Labour Market Competition and Employment Spillovers: Evidence from Firm Export Shocks[1]

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Abstract Are export shocks transmitted between firms competing in the same labour market? In particular, how does labour market competition affect firms and workers that are exposed to successful exporters? To answer these questions, we employ administrative linked employer-employee dataset covering the population of Danish firms and workers, a novel approach to define labour markets through clustered worker transitions between jobs, and an empirical strategy based on shocks to firm-level export stemming from variation in world import demand. Overall, we find evidence for positive spillover effects for both workers and firms indirectly exposed to positive export shocks through the labour market. Our analysis reveals two distinct and co-existing mechanisms underlying transmission of export shocks: a direct within-market competitive pressure, causing firms to increase wages and reallocation of workers towards firms experiencing an export boost, and a positive employment spillover for firms competing with growing exporters. Positive employment spillovers and competitive worker reallocations act in different directions. Which effect dominates depends on how permeable the boundaries of a given labour market are. In self-contained labour markets, firms mainly compete for a fixed pool of workers. This generates intense wage competition and reallocation of workers to firms that experience positive export shocks. Conversely, in markets where boundaries are loose, competitors' export shocks trigger the entry of new workers from other labour markets, improving vacancy filling rates and/or match quality.

Key Words: Labour Market Competition, Employment Spillovers, Trade Shocks.

JEL Classification: F14, F16, J20, J31, L24 J61; J62, R12, R23

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1 Introduction

How do changes in the labour demand of one firm permeate through the labour market? Are firms that compete with thriving firms for the same type of labour better or worse off? These questions lie at the heart of many contemporary policy debates. For example, in the US, public policies aiming to create positive local labour market externalities cost around 50 billion USD annually (Bartik, 2020)[2].

Trade shocks are one, usually exogenous, source of variation in firm-level labour demand (Hummels et al., 2014). Nevertheless, are welfare effects of trade-shocks limited to the directly affected firms, or are they transmitted through the labour market to other firms as well? We answer these questions in a novel way, using Danish linked employer-employee data together with product-firm-level trade data. This allows us to investigate how export shocks induced by the global demand affect other firms that compete for the same workers through labour market competition.

In order to identify the effect of export shocks on the labour market, it is essential to understand if only workers hired by thriving firms share the benefits of the increasing export activity, or if these benefits are also transmitted to other workers in the same labour market. From the worker's perspective, different firms provide a set of relevant outside options. Theoretically, the existence of a competitive mechanism insures a connection between outside options and worker's outcomes. Hence, conditional on a firm's economic success, the growth of competitors in the labour market might both trigger worker reallocation (quits) and force firms to increase wages to retain their workers.

From the perspective of a firm unaffected by export shocks, the effect of competitors' success is ambiguous. An increase in competitors' product demand might cause an increase in their labour demand. Consequently, some its workers might quit and move to the competitors. However, potentially positive spillovers between firms may counteract the worker reallocation effect. Assuming that labour supply to a given market is elastic, the competitor's growth attracts new workers to the market. The larger pool of

[2]Examples of policies are tax breaks, discretionary cash transfers, job training, consulting services, and infrastructure investments.

workers might lead to persistent knowledge spillovers between firms (Serafinelli, 2019) or ease the search process for a firm and improve the match quality (Harmon, 2013). Thus, export shocks to one firm might have positive effects on all firms in the same labour market.

To identify and disentangle those effects, we need to overcome numerous empirical challenges. First, it is necessary to define the boundaries of labour markets. Traditionally, economists often proxy these boundaries by some observed categories - occupations, industries or regions. However, some of the jobs in a given unit, say a region, might not constitute a proper outside option for a worker. Moreover, some relevant outside options might not be included if they lie outside the boundaries of a unit. The last point is especially relevant in the light of the observed mobility of workers between industries, occupations and regions, see Schubert et al. (2019). Secondly, identifying market interactions between firms is challenging: firms might self-select to compete in a given market; they might be subject to common shocks, and, through labour market competition, they might influence their outcomes simultaneously.

In this project, we apply a novel approach to determine the boundaries of labour markets using observed worker mobility. The history of workers' transitions between jobs reveals which jobs workers consider as their relevant outside options. Our strategy relies on calculating mobility between occupation-municipality cells and implementing a clustering approach to group job cells that are connected by the most intense worker flows.

We provide descriptive statistics on the resulting labour markets and demonstrate that they would be poorly proxied by any observed administrative, occupational, or industrial units. We identify several market types: (i) markets which cover a narrow geographical area for a broad set of low-skill occupations; (ii) markets that cover a large macro-region, usually clustered around Sjælland or Jutland, for a narrow set of high-skill occupations; (iii) markets for specific occupations that link the metropolitan cities exclusively.

Having labour markets defined, we rely on variation in world import demand (WID) to identify export shocks. WID shocks vary on the country-by-product level and are exogenous to Danish firms. Following Hummels et al. (2014), we are able to identify the effect of competitors' export shocks

(for both exporters and non-exporters) provided that export portfolios vary widely between exporters competing on the same labour market. To construct the instrument, we use predetermined firm export product-country portfolios as weights for the global import demand values. Using predetermined weights together with global trade shocks allows us to overcome the endogeneity of a firm's exporting behaviour. Given that firms' export portfolios tend to be relatively stable, the predetermined product-country structure of firms' export appears to be a good predictor of the product-country export portfolio over time.[3]

We start by investigating how export shocks affect workers hired at firms that are not directly affected by export shocks. Our findings confirm the hypothesis that the growth of competitor firms improves outside options of a worker. We show that positive export shocks to "outside firms" competing on the same labour market increase wages of incumbent workers and make them more likely to switch to within-market competitors, hence increasing the risk of losing the worker to another firm in the market (but not outside the market). We confirm that along the lines of many previous studies (e.g. Hummels et al. (2014) and Garin and Silverio (2019)), a positive export shock leads to a wage increase for incumbent workers of directly affected firms. On the other hand, the probability of a worker leaving a firm and joining the competitors within his/her market tends to decrease when a firm's export goes up. Overall, worker-level evidence sheds light on labour market competition between firms - export shocks to one group of firms leads to wage pressure on "outsiders" and worker reallocation from them to firms experiencing the surge in export.

Does it mean that competitive pressure from firms with growing exports make other firms shrink? Results from the firm and firm-market level analysis point to the opposite conclusion: positive export shocks increase employment not only at firms directly experiencing the export surge but also at other firms sourcing workers from the same labour market. These positive employment spillovers act as a counterforce to competitive worker reallocation towards firms experiencing export growth. Increases

[3]Our strategy is similar to the firm-level instrumental variable strategy implemented by Hummels et al. (2014) and the industry-level competitors' trade shock approach by Helm (2020).

in employment go hand in hand with increases in labour turnover in firms exposed to growing competitors: firms overcompensate an increasing quit rate with an increased hiring rate. Ultimately, our results show that the labour market competition and positive employment spillovers caused by export shocks co-exist.

Differences in self-containedness between markets, that is, the degree to which a given market is separated from other markets, help to shed light on the potential mechanism underlying the results. When firms compete in an isolated labour market, positive export shocks to competitors cause stronger worker-level responses (firm mobility and wage increases) and depress firms' employment. Hence, the more self-contained a market, the more competition and reallocation forces dominate the positive employment spillovers. On the other hand, firms competing on markets with loose boundaries (which are more likely to attract workers from outside markets) are more prone to experience positive employment spillovers when competitors' export increases.

Also, we investigate how labour market competition differs if we compare competitors from the same industry/municipality/region to competitors from a different industry/municipality/region. By showing that both types of competitors matter, we illustrate that defining labour markets along observed administrative or industrial dimensions would miss relevant competitors and outside options for workers. Additionally, we show that the employment effects differ by firm size: smaller firms are more sensitive to competitors' export shocks than large firms, while the opposite holds when we consider a surge in a firm's export - the effect is here most significant for big companies.

This paper contributes to several branches of literature. First, this project is related to a growing empirical literature focusing on flows of workers between jobs (e.g.: Gathmann and Schönberg (2010), Neffke et al. (2017), Nimczik (2019), Schmutte (2014) and Schubert et al. (2019)). Building on this literature, we propose a novel approach to define labour markets through clusters of intense worker mobility between jobs. Secondly, our paper is related to other studies attempting to connect workers' outcomes to workers' outside options. Outside options are a pivotal part of theoretical models of the (perfectly and imperfectly competitive) labour market (Man-

ning (2003), Pissarides (2000), Postel-Vinay and Robin (2002)). However, empirical evidence describing worker's outside options and linking it to the wage-setting process on the granular worker-firm level is rather limited. Jäger et al. (2020) investigate the role of nonemployment for wage determination. Caldwell and Harmon (2019) define outside options through coworker networks to estimate the effects of shocks to outside options on wages and worker mobility. Beaudry et al. (2012) provide evidence that changes in local industry composition affect worker's wages under the hypothesis that the availability of high-paying jobs improves worker's outside options. A similar mechanism is linked to the decreasing gender gap in the US by Bidner and Sand (2016). Schubert et al. (2019) use occupational mobility to show that occupations tightly connected by worker flows represent outside options for each other, so exogenous wage increases in outside-occupations have a positive effect on wages in a worker's occupation. Danieli and Caldwell (2018) proxy the quality of a worker's outside options constructing an index based on the distribution of similar workers across jobs and show that changes in the diversity of outside options are positively associated with worker's wages. Carlsson et al. (2016) show that productivity shocks to competitors within the same industry have a strong effect on worker's wages, suggesting improved outside options as a mechanism. We contribute to this branch of research by combining a novel approach to define labour markets capturing complex patterns of occupational and spatial mobility, matched employer-employee data and arguably exogenous firm-level shocks to outside options.

