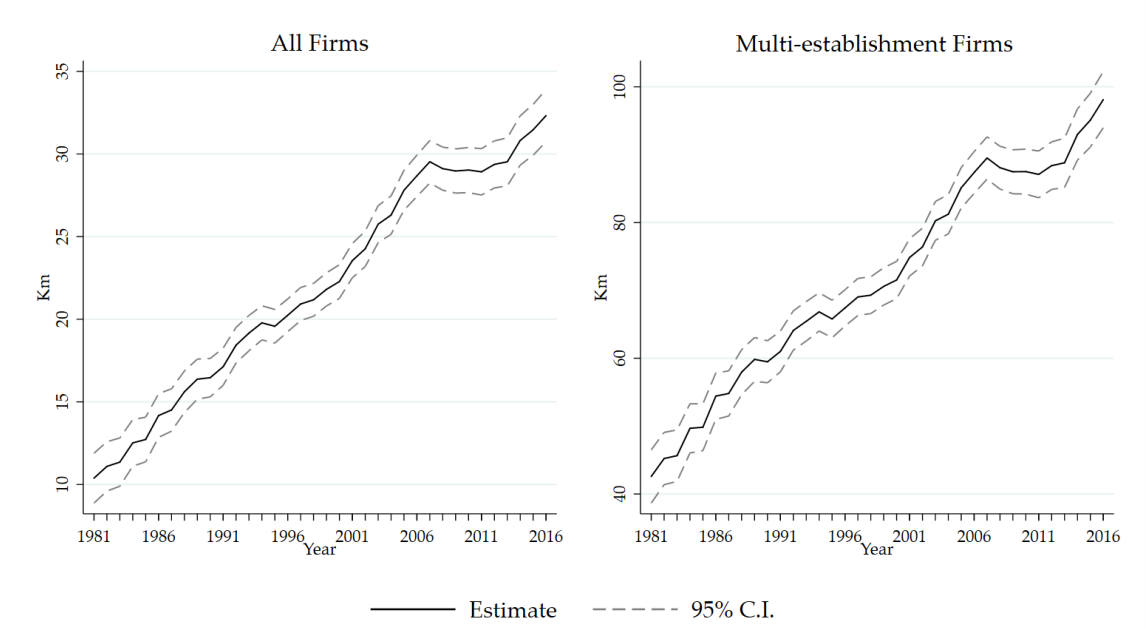
This figure shows the estimated year fixed effects from a regression of each firm's total number of establishments on year and firm fixed effects, separating by each one of these four sectors.

Figure A4: Average Distance between Establishments and Headquarter for Multi-establishment Firms



This figure shows the estimated year fixed effects from a regression of each firm's average distance between its establishments and headquarters on year and firm fixed effects, using only firms that had a multiple establishment at some point between 1981 and 2016. In the left panel, we use an unweighted average distance, while in the right panel, we weight by the total number of workers in the establishment.

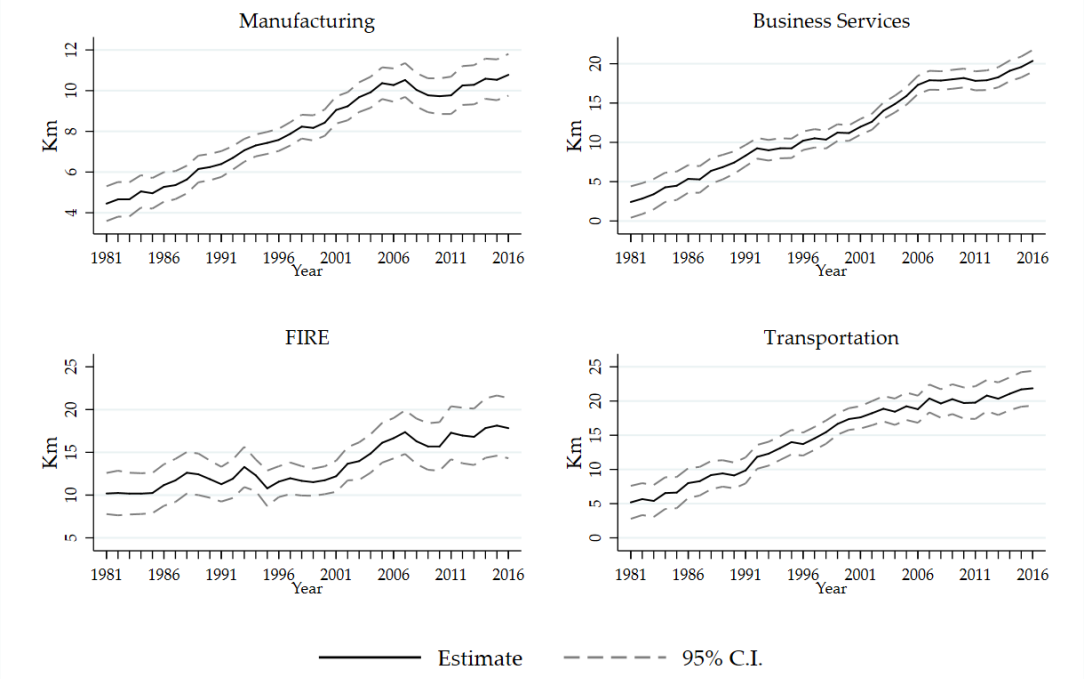
Figure A5: Maximum Distance between Establishments and Headquarters