Moreover, this project adds to the literature on the local employment spillovers, which aims to identify the effects of local shocks. Gathmann et al. (2020) show how local plant closures create a labour market "multiplier" that causes a region to lose more jobs than in the initial layoff. By exploiting national level industry shocks and variation in local industry composition, Helm (2020) identifies substantial employment spillovers between local industries. However, the labour markets we identify show that the degree to which labour markets are local varies a lot, being often hard to predict using observable administrative borders. Moreover, in contrast to the papers mentioned above, using matched employer-employee data together with firm-level shocks allows us to investigate spillovers on a more

disaggregated level.

Lastly, the project aims to contribute to the literature on labour market effects of trade shocks (and export shocks in particular). Existing papers fall into one of two categories: studies focused on the aggregate effects of trade shocks on the labour market (e.g.: Acemoglu et al. (2016), Autor et al. (2016), Dauth et al. (2014), Dix-Carneiro and Kovak (2017)) and papers analyzing firm-level response to trade shocks (among others Garin and Silverio (2019), Hummels et al. (2014), Macis and Schivardi (2016), Utar (2018)). In this paper, we aim to build a bridge between these two branches of the literature by investigating how export shocks diffuse between firms competing in the same labour market.

The paper is structured as follows. In Section 2, we discuss the data and provide some descriptive statistics. Section 3 presents the approach to define labour markets through clustered worker flows and analyses the resulting labour markets. Section 4 introduces our empirical strategy to analyze the transmission of export shocks between firms. In Section 5, the main results are reported. Section 6 concludes.

2 Data

This section presents the matched product-worker-firm dataset employed in the analysis. It covers eighteen years, from 1999-2016. The first part presents the Danish administrative data. The second part provides descriptive statistics of the samples used.

2.1 Data Sources

The firm-level data stems from several registers. The Firm-Integrated Database for Labour Market Research (FIDA) allows us to match all workers to their private-sector employers in any given year. FIRE contains information on the balance sheet and accounting data of Danish firms[4]. The dataset reports a firm's industry affiliation, portfolio of assets, and capital structure.[5] All monetary information is reported in DKK at an annual

[4]Firms are identified by a firm ID that is consistent across registries

[5]Information in FIRE comes from different sources. Statistics Denmark builds the dataset combining firms self-reporting and information obtained from the tax authorities

frequency.

The register UHDI reports yearly import and export flows of Danish firms including the source/destination country, the value of import and export in DKK at an 8-digit CN product level[6] and it is used to identify importers and exporters. UHDI is constructed based on two registers: Intrastat and Extrastat. Data in Intrastat is self-reported and covers within-EU trade. The data in Extrastat covers goods exported to non-EU countries.[7]

Finally, the public/private nature of firms in the economy is obtained through the FIRM register, which covers the universe of active firms in Denmark and can be linked to FIRE through the firm identifier. Moreover, FIRM provides aggregate measures of import and export that are not subject to the limitations of UHDI. We use product-level data from UHDI to construct the WID shift-share instrument.

To construct firm-level instruments that capture product-level World Import Demand (WID), we use the BACI dataset by CEPII.[8] The BACI dataset covers the universe of annual trade flows between countries at the 6-digit HS level, that can be linked to product level information present in UDHI matching the CN8 to the 6-digit HS product identifier.

Information on workers is provided by the Integrated Database for Labour Market Research (IDAN), covering the universe of Danish workers[9]. IDAN contains information on industry affiliation, firm of employment on the 28th of November each year, job-to-job transition and transition into unemployment, leave, early retirement at an annual level. It is linked to FIDA through CVRs. Through IDAN, we can identify workers' occupation using DISCO codes, the Danish equivalent ISCO-88/08 classification.

[6]Because the CN classification is subject to annual revisions, changing the classification of particular products from one year to the next, following Van Beveren et al. (2012), we concord product identifiers into a new classification that accounts for temporal alterations.

[7]Extrastat covers all firms exporting outside the EU. However, Intrastat' coverage is not complete as firms with low export and/or low import from EU-countries do not have to report within-EU trade. The exact threshold is set such that reported exports account for an estimated 97 percent of total within-EU exports. In 2008 the threshold was 5.2 million Danish Kroner DST (2008). According to Statistics Denmark 40.000-50.000 firms are below the threshold each year, while additional 12.000 firms are above the threshold and thus in Intrastat (Statistics Denmark (2008)).

[8]Gaulier and Zignago (2010) provide a description of the dataset.

[9]Workers are identified by an individual ID that is consistent across registries

Moreover, the population registry IDAPALL additionally reports individual information on demographics and education: gender, age, marriage, country of birth, highest completed and ongoing education. To compute yearly, daily, and hourly wages, we use BFL, which is worker-firm specific and follows individuals through all labour market spells from 2008 onwards. We obtain information on the workers' establishment from the IDAS register[10].

Finally, there are two structural brakes we have to address, a change in municipality codes in 2007 and a change in DISCO codes in 2010. Both brakes are discussed in details in Appendix B.

2.2 Descriptive Statistics

In the following, we present descriptive statistics at the firm, firm-market and worker level for key variables. The panel used for the analysis of the diffusion of export shocks covers the period from 2010 to 2016. In the estimation of labour markets presented in Section 3, we use the years between 1999 and 2008, which we thus exclude from the sample used in the analysis. 2009 is used as out-of-sample year to fix market-specific weights.

We use the entirety of firms in the economy to define competitors in a given labour market, yet, we split the sample used is all the empirical regressions into two main groups of interest. The first group - *Sample 1* - consists of exporters present in the UHDI register before 2010. For this first sample, we can control for shocks in export activity, being able to build a firm-level instrument using shocks in World Import Demand (WID). The second group - *Sample 2* - consists of all remaining private firms. Note that the second sample contains some exporters because some firms enters the economy and start exporting after 2010.[11]

2.2.1 Firm-level Data

Table 1 presents descriptive statistics of the data at the firm level. *Sample 1* consists of approximately 44 thousand firm-year observations from 2010 to 2016. *Sample 2* covers 132 thousand firm-year observations in the same

[10] An establishment is defined as a physical entity located at a specified address.
[11] The second reason is that the UHDI dataset does not cover all export activities.

Table 1: Firm-level Descriptive Statistics

Variables[3]	**Sample 1**			**Sample 2**		
	N. Obs	Mean	Std.	N. Obs	Mean	Std.
$log(Emp.)$	44,737	2.926	1.276	132,923	2.013	1.010
$log(Sales)$	44,737	18.19	1.508	132,923	16.45	1.263
$log(WageBill)$	44,737	15.85	1.384	132,923	14.55	1.213
$log(Asset)$	44,737	16.92	1.554	132,923	15.14	1.411
$log(MeanWage)$	44,737	12.72	0.477	132,923	12.30	0.827
$log(Export)$	44,737	16.13	2.514	132,923	3.612	6.102
$log(Import)$	44,737	15.46	4.133	132,923	4.139	6.079
Total Turnover	44,737	0.340	0.356	132,923	0.572	0.525
Seniority Index[1]	44,737	0.642	0.299	132,923	0.415	0.316
Education[2]	43,965	165.9	13.93	123,010	164.7	21.15
Low Skill (Share)	44,737	0.096	0.182	132,923	0.102	0.239
Med. Skill (Share)	44,737	0.506	0.329	132,923	0.579	0.407
High Skill (Share)	44,737	0.398	0.318	132,923	0.319	0.394

[1] Defined as in Buhai et al. (2014);
[2] Variable: HFPRIA - Measured as months necessary to received highest obtained degree;
[3] Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

period. Firms in the exporter sample are bigger in terms of employment, sales, wage bill and assets. Moreover, they employ a higher share of high-skill workers relative to firms in *Sample 2*, which, in turn, have a larger turnover rate. The average education level of workers is also higher among exporting firms, which, together with differences in labour force composition, is partly responsible for the higher mean wage paid by exporters. Finally, as mentioned above, firms in *Sample 2* show some residual exporting activity, due to firms starting to export after 2010.

2.2.2 Firm-Market-level Data

Table 2 presents descriptive statistics of the data at the firm-market level. Even though *Sample 1* consists of a more than 3-times smaller set of firms

Table 2: Firm-Market-level Descriptive Statistics

Variables[3]	**Sample 1**			**Sample 2**		
	N. Obs	Mean	Std.	N. Obs	Mean	Std.
$log(MeanWage_{jk})$[1]	259,176	12.75	0.733	308,053	12.26	1.038
$log(Emp_{jk})$[1]	259,176	1.074	1.214	308,053	0.629	0.921

[1] Log of Mean wage of workers in firm j belonging to market k;
[2] Log of employment in firm j belonging to market k;
[3] Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

than *Sample 2*, the market coverage of exporting firms, that is the number of firm-market observations in *Sample 1*, is nearly as extensive as non-exporters. This is because large firms, which crowd the first sample, hire workers from numerous labour markets, as later described in Section 3. Table 2 shows that exporting firms employ a larger set of workers in a given market and pay larger wages than non-exporters, even within-market.

2.2.3 Worker-level Data

Table 3 presents descriptive statistics of the data at the worker level. In line with the firm and firm-market level statistics, *Sample 1* covers a larger set of workers than *Sample 2*. Workers in the exporting sample are older, more educated, have higher seniority, and there is a higher share of males. Differences in industrial composition cause a fair degree of heterogeneity in occupations between the two sample, in particular, exporting firms employ more workers in a managerial position, more technicians and machine operators. Non-exporters employ more workers in services and sales and a higher degree of artisans and elementary, low-skill occupations. Confirming results on turnover, transition probabilities are larger for workers in non-exporting firms while wages are lower at yearly, daily, and hourly level.

Table 3: Worker-level Descriptive Statistics

Variables [6]	**Sample 1**			**Sample 2**		
	N. Obs	Mean	Std.	N. Obs	Mean	Std.
Age	2,299,965	40.82	11.18	1,194,614	37.57	12.00
Male (share)	2,299,965	0.663	0.473	1,194,614	0.639	0.480
Education[1]	2,114,889	166.3	27.73	1,012,744	163.2	27.21
Seniority Index[2]	2,299,965	0.902	0.883	1,194,614	0.747	0.781
Seniority (year)	2,299,965	6.281	6.377	1,194,614	4.121	5.323
Managers	2,299,965	0.073	0.260	1,194,614	0.054	0.227
Professionals	2,299,965	0.108	0.311	1,194,614	0.099	0.298
Technicians	2,299,965	0.235	0.424	1,194,614	0.176	0.381
Office Support	2,299,965	0.098	0.297	1,194,614	0.0779	0.268
Service/Sales	2,299,965	0.124	0.330	1,194,614	0.192	0.394
AgroForestry	2,299,965	0.0006	0.0245	1,194,614	0.0035	0.0586
Craft/Trade	2,299,965	0.134	0.341	1,194,614	0.188	0.390
Machine Operators	2,299,965	0.126	0.332	1,194,614	0.064	0.244
Elementary Jobs	2,299,965	0.101	0.301	1,194,614	0.146	0.353
$Pr(ChangeFirm)$[3]	1,563,901	0.051	0.221	610,216	0.099	0.299
$Pr(ChangeFirm_k)$[4]	1,563,901	0.025	0.157	610,216	0.067	0.250
$Pr(ChangeFirm_{\overline{k}})$[5]	1,563,901	0.026	0.159	610,216	0.0321	0.176
$Log(Wage_{year})$	2,299,965	12.62	0.818	1,194,614	12.21	1.081
$Log(Wage_{daily})$	2,299,965	6.882	0.635	1,194,614	6.629	0.772
$Log(Wage_{hourly})$	2,299,965	5.280	0.485	1,194,614	5.120	0.592

[1] Variable: HFPRIA - Measured as months necessary to received highest obtained degree;
[2] Defined as in Buhai et al. (2014);
[3] 1-year probability of moving to another firm;
[4] 1-year probability of moving to another firm in the same labour market;
[5] 1-year probability of moving to another firm in a different labour market;
[6] Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

3 Identifying Labour Markets

3.1 Conceptual Approaches

To a simple worker, the relevant labour market contains the set of his/her most likely future employers. This set is determined by the worker's set of skill and education, his geographical preferences, and other constraints, i.e. related to the family. Labour markets relevant to individual workers overlap because workers compete for similar jobs. The earlier literature identifies labour markets using pre-defined geographical area, such as a worker's county or region of residence, or as a worker's occupation, broadly defined.

To tackle the limitations of pre-defined geographical boundaries, Autor et al. (2016) identify labour markets as commuting zones, i.e. clusters of municipalities with strong observed commuting ties. Similarly, Schubert et al. (2019) use flows of workers between different professions to define labour markets as clusters of connected occupations. Empirically, however, we can observe simultaneous flows of workers across geographical areas and occupations. Thus, identifying labour markets by either geography or occupation poses several limitations.

We propose a novel and easily implementable strategy to identify labour markets. We show that: (i) the markets we identify make both geographic and economic sense; (ii) labour markets are very heterogeneous across occupations and geography.

This section proceeds as follows: first, we define the objects of interest and present the clustering algorithm used to identify labour markets. Second, we present a detailed descriptive and graphical analysis of the identified markets.

3.2 Methodology

3.2.1 Flows

For an employed worker searching on the job, an outside option, that is, a potential external job offer, is the more valuable, the higher is the productivity and, hence, the wage, net of costs of commuting. In this sense,

the set of relevant outside options is an individual-specific function of both skills, personal preferences, and other constraints that are unobserved by the econometrician. The empirical identification of these labour markets is difficult, but observed job choices are informative about the boundaries of the "true" labour markets.

We focus on cells composed of occupation-municipality pairs and determine how valuable jobs in occupations o' in municipality m' are as outside options for workers employed in occupation o in municipality m.

This flexibility allows us to captures differences in the geographical spread of labour markets for different clusters of occupations. For example, a manager that works in the middle of Jutland will have a much more dispersed set of outside options than a bartender working in Copenhagen. At the same time, a manager in Jutland will probably not consider valuable occupations in Sjaelland as potential jobs due to the long commuting distance. Another important aspect we will be able to capture is the metropolitan characteristics of specific labour markets, as noted by Nimczik (2019). In other words, for many individuals with strong preferences for metropolitan areas, valuable outside options might only be those offered in big cities. Hence, a type of labour market could be the connected set of metropolitan areas in the country for a given set of occupations.

We consider occupation o' in municipality m', (o', m'), as a more valid outside option for workers employed in occupation o in municipality m, (o, m), the more workers move from cell (o, m) towards cell (o', m') in adjacent years. A transition-based approach, in this sense, is non-parametric, and it does not impose a matching structure defining how workers and firm meet.

We identify flows between occupation-municipality cells by following workers over time. We only count switchers between occupation-municipality cells if the worker is full-time employed and if he switches to a new occupation-municipality cell outside of his firm, so we disregard within-firm occupational/establishment changes.[12]

To identify the labour market clusters and provide descriptive statistics on them, we compute the following measures of interest:

[12]More details on data sampling in Appendix B.

- The occupation-municipality transition probability:

$$\pi_{(om)(o'm')t} = \frac{f_{(om)(o'm')t}}{\sum\limits_{o'm'} f_{(om)(o'm')t}} \tag{1}$$

  where $f_{om \to o'm',t}$ is the number of workers employed in occupation o in municipality m in year t that are observed in occupation o' in municipality m' in year $t+1$. The denominator denotes the total number of workers that are observed in a different cell in year $t+1$.

- The occupation-municipality leave share:

$$ls_{omt} = \frac{\sum\limits_{o'm'} f_{(om)(o'm')t}}{LB_{omt}} \tag{2}$$

  where the numerator now denotes the total number of workers leaving cell (o, m) in year t, while the denominator is the total labour force employed in cell (o, m) in year t.

- The maximum of relative transition flows between occupation-municipality cells:

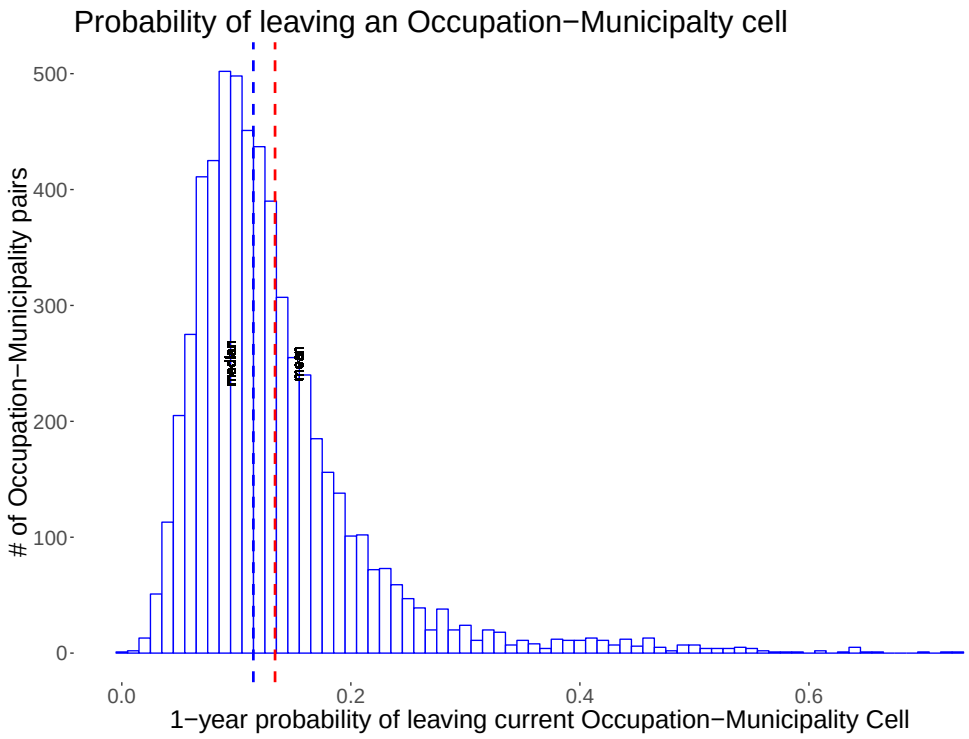
$$F_{(om)(o'm')} = F_{(o'm')(om)} = \max\left(\frac{\sum\limits_t f_{(om)(o'm')t}}{\sum\limits_t Tf_{(om)t}}, \frac{\sum\limits_t f_{(o'm')(om)t}}{\sum\limits_t Tf_{(o'm')t}}\right) \tag{3}$$

  where $f_{(om)(o'm')t}$ is the flow of workers from cell (om) to cell $(o'm')$ in year t and $Tf_{(o'm')t}$ is the total out-flow from cell (om) in year t.