This figure shows the estimated year fixed effects from a regression of the maximum distance between a firm's establishment and its HQ on year and firm fixed effects. In the left panel, we use all the firms in our sample, while in the right panel, we use only firms that had a multiple establishment at some point between 1981 and 2016.

Figure A6: Average Distance between Establishments and Headquarters by Sectors

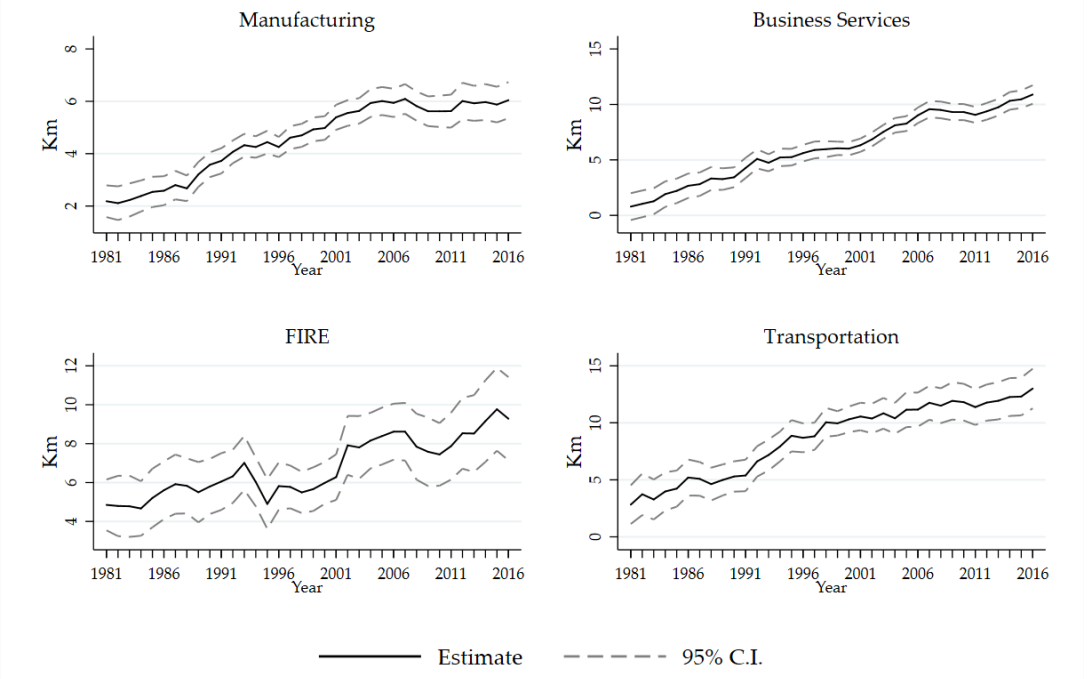
Unweighted



This figure shows the estimated year fixed effects from a regression of each firm's (unweighted) average distance between its establishments and headquarters on year and firm fixed effects, separating by each one of these four sectors.

Figure A7: Average Distance between Establishments and Headquarters by Sectors

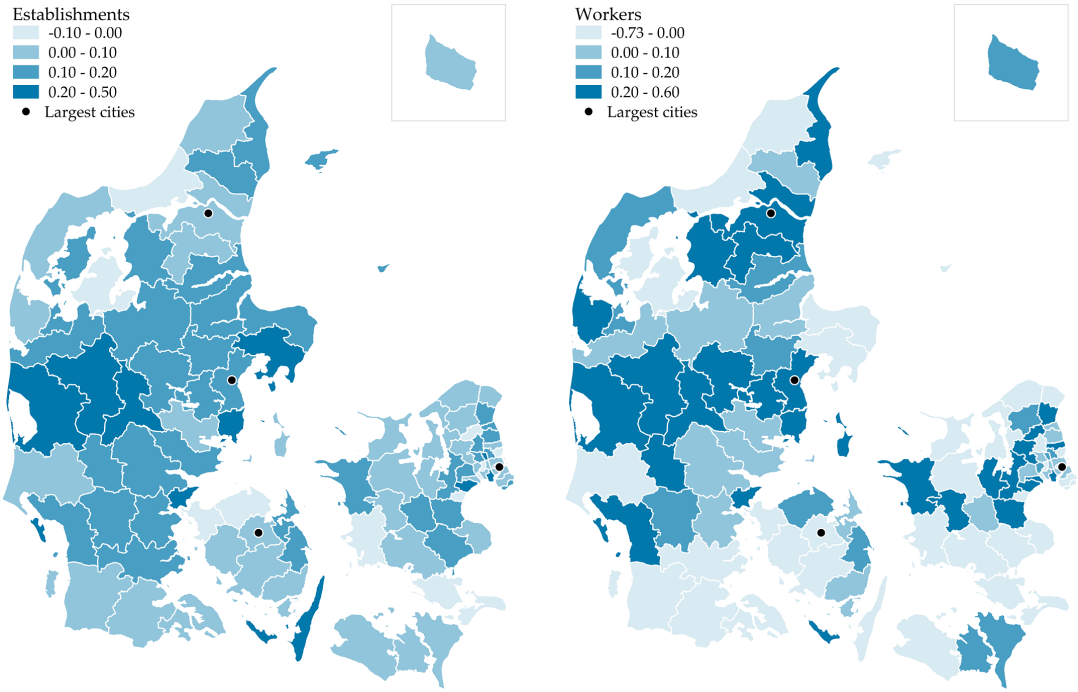
Weighted by Number of Workers



This figure shows the estimated year fixed effects from a regression of each firm's (weighted by the number of workers) average distance between its establishments and headquarters on year and firm fixed effects, separating by each one of these four sectors.

Figure A8: Changes in the Share of Establishments and Workers

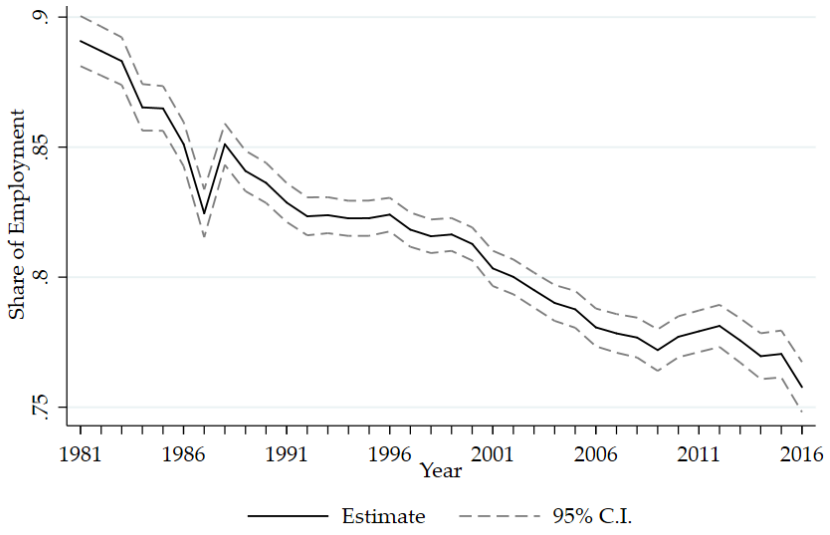
Belonging to Multi-establishment Firms, 1981-2016



This figure shows changes in the share of establishments (left panel) and workers (right panel) belonging to multi-establishment firms, by municipalities. The black dots denote the largest municipalities: Copenhagen, Aarhus, Aalborg and Odense.