We estimate the leave shares and transition probabilities at the national level using occupations defined by the 3-digit DISCO codes and the 98 post-reform municipalities[13]. We average the leave shares and transition probabilities over the years 1999 to 2008. Figure 1 shows the full distribution of the time-average 1-year probability that a worker leaves its occupation-municipality cell. The mean of the leave share is approximately 13 percent. As shown in Figure 1, this high average is not driven by a small number of unusual occupation-municipality cells.

[13]For a note on the 2007 municipality reform see Appendix B.

Figure 1: Distribution of the 1-year probability of leaving an occupation-municipality cell



3.2.2 Clustering

To identify the labour markets, rely on a clustering approach. We make use of the relative transition flows between occupation-municipality cells defined above. We use the relative flows to construct a similarity matrix, M, where each cell defines the "closeness" of the occupation-municipality pairs (o, m) and (o', m'). The higher the value of $F_{(om,o'm')}$ in matrix M , the higher the flows of workers between the occupation-municipality pairs.

Since the hierarchical clustering algorithm employed requires a matrix of distance coefficients, we compute the distance measure of the occupation-municipality pair $(om, o'm')$ as:

$$D_{(om,o'm')} = D_{(o'm',om)} = \left(1 - F_{(om,o'm')}\right) \tag{4}$$

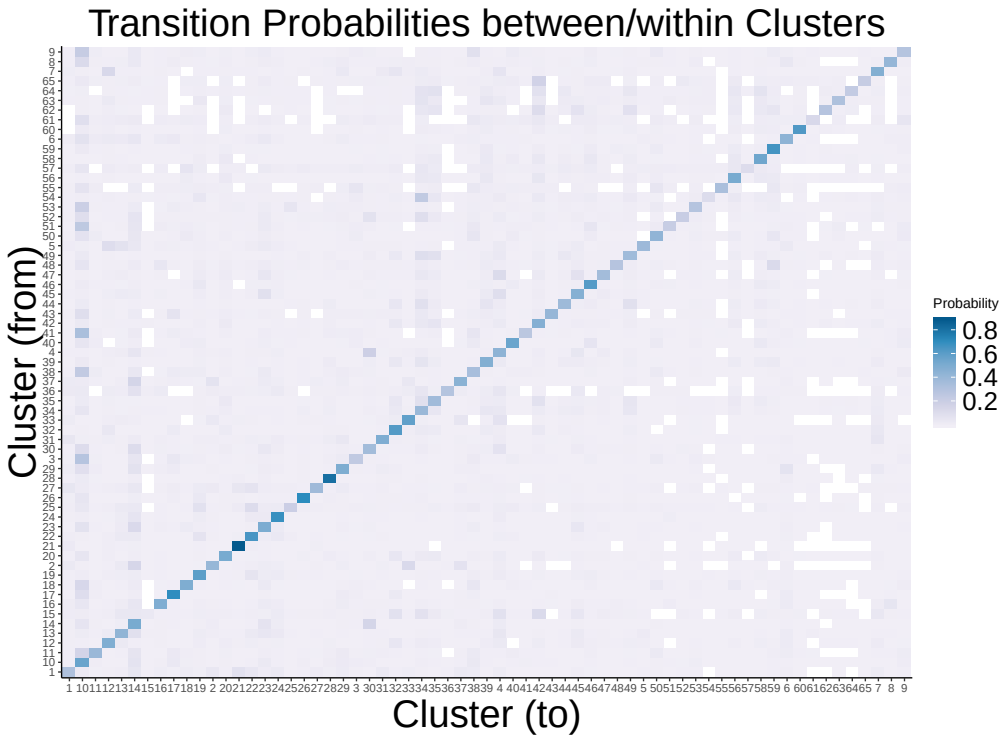
Here, values of $D_{(om,o'm')}$ that approach 0 denote a very strong relationship. To identify labour markets as groups of occupation-municipality cells with strong flows between them, we employ the average link hierarchical algorithm. We compute the optimal number of labour markets using the Duda-Hart stopping rule, which suggests 65 labour markets.[14]

Distinct labour markets must be separate and self-contained to be adequately defined. However, workers are subject to frictions and shocks and free to move between markets. To show that the markets we computed are effectually self-contained, in Figure 2 we plot the between-cluster transition matrix, where each cell represent the 1-year probability of moving from cluster y to cluster x.

In Figure 2, a cell is the bluer, the higher is the probability of moving between the two labour markets. White cells represent markets pairs where no flow is observed. On average, over half of all transitions occur within-cluster. Between-cluster transitions are less likely. Markets' boundaries appear to have a rather heterogeneous permeability, that is, the degree to which workers can move between markets. This is shown by the diagonal of Figure 2. The higher the diagonal value, the higher the chance a movement happens within a given market (cluster), that is, the more rigid or less permeable the market's boundaries are. We refer to the degree of permeability of a market as its degree of self-containedness. In other words, a

[14]For robustness, we check different numbers of markets.

Figure 2: Transition probability matrix between clusters



market is more self-contained, the higher the probability that worker flows between jobs happen within its boundaries. The lower is the permeability of a given market, the more self-contained the market is.

3.3 Describing Labour Markets

The identified labour markets differ significantly in many dimensions and can be categorised in several groups[15]. Figure 7 plots six different types of labour markets that depict well the clustering exercise. The municipalities included in each market are marked in blue and we list the occupations it covers.

The first type of labour market is geographically contained, as shown in Panel (a) of Figure 3. Panel (a) represents a labour market for various jobs in the north-western part of Jutland, surrounding the Limfjord. Markets of this type are relatively similar to a standard commuting zone. They

[15]The average labour market we estimate consists of 41 municipalities and 10 occupations.

generally cover low-skill occupations such as cleaning, kitchen help, care work, and unqualified manufacturing and commercial work.

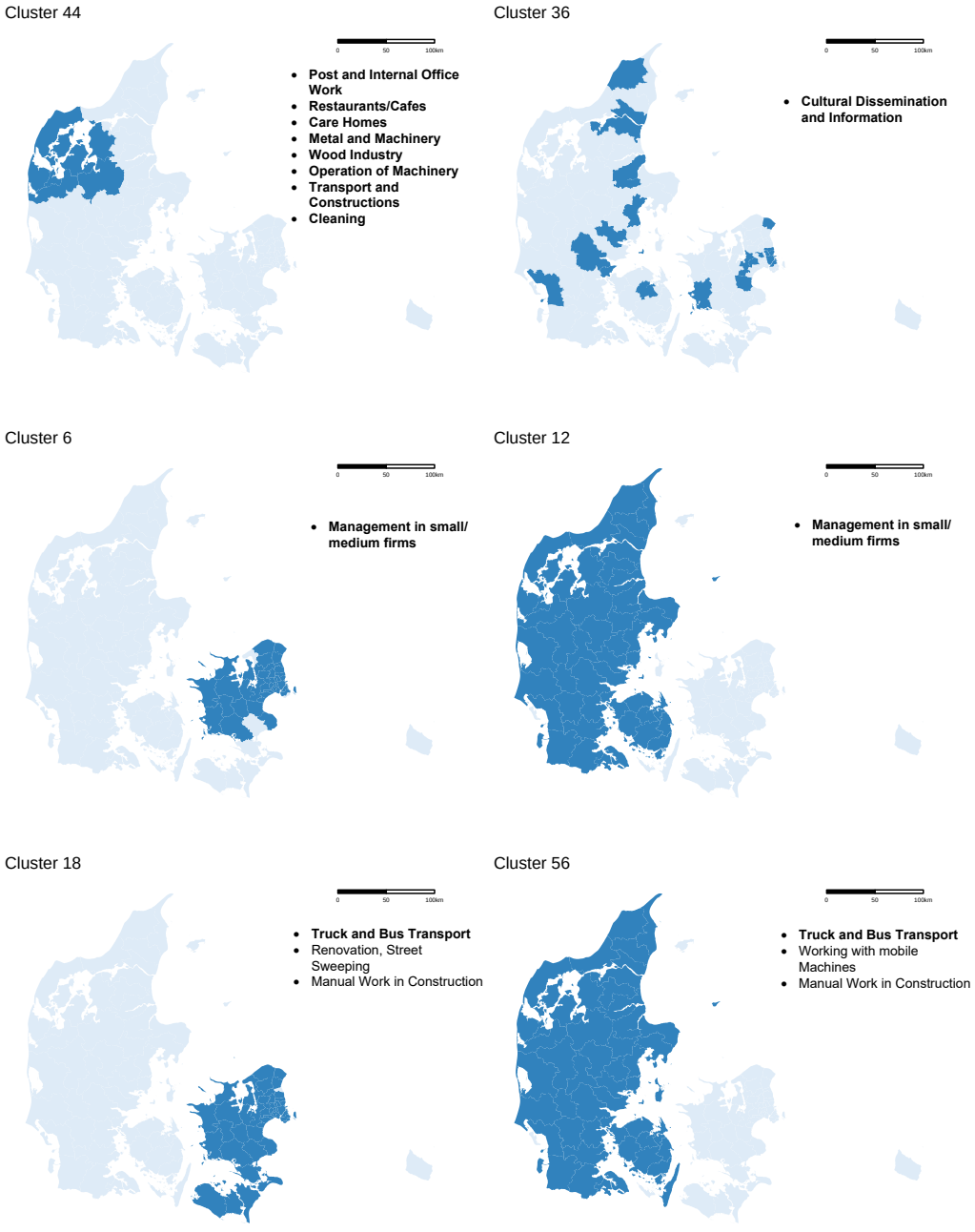
The second type of clusters connects occupations only across specific metropolitan areas, as shown in Panel (b), picturing a labour market for workers employed in cultural dissemination. The market connects several urban municipalities across the country, such as Copenhagen, Aarhus, Odense, Esbjerg, Aalborg. This can be explained by: i) individuals have a strong preference for large metropolitan areas or ii) certain occupations are only present in specific municipalities across the country, so workers in these occupations have to move. Occupations covered by markets of this type are generally high-skill.