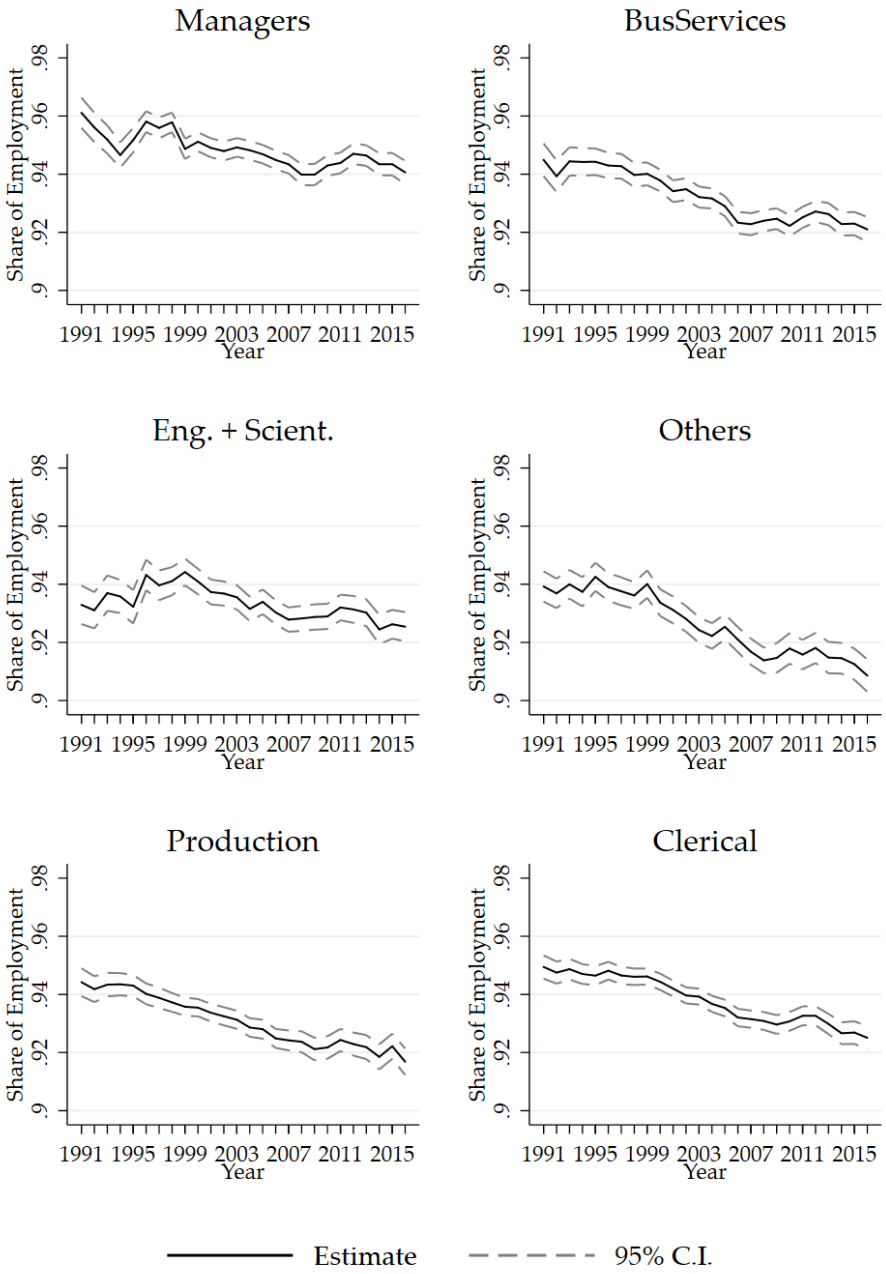
Figure A9: Concentration of Employment at the HQ

for Multi-establishment Firms



This figure shows the estimated year fixed effects of a regression of each firm's share of employment at their HQ on year and firm fixed effects, using only firms that had a multiple establishment at some point between 1981 and 2016.

Figure A10: Concentration of Employment at the HQ by Occupation



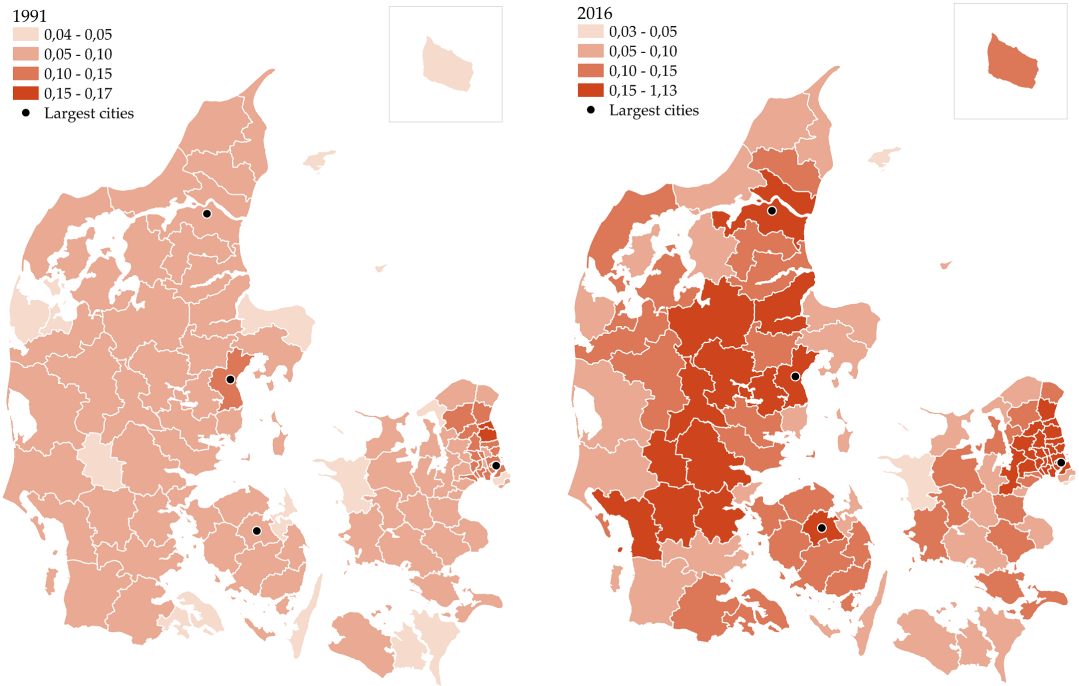
This figure shows the estimated year fixed effects of regressions of each firm's share of employment at their HQ for each occupation on year and firm fixed effects.

Figure A11: Managers to Production and Clerical Workers, and Municipality Size

This figure shows the estimated year times municipality size fixed effects of regressions of each establishment's managers to production and clerical workers ratio on year, firm and year times municipality size fixed effects.

Figure A12: Managers to Production and Clerical Workers Ratio by Municipality

1991 Levels - 2016 Levels



This figure shows the average ratio of managers to production and clerical workers across establishments for each municipality in 1991 (left panel) and in 2016 (right panel). The black dots denote the largest municipalities: Copenhagen, Aarhus, Aalborg and Odense.

B DISCO Categories

In this appendix we describe what occupations belong to each one of the six occupational categories that we use throughout the paper.

Category	**DISCO Codes (ISCO)**
Managers	1000-1999
Production Workers	60-83, 92-93
Business Service Workers	2400-2419, 242, 2440-2449, 3400-3439, 344, 346-347
Clerks	243, 40-52, 90-91
Engineers and Scientists	200, 21, 220-222, 231, 311-312, 32

Finally, we build an "Others" category containing every other occupation that is not in any of the categories defined above. For example, groups like "Other Associate Professionals", "Primary Education Teaching Professionals" or "Authors, Journalists and Other Writers". This category also includes those workers with a missing DISCO code.