The third type of labour market is geographically dispersed and covers a rather small number of occupations, as shown in Panels (c) and (d) in Figure 3, depicting the labour market for managers in small and medium firms. The algorithm identified two specific labour markets for this occupation, one clustered around the Jutland peninsula, one around Copenhagen. The conclusion here is twofold: i) managers, as many high-skill occupations, move a lot compared to the low-skilled occupations of Panel (a); ii) even though they move a lot, they tend to gravitate in a specific macro-region. A similar partition exists for clusters covering low-skilled occupations that tend to be geographically dispersed, as shown in Panels (e) and (f). These clusters cover bus and truck drivers, mobile machine and skilled construction workers. As before, they appear to be extremely mobile within a certain macro-region, not across regions.

The results obtained by our clustering of interconnected labour markets confirms that the interaction between geography and occupation, which simple approaches miss, is clearly important. For many low-skill occupations, a more geographically centred approach might work well. Nevertheless, using geographical proxies would misclassify outside options for a broad set of high-skilled employees. Conversely, defining labour markets through occupations or industry attachment would work for geographically dispersed but occupationally centred markets, as those in Panels (b)-(f) of Figure 3, but misclassify labour markets for many low-skill employees.[16]

[16]Defining labour markets trough zones of commute, as pictured by Figure 10 in the appendix will lead to misclassification for a large sample of both high-skill and low-skill

Figure 3: Identified Labour Markets



To shed more light on the labour market structure, we defined a geographical and occupational Herfindahl-Hirschman concentration Index (HHI) for each labour market, computed as:

$$HHI_k^{occ} = s_{o_1,k}^2 + s_{o_1,k}^2 + ... + s_{o_1,k}^2$$

$$HHI_k^{mun} = s_{m_1,k}^2 + s_{m_1,k}^2 + ... + s_{m_1,k}^2$$

where $s_{o_1,k}^2$ denotes the squared integer share of occupation o_1 in labour market k, while $s_{m_1,k}^2$ is the squared integer share of municipality m_1 in labour market k. For labour markets that are heavily occupationally or geographically concentrated, consisting of a single occupation or a single municipality, $s_{o_1,k} = 100$, that is, the single occupation, o_1, covers 100 percent of the market, and HHI would equal $100^2 = 10000$. The lower the index, the higher the number of occupations or municipalities in each labour market and the lower the concentration.

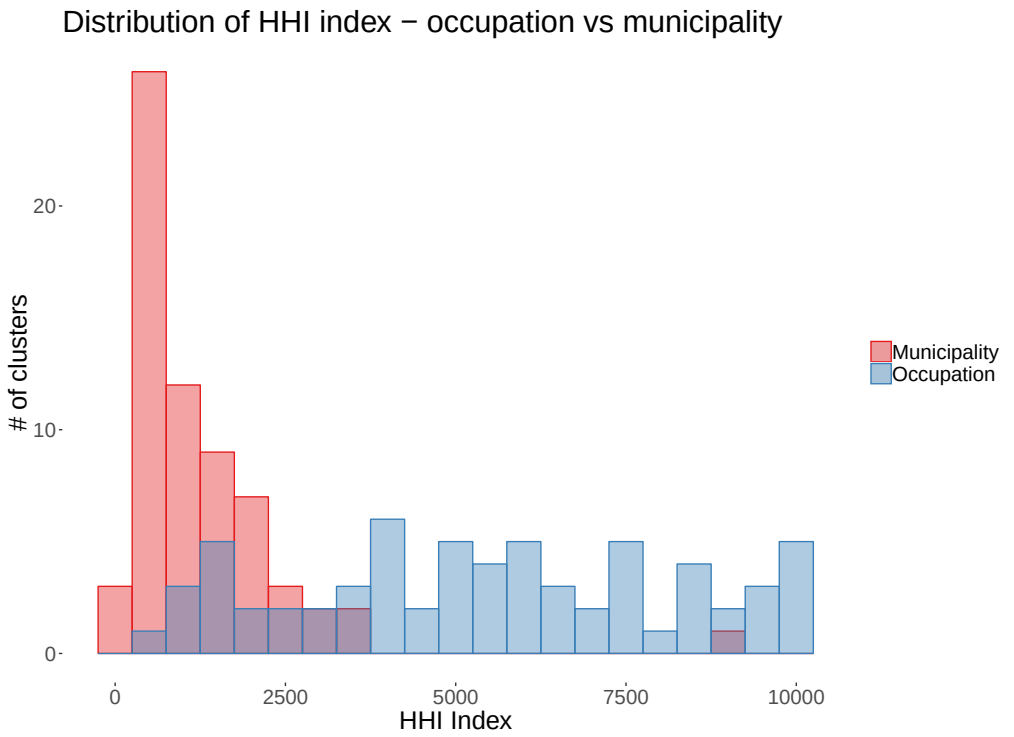
Figure 4 plots the distribution of HHI_k^{occ} and HHI_k^{mun} across labour markets. Clusters tend to be geographically dispersed (low values of HHI_k^{mun}) but the range of occupations they span is rather heterogeneous. The rather broad geographical area covered by the average market confirms the mobile nature of the Danish labour market. One observes a high turnover rate and a large number of flows between occupations and firms.

To capture the relationships linking specific features of each labour market to the occupations they cover, for each occupation, o, we averaged HHI_k^o across all clusters that contain occupation o, together with specific information of the workers employed.

As we can see from Panel (a) in Figure 5, occupations that are part of concentrated clusters, i.e. occupations with a high HHI_k^o, tend to be occupations where individual workers are more educated. The relationship between education and clusters' occupational concentration is strongly positive. This is confirmed by Panel (b), where the same concentration measure is plotted against the average wage of workers employed in each occupation. Similarly, in Panel (c) we used the hierarchical classification

jobs.

Figure 4: HHI concentration index - Occupation vs Municipality



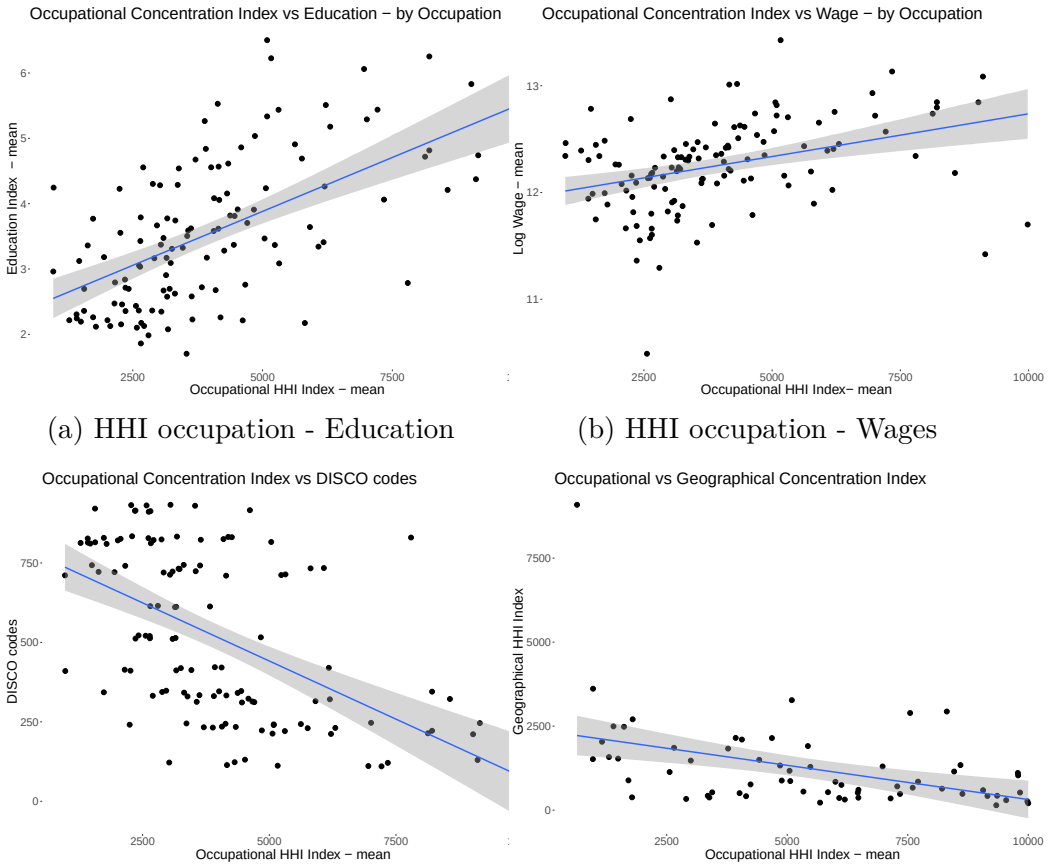
structure of occupational codes[17], and plot the average HHI_k^o across clusters for each occupation against its occupational code. Broadly, the lower the code, the higher the skill level required in a given occupation. Again, we observe high-skilled occupations to be part of clusters that are much more concentrated than low-skilled occupations.

Finally, Panel (d) shows how, HHI_k^o and HHI_k^m are inversely related, i.e. the broader the geographical area covered by a cluster, the narrower the set of occupations. Taken together with Panels (a)-(d) this show that labour markets increase in geographical size with workers' skill level, simultaneously narrowing down their occupational coverage, hence reducing competition between occupations while expanding competition across regions the more highly skilled the occupation.

Figure 6 plot the relationship between markets' degree of self-containedness and workers characteristic. Panels (a) and (b) show a positive relationship between the markets' degree of self-containedness and workers' education

[17]For a detailed description: https://www.dst.dk/da/Statistik/dokumentation/nomenklaturer/disco-08?id=ec4f3246-ea1a-4e8b-b229-f03c0dc680c6

Figure 5: Occupational concentration across clusters - by occupation



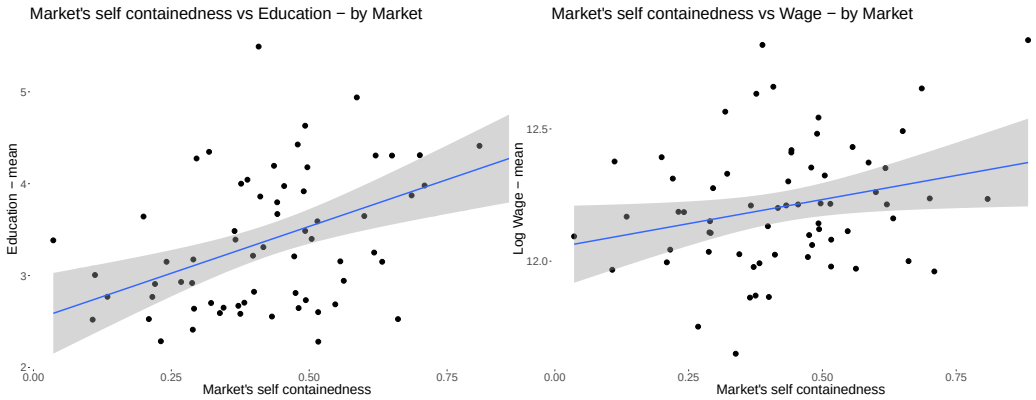
(a) HHI occupation - Education

(b) HHI occupation - Wages

(c) HHI occupation - Disco

(d) HHI occupation - HHI municipality

Figure 6: Self-containedness across markets



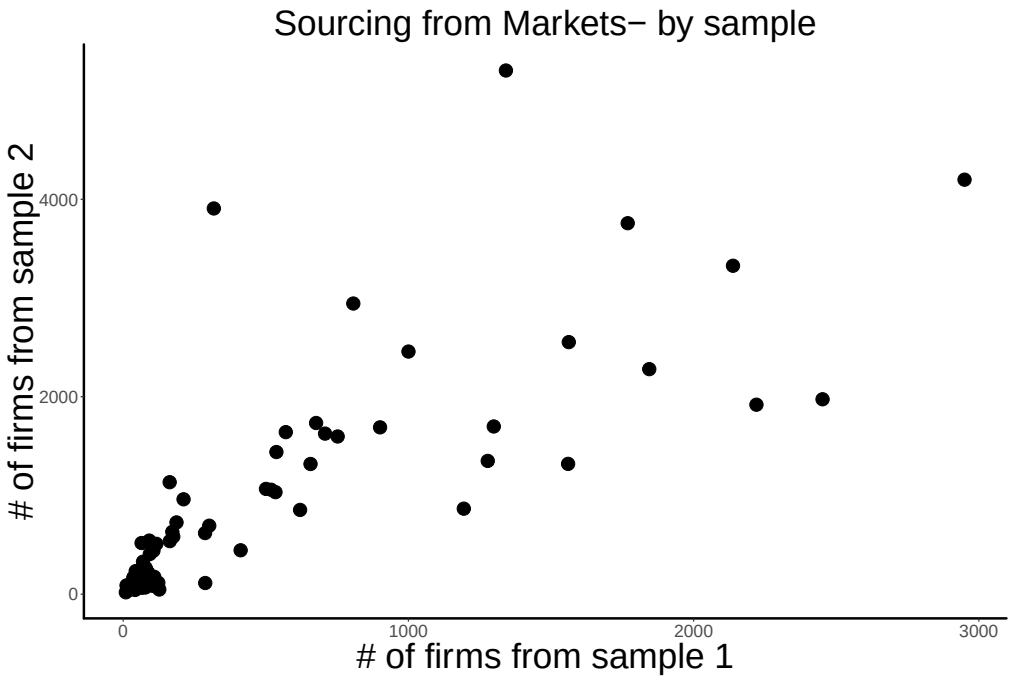
(a) Self Containedness - Education (b) Self Containedness - Wages

and a mildly positive relationship with wages. This suggests that self-contained markets are markets covering high-skill, specialized jobs, whose barriers to entry make switching between markets less likely.

These facts, taken together, shows that labour markets increase in geographical size with workers' skill level while they tend to narrow their occupational cover. Moreover, markets with highly educated workers are characterised by stricter, less permeable boundaries and hence by a higher degree of self-containedness. These differences have a substantial impact on the potential diffusion of shocks in the economy because outcomes like wages and labour mobility might respond asymmetrically across different labour markets.

Finally, if firms in *Sample 1* (exporters) and *Sample 2* (non-exporters) hired workers from non-overlapping labour markets, by construction, we would not see any transmission of labour market competition caused by shocks in exports. To check the hiring strategy of firms in the two samples, Figure 7 plots the number of firms by market that belong to *Sample 1* (x) and *Sample 2* (y) respectively. Even though there exist markets predominately used by non-exporters/exporters, the observations develop along the diagonal, suggesting that exporting and non-exporting firms source workers from the same markets.

Figure 7: Firms by Sample in each market



4 Identifying Labour Market Spillovers

In this paper, we investigate how product shocks induced by the global demand spread from exporters to firms competing in the same labour market. There are two main aspects to consider. On the worker side, positive shocks to firm i's competitors might increase their relative attractiveness in a given labour market. For a worker employed in firm i this would be seen as an increase in his/her outside options value, making workers' implicit risk or explicit threat of leaving more credible. The wage competition that would arise would then push wages for workers in a given market upward. A shock to competitors might also lead to workers reallocation from firm i to firm i's competitors, due to the now more favourable conditions.

On the firm side, things are less obvious. While it is true that a shift in competitors' labour demand is perceived as an inward shift in a firm's labour supply and might lead to higher wages and lower employment, the existence of positive spillovers between firms might reverse the line of reasoning. Competitors' growth might attract new workers in a given market. The now larger pool of workers would translate into a higher vacancy filling

rate and improved matching quality, leading to a higher employment level in firm i.[18]

To investigate the existence of wage competition, reallocation and labour market spillovers, we analyse the matched employer-employee data at three different levels of aggregation. While the analysis on the firm and the firm-market level help us to see the effects of competitors' export shocks (comprising both worker reallocation and employment spillovers), worker-level results shed light on existing wage competition effects between firms. The subsequent section presents the estimating equations at the three different level of aggregations and the IV strategy we propose to overcome several identification issues.

4.1 Empirical Strategy

We now present the regression framework at the worker, firm-market and firm-level. On all three levels we investigate two different sub-samples of the data: "exporters" and "non-exporters".[19] The reason for the split concerns the fact that the export activity of competitors might affect a firm's export, both at the intensive and extensive margin. For the first sample of interest, we can disentangle the own's from competitors' export effect by constructing global import demand instruments for a firm's export activity. For the second sample, we are not able to separate these two effects. The results here are interpreted as the overall impact of competitors' export shocks, including the indirect effect caused by changes in a firm's export behaviour.

Worker-level Regressions: To study how competitors export translates into labour market outcomes of worker's hired at other firms, we use the following specification, for sample 1 and sample 2, respectively:

[18] Competitors' growth could also foster different types of agglomerations economies. For example, it can attract high-skilled workers and enhance knowledge flows between firms (Helm, 2020).

[19] As is was mentioned in Section 2 "non-exporters" include firms, which are not observed exporting in UHDI before 2010. This restriction is caused by the necessity to use predetermined product-country export portfolios to construct the instrument.

$$y^{\mathbb{1}}_{ijt} = \alpha_{ij} + \beta log(Exp_{jt}) + \gamma_1 \overline{log(Exp_{-jkt})} + \tau_{IND,t} + \tau_{MUN,t} + \varepsilon_{ijt} \quad (5)$$

$$y^{2}_{ijt} = \alpha_{ij} + \gamma_1 \overline{log(Exp_{-jkt})} + \tau_{IND,t} + \tau_{MUN,t} + \varepsilon_{ijt} \quad (6)$$

where y_{ijt} denotes either the log of yearly, daily or hourly wages of worker i in firm j at year t or a dummy equal to 1 if worker i leaves firm j within the next year for a different firm within/outside its labour market. The former would capture wage competition due to the higher threat of leaving; the latter would capture the actual reallocation caused by increased labour demand of j's competitors. α_{ij} denotes spell fixed effects, $log(Exp_{jt})$ is the log of value of export of firm j in year t, $\tau_{IND,t}$ denotes 6-digit industry-year fixed effects, $\tau_{MUN,t}$ stands for municipality-year fixed effect, $\overline{log(Exp_{-jkt})}$ is the weighted average of the log of export of firm j's competitors in labour market k. We define $\overline{log(Exp_{-jkt})}$ as

$$\overline{log(Exp_{-jkt})} = \sum_{z \neq j} \rho_{kz} log(Exp_{zt}) \mathbb{1}\left[z \in k\right] \quad (7)$$

where ρ_{kj} is the ratio of workers in cluster k employed by firm j over all workers in cluster k pre-determined in 2009.[20]

The main coefficient of interest in equation 5 and 6 is γ_1, which captures the elasticity of the within-spell wages or the increase in leaving probability of worker i employed in firm j to changes in export of j's competitors in market k, where worker i belongs. The own effects of export on wages and firm mobility is reflected in β in equation 5. We include an age polynomial in all worker-level regressions.

Firm-Market level Regressions: To capture the employment effect caused by export shocks in firm j's competitors in a given market, we use the following specifications, for market 1 and market 2, respectively:

[20]Note that weights are computed, taking into account all private firms in a given market, regardless of their export activity. If a given competitor does not export, its term in the summation is 0, although its weights are positive. This is to capture the truthful "importance" of exporting firms in a given market.

$$log(emp^{\mathbb{1}}_{jkt}) = \alpha_{jk} + \beta log(Exp_{jt}) + \gamma_1 \overline{log(Exp_{-jkt})} + \tau_{IND,t} + \tau_{MUN,t} + \varepsilon_{jkt} \tag{8}$$

$$log(emp^{2}_{jkt}) = \alpha_{jk} + \gamma_1 \overline{log(Exp_{-jkt})} + \tau_{IND,t} + \tau_{MUN,t} + \varepsilon_{jkt} \tag{9}$$

where $log(emp_{jkt})$ represents the log of employment in firm i that belongs to market k in year t, α_{jk} denotes firm-market fixed effects, $\tau_{IND,t}$ and $\tau_{MUN,t}$ stand for the 6-digit industry-year and municipality-year fixed effects respectively, as before. In a similar way, $\overline{log(Exp_{-jkt})}$ denotes the weighted average of firm j's comepetitors' export.

The coefficient of interest, γ_1, captures the elasticity on within-market employment in firm j to changes in export of j's competitors in market k. A negative γ_1 would imply that positive export shocks to j's competitors trigger reallocation of workers from firm j that dominate any potential positive spillover effects. A positive γ_1, instead, would imply the opposite. Own export effect on employment is captured by β.

Firm-level Regressions: To estimate the magnitudes of the pass-through and strategic complementary in firms' labour demand, that is, how a firm's labour demand responds to changes in competitors' demand for labour, we use the following specification for the two samples:

$$\eta^{\mathbb{1}}_{jt} = \alpha_j + \beta log(Exp_{jt}) + \gamma \overline{log(Exp_{-jt})} + \tau_{IND,t} + \tau_{MUN,t} + \varepsilon_{jt} \tag{10}$$

$$\eta^{2}_{jt} = \alpha_j + \gamma \overline{log(Exp_{-jt})} + \tau_{IND,t} + \tau_{MUN,t} + \varepsilon_{jt} \tag{11}$$

where η_{jt} denotes the outcome of interest of firm i in year t, $log(Exp_{jt})$ the log of export of firm i in year t, α_j denotes firm fixed effects, $\tau_{IND,t}$ and $\tau_{MUN,t}$ stand for the 6-digit industry-year and municipality-year fixed effects respectively, as before and $\overline{log(Exp)}_{-jt}$ denotes the aggregate log of export of a firm's competitors.

Figure 8: Employment vs # of markets

However, while the definition of $\overline{log(Exp)}_{-jkt}$ within a given market is rather straightforward, aggregating it at the firm level is not. Given our definition of labour markets, as macro-sets consisting of occupations-municipality cells, firm j is simultaneously competing in many different markets depending on the composition of its labour force. As an example, think of a manufacturing firm that employs highly specialized engineers and cleaners at the same time. According to the results presented in the first part of the paper, the labour market for highly specialized engineers will be a much broader area than the labour market for cleaners, which firm i would probably hire among low-skilled workers in the proximity of the establishment, contrary to the engineers that it would likely source across the entire country. To show the heterogeneity of firms' dependency on different markets, figure 8 plots firms employment level against the number of labour markets they source their workers from.

To take this into account, we present an aggregation strategy to compute $\overline{log(Exp)}_{-jt}$, the log of export of i's competitors. We define $\overline{log(Exp)}_{-it}$ as:

$$\overline{log(Exp_{-jt})} = \sum_{k \in K} \left(\sum_{z \neq j} (\rho_{kjz} log(Exp_{zt}) \mathbb{1}\left[z \in K\right]) \right) \tag{12}$$

This compound object should be read as follows: for every cluster k, we compute the log of export across all non-i firms in municipalities that are contained in cluster k. The averaged cluster-specific log of export is then weighted by ρ_{kjz}, defined as:

$$\rho_{kjz} = \frac{\rho_{kz}}{1 - \rho_{kj}}$$

where ρ_{kj} denotes the share of employees of firm j from cluster k over all workers present in cluster k, computed in 2009 and fixed in time, to take care of potential endogeneity of firm sourcing strategy from a particular labour market. Following Amiti et al. (2019), we define ρ_{kjz} so that it weights firm z's competitors based on how many employees they have from cluster k relative to firm j. It takes into account the relative labour market dependence of firm j and its competitors. This captures the fact that firms could source from extremely different sets of clusters. The summation across all clusters gives us a measure that defines the export of j's competitors, taking into account j's own labour composition and the labour composition of j's competitors.

The identification of the equations presented above poses several challenges to the econometrician. In the following section, we discuss: (i) the selection of time constant unobservables (ii) the issue of common shocks, both across industries and regions (iii) the endogeneity and simultaneity problems concerning a firm's and competitors' export.

4.1.1 Challenges to Identification and Instrument

Identifying spillover effects between firm competing at the same labour market faces several challenges similar in nature to issues widely discussed in the peer effects literature (Manski, 1993). The first major challenge is selection. To address the issue, equations 5 and 6 contain spell fixed effects - we focus only on within-spell variation in competitors' export to identify the spillover effects. Equations 8 and 9 include firm-market fixed effect and equations 10 and 11 - firm fixed effect. Inclusion of fixed effects addresses

similar issues in identification of own export effects in equations 5, 8 and 10.[21] The inclusion of fixed effects is necessary because firms and workers (generally) choose which market to enter. If unobserved characteristics of firms and workers that correlate with outcomes are also correlated with market-level determinants of export, the observed connection between outcomes and competitors' export levels might be spurious. For example, if more productive firms tend to compete for workers with other more productive firms (which tend to be exporters), without any causal link positive association between firm's employment and competitors' export levels might emerge. Similarly, if high-wage workers tend to sort to markets with more exporters - competitors' export will be positively correlated with wages.

Secondly, even after accounting for selection on unobserved (time-constant) factors, competitors' export activity and firm (or worker) outcomes could co-move spuriously due to common shocks. For instance, global technological shocks to a specific industry might cause worldwide change in global exports of this industry and employment (wage) levels in this industry nationally (even for non-exporting firms). Consequently, the existence of labour market competitors from the same industry would create a misleading correlation between the competitors' exports and a firm's employment/wages. An alternative type of correlated shocks is spatial shocks. For example, regional infrastructural investment might boost both export and employment/wages at neighbouring firms. Given that, as it was highlighted before, many labour markets are local - spatial shocks might pose an identification challenge.[22] To address this problem, all regressions discussed above include 6-digit industry-year fixed effects and municipality-year fixed effects.

Lastly, another crucial element of our empirical strategy is instrumenting both own firm and competitors' export with a shift-share type instrument *a la* Hummels et al. (2014), which relies on World Import Demand variation and predetermined firm-level product-country portfolios.

[21]For example, more productive firms might be simultaneously more likely to export and have larger workforce and wages; more productive workers might self-select to jobs in exporter firms.

[22]Note that by implementing an instrumental variable strategy, which relies on variation stemming from global import demand variation (described below), we alleviate the common shock issue. Specifically, not any local shock would cause bias, but only one correlated with World Import Demand.

We construct a firm-level instrument as:

$$log(WID_{it})^{\mathbb{IV}} = \sum_{c} \sum_{p} \overline{s}_{icp} log(WID_{cpt}) \tag{13}$$

where $\overline{s}_{icp}$ denotes the product-country export revenue share for firm i the first year firm i enters the sample before 2010, while WID_{cpt} is world import demand from country c of product p at time t, excluding Denmark for each product category.[23] Changes in WID_{cpt} might reflect shocks to consumer tastes, industrial use of products and changing patterns of comparative advantage.

Analogously, to build an instrument for firm i's competitors, both aggregated and within-market, we use the same (predetermined) weights employed to construct the competitors export measures:

- The aggregate competitors export is thus instrumented by:

$$\overline{log(WID_{-it})}^{\mathbb{IV}} = \sum_{k \in K} \left(\sum_{j \neq i} \rho_{kij} log(WID_{jt})^{IV} 1\left[j \in K\right] \right) \tag{14}$$

- Market-specific competitors export by:

$$\overline{log(WID_{-ikt})}^{\mathbb{IV}} = \sum_{j \neq i} \rho_{kj} log(WID_{jt})^{IV} 1\left[j \in k\right] \tag{15}$$

WID instrument is a good predictor of firm-level export (and, similarly, competitors' export). The identification requires not only that firm export is responsive to WID_{cpt}, but also that predetermined export portfolios reflected in weights $\overline{s}_{icp}$ are relatively stable over time. This could be explained by costly switching between export destinations or changes in the product portfolio.

Using WID variation is pivotal to identify both own and competitors' export effects (on all three levels of analysis). In identifying the effects of

[23] Contrary to Hummels et al. (2014), we take the weighted average of the log of WID, instead of the log of the weighted average of WID, which is a value in DKK whose distribution is particularly skewed. This only affects the magnitude of the first-stage regression, though it perfectly preserves Hummels et al. (2014) results, as presented in Section 5

a firm's export, the instrument helps to alleviate concerns about the endogeneity of a firm' export in relation to the firm's and worker's outcomes.[24] Unobserved drivers of firm-level performance might cause both - export and labour demand growth - leading to bias in the estimates. Changes in WID, on the other hand, are assumed to be exogenous to Denmark and in turn exogenous to unobserved firm-level outcome shocks.

Instrumenting competitors' export with WID variation helps to address concerns connected to (residual) common shocks and the reflection (or simultaneity) problem. Firstly, unobserved shocks driving firms' export on the market level (and not captured by industry-time and municipality-time fixed effects) might also shift the competitors' labour demand. Instead of assuming that these unobserved shocks to firm labour demand are orthogonal to competitors' export, we assume that competitors' WID shocks affect firm and worker outcomes only through competitors' export. Secondly, aiming to identify the effect of competitors choices on outcomes of firm j, we face a challenge to disentangle it from the effect of firm j choices on its competitors. Therefore, having variation in competitors' export stemming from the global factors and hence completely exogenous to firm j's choices helps to "break" the vicious circle of simultaneity.

The issues described above concern the identification of the effect of labour market competitors' export on firm-, and worker-level outcomes. Nevertheless, our interpretation of the effect relies on a more restrictive assumption that these export shocks act as shifters of competitors' labour demand. We cannot exclude *ex ante* alternative mechanisms on how competitors' export might be related to the outcome variables. Among potential mechanisms are product competition, input-output shocks and local housing demand changes. If labour demand competitors are also competing on the product markets, a positive export shock to them could change their behaviour on the domestic product market, which in turn might affect a firm's labour demand. Similarly, if among labour market competitors, there are firm's clients or suppliers, the input-output channel might be important for explaining the effect. If labour markets are local, competitors' export boost might affect a firm's outcomes through housing

[24] Another major issue concerns measurement error, which might cause attenuation bias in resulting estimates of own export effects.

prices. These issues are only partially handled by the inclusion of industry-time and municipality-time fixed effects. To accommodate this concern, we investigate how competitors' effects differ between same-industry, same-municipality, different-industry and different-municipality competitors.

5 Results

5.1 Main Results

Following the structure presented in Section 4, we describe the main results at the worker level first. In particular, we investigate how own export shocks and export shocks to competitors affect worker's wages and mobility. After having defined results at the worker level, we proceed with the analysis of firm adjustment at the granular market level, where the existence of employment spillovers is assessed. On the firm level, we aggregate all shocks that a firm receives on the different markets it sources workers from (as described in 4) to investigate the effect on various firm-level outcomes. Besides employment, wage bill and sales, we also analyze labour turnover, corroborating the findings on the joint effects of worker reallocation and positive employment spillovers.

We use the remaining part of the section to rationalize results, discussing possible mechanisms. In particular, we test the hypothesis that the relative strength of worker reallocation between firms and employment spillovers depends on how permeable the boundaries in a given labour market are. Furthermore, we analyze if the effect of competitors' export differs between different groups of competitors. We define competitors within and competitors outside a firm's municipality, region and 2-digit industry. To conclude the section, we study how the identified effects depend on firms size.

In the empirical model, at all levels, the main parameter we focus on is γ_1, which measures the elasticity of the outcome of interest to changes in competitors' export[25]. Throughout the analysis, we use labour markets

[25]In Appendix D we define a further control to take into account possible cross-effects between markets and report all results at the worker and firm-market level when activity in other markets is taken into account.

with borders predetermined based on data from 1999 to 2008. We, then, project labour markets into the post-2009 panel. The sample used for the following analysis covers the period between 2010 and 2016.

5.1.1 Worker level Analysis

If labour markets are correctly defined, positive export shocks to competitors will lead to an increase in their labour demand. While a boost in own export could be seen through the rent-sharing lenses as an increase in the size of the "pie" to be shared with workers, an increase in competitors' export, on the other hand, might lead to an improvement in worker's outside options. In this case, we expect both own and competitors' export shocks to affect wages of job stayers in the same direction. The effect of a surge in a firm's export is expected to improve job-stability, while the boost in competitors' export should increase worker reallocation towards them.

To capture the wage competition and mobility at the worker level, the outcomes we focus on are workers' wages, both yearly, daily and hourly, and reallocation intensities, measured as the 1-year probability of leaving a given firm. We define three different probabilities, to validate the estimated labour markets: (i) the probability that a worker leaves regardless of the destination; (ii) the probability that a worker leaves for a job in a firm within his/her labour market; (iii) the probability that a worker leaves for a job outside of his/her labour market.

To account for sample differences, we begin by reporting first stage regressions in table 4 on export for both samples and both outcomes of interest. Across all samples and outcomes, world import demand correlates, strongly and significantly, with firms export and competitors' export. In particular, there appears to be little "cross-contamination". Intuitively, WID targeting a firm's export mainly correlates with export at the given firm and has no predictive power on competitors' activity, and vice versa[26]. All specification are statically demanding, including spell fixed effects, 6-digit industry-year fixed effect and municipality-year fixed effects. More-

[26]The main difference in the magnitude of the coefficient for own export compared to Hummels et al. (2014) is uniquely driven by the fact that we take the average of log WID instead of log of the average. Taking the average of logs does not affect the second stage results at all, which replicates Hummels et al. (2014) perfectly.

over, we cluster errors at the firm-level for all specifications at all levels. Finally, the F-statistics for both own export and competitors is larger than the threshold suggested by Staiger and Stock (1997), confirming a strong correlation between the WID-instrument and firm-level export, both for individual firms and within-market competitors.

Table 5 and 6 report the OLS and second-stage IV estimates for each outcome side-by-side. Table 5 shows the results on worker wages, from the most time-aggregated (yearly) level to the most time-disaggregated (hourly) level. Note that choosing the wage measure involves important trade-offs. On the one hand, shocks to competitors firms might affect wages and employment at a given firm in different directions (for instance, a positive shock to competitors might simultaneously increase wages and probability to switch firms). In this sense, annual wages might be misleading. On the opposite side, while hourly wages are closer to measure pure "price effects", they are more prone to measurement error.[27]

The first row for the Sample 1 panel in table 5 reports the β coefficients, capturing the effect of a firm's export. The second row reports the γ_1 coefficients capturing the effect of competitors' export. For the exporter sample, OLS and IV results are strongly significant across all wage types. However, for the non-exporting sample, the effect is identified for daily wages only.[28]

Both a firm's own and competitors' export appear to influence within-spell workers' wages positively. Specifically, we find that the elasticity of daily wages to changes in own and competitors' export is 0.0116 and 0.0046 respectively for *Sample 1*. For *Sample 2*, the effect of competitors export on wages is 0.0015, thus four times smaller than for workers employed in exporting firms. Smaller effects on non-exporters could be explained, for example, by the fact that skill requirements of exporters are systematically different from non-exporters.[29] However, although causing a smaller effect among non-exporters, the same mechanism appears to be consistently

[27] A part of observations have employment hours not reported by the employer (imputed).

[28] This could (in part) be explained by the issues with annual wage and hourly wage measures explained above.

[29] As it is shown by Bødker et al. (2018), workers might self-selected to exporters according to their comparative advantage.

Table 4: Worker-level First Stage regressions

		Sample 1		
	WAGES		MOBILITY	
EXPORT	Own	Competitors	Own	Competitors
Own IV	0.0073***	0.0008	0.0070***	0.0011***
	(0.0010)	(0.0005)	(0.0010)	(0.0004)
Competitors IV	-0.0001	0.6271***	0.0002	0.6120***
	(0.0015)	(0.0524)	(0.0015)	(0.0556)
R-squared	0.980411	0.948890	0.9834	0.9501
F-stat.	27.56	71.88	27.30	60.88
N. Obs	2,031,989	2,031,989	1,401,783	1,401,783
		Sample 2		
Competitors IV		0.8539***		0.8403***
		(0.0098)		(0.0111)
R-squared		0.9733		0.9763
F-stat.		7653		5690
N. Obs		859,186		462,519
IND-Year FE	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes
Spell FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

working across both samples, as later shown in Section 5.2.1, where we estimate the wage competition and mobility effects by the degree of self-containedness of a given market. The fact that results by market's self containedness are qualitatively in line across samples might signify that the small local firms that crowd *Sample 2* act as noise in the estimation of the overall effect of labour market competition.

Results on the effects of a firm's own export shock are intuitive, well discussed in the literature and match Hummels et al. (2014).[30] Quoting Hummels et al. (2014): *"Rising exports are a rising tide that lifts all boats"*.

On the other hand, the positive and strongly significant effect of an increase in firm's j competitors' export on wages of firm j's workers documents the existence of labour market competition between firms sourcing workers from the same markets. The intuitive explanation is that an increase in exporting activity for competitors of firm j translates into an expansion of their labour demand in markets where they source workers. Firm j perceives the expansion in competitors' labour demand as an inward shift in labour supply in a given market, which pushes wages upward. The estimates report results within-spell, which signifies that the effect of competitors increases the leaving threat of a worker, raising his/her bargaining power. The increased bargaining power of workers pushes firm j to raise wages to retain its attractiveness in the market. Importantly, since we estimate wage effects on stayers, our results bridge firm-level to market-level wage effects. The