C Estimating Equations

C.1 Firm Fragmentation

In order to know the evolution of the average number of establishments per firm from Figure 1, we run the following regression:

$$Esta_{ft} = \alpha_f + \delta_t + \varepsilon_{ft},$$

where $Esta_{ft}$ denotes the number of establishments of a firm f in time t, α_f are firm fixed effects and δ_t time fixed effects. For the figures by sector, we ran the previous regression only for firms belonging to each one of the sectors.

For Table 1, we run the following logistic regressions for columns 1 to 4, respectively:

$$\begin{aligned}
Open_{ft} &= Close_{ft} + \alpha_f + \delta_t + \varepsilon_{ft} \\
Open_{ft} &= Close_{ft} + Close_{f,t-1} + Close_{f,t-2} + Open_{f,t-1} + Open_{f,t-2} + \alpha_f + \delta_t + \varepsilon_{ft} \\
Close_{ft} &= Open_{ft} + \alpha_f + \delta_t + \varepsilon_{ft} \\
Close_{ft} &= Open_{ft} + Open_{f,t-1} + Open_{f,t-2} + Close_{f,t-1} + Close_{f,t-2} + \alpha_f + \delta_t + \varepsilon_{ft},
\end{aligned}$$

where $Open_{ft}$ is a dummy variable that equals 1 if a firm opened an establishment in period t, and $Close_{ft}$ equals 1 if a firm closed an establishment in period t.

C.2 Spatial decentralization

In order to know the evolution of the average distance of establishments to their HQ from Figure 2, we start by defining it as:

$$\bar{D}^{u}_{ft} = \frac{1}{E_{ft}} \sum_{j} dist_{j,HQ},$$

where $\bar{D}^{u}_{ft}$ denotes the average distance between the firm's establishments and its HQ, E_{ft} denotes the number of establishments of a firm f in time t, and $dist_{j,HQ}$ the distance of a particular establishment j to their HQ. We also define a weighted version of this distance, where the weights are the relative size of each one of the establishments:

$$\bar{D}^{w}_{ft} = \sum_{j} dist_{j,HQ} \left(\frac{L_{jt}}{L_{ft}} \right), \tag{A1}$$

where L_{jt} is the total employment in establishment j and L_{ft} is the total employment in the firm at time t. We then run the following regression for each of these two variables:

$$\bar{D}_{ft} = \alpha_f + \delta_t + \varepsilon_{ft},$$

where $\bar{D}_{ft}$ denotes either $\bar{D}^{u}_{ft}$ or $\bar{D}^{w}_{ft}$. For the figures by sector, we run these regressions only for firms belonging to each of the sectors.

For Figure 5, we run the same regression, but the dependent variables are defined as:

$$\bar{Dist}_{oft} = \sum_{j} dist_{j} \left(\frac{L_{ojt}}{L_{oft}} \right), \tag{A2}$$

where L_{ojt} is the total employment of occupation o in establishment j and L_{oft} is the total employment of occupation o in the firm at time t.

For the evolution of the share of workers employed at the firm's HQ from Figure 4, we run the following regression:

$$\frac{L_{HQ,t}}{L_{f,t}} = \alpha_f + \delta_t + \varepsilon_{ft},$$

where α_f are firm fixed effects and δ_t time fixed effects. For the figures by occupation, we compute the shares for each occupation and run the previous regression for each of them.

C.3 Small Teams in Big Cities

In order to know the evolution of the ratio of managers (M) to production and clerical workers ($P + C$) from Figure 6, we run the following regression:

$$\left(\frac{M}{P+C}\right)_{jft} = \alpha_f + \delta_t + \varepsilon_{jft},$$

where j denotes an establishment, α_f are firm fixed effects and δ_t time fixed effects. For Figure 7, we run the same regression but include a year specific fixed effect for each one of the municipality groups:

$$\left(\frac{M}{P+C}\right)_{jft} = \alpha_f + \delta_{c,t}\mathbf{1}_{\{j,CPH\}} + \delta_{a,t}\mathbf{1}_{\{j,Aarhus\}} + \delta_{a,t}\mathbf{1}_{\{j,Rest\}}\varepsilon_{jft},$$

where $\mathbf{1}_{\{j,X\}}$ is an indicator function that equals to 1 if the establishment j is located in $X \in \{CPH, Aarhus, Rest\}$, and CPH denotes Copenhagen metropolitan area, which we defined as the municipality of Copenhagen, its surroundings and Northern Zealand. Finally, for Figure A11, we run:

$$\left(\frac{M}{P+C}\right)_{jft} = \alpha_f + \delta_t + \beta_t \log(N_{jt}) + \varepsilon_{jft},$$

where $\log(N_{et})$ denotes logarithm of the number of the workers in the municipality where the establishment j is located.

C.4 Functional Specialization - Decomposition of Distance by Occupation

For the decomposition presented in Table 2, we take equation (A1)

$$\bar{D}_{ft} = \sum_j dist_j \left(\frac{L_{jt}}{L_{ft}}\right) = \sum_j dist_j \left(\frac{\sum_o L_{ojt}}{L_{ft}}\right),$$

where o denotes an occupation. Multiplying and diving inside the summation by the number of people of an occupation o inside the firm L_{oft}, we can rewrite this expression as:

$$\bar{D}_{HQ,t} = \sum_o \frac{L_{oft}}{L_{ft}} \left[\sum_j dist_j \left(\frac{L_{ojt}}{L_{oft}}\right)\right] \equiv \sum_o \left(\frac{L_{of}}{L_f}\right)_t \bar{D}^o_{ft}, \tag{A3}$$

which is Equation (1) from the text. To find out the contribution of each occupational category to the average distance of the workers to their HQ, we run the following regression for each occupation o:

$$\bar{D}^o_{ft} = \alpha_f + \delta^o_{decomp,t} + \varepsilon_{ft}.$$

Then, we use the estimate of the year fixed effects as the predicted average value of $\hat{\bar{D}}_t^o = \hat{\delta}^o_{decomp,t}$ for each occupation o in year t.

To further decompose each occupation's contribution between the firm's relative use of the occupation and the average distance of workers from this occupation to their HQ, we start by running a regression:

$$\frac{L_{oft}}{L_{ft}} = \alpha_f + \delta^o_{use,t} + \varepsilon_{ft}.$$

Similarly, we use the estimate of the year fixed effects as the predicted average value of the relative use of each occupation $\frac{\hat{L_{ot}}}{L_t} = \hat{\delta}^o_{use,t}$. Finally, we compute the predicted average distance of workers in an occupation o to their HQ as $\hat{\bar{Dist}}_{ot} = \hat{\delta}^o_{dec,t}/\hat{\delta}^o_{use,t}$. Using these predicted averages, we can define for each occupation and year:

$$\hat{\bar{D}}_t^o = \frac{\hat{L_{ot}}}{L_t} \cdot \hat{\bar{Dist}}_{ot}.$$

In particular, consider the change in $\hat{\bar{D}}^o$ between 1991 and 2016:

$$\Delta_{25}\hat{\bar{D}}^o \equiv \hat{\bar{D}}^o_{2016} - \hat{\bar{D}}^o_{1991} = \frac{\hat{L_{o,2016}}}{L_{2016}} \cdot \hat{\bar{Dist}}_{o,2016} - \frac{\hat{L_{o,1991}}}{L_{1991}} \cdot \hat{\bar{Dist}}_{of=,1991}. \tag{A4}$$

Adding and subtracting $\frac{\hat{L_{o,1991}}}{L_{1991}} \cdot \hat{\bar{Dist}}_{of,2016}$ to the right-hand side of the equation, we can rewrite it as:

$$\Delta_{25}\hat{\bar{D}}^o = \Delta_{25}\left(\frac{\hat{L_o}}{L}\right) \cdot \hat{\bar{Dist}}_{o,2016} + \Delta_{25}\hat{\bar{Dist}}_o \cdot \frac{\hat{L_{o,1991}}}{L_{1991}}. \tag{A5}$$

We use Equation (A5) to decompose the contribution of each one of the occupational categories into two parts: the changes in the relative use of the occupation, and the changes in the average distance of workers of this occupation to their HQ. Alternatively, we could add and subtract $\frac{\hat{L_{o,2016}}}{L_{2016}} \cdot \hat{\bar{Dist}}_{of,1991}$ to the right-hand side of equation (A4). The results obtained from this alternative decomposition are very similar to the ones we show in Table 2 and are available on request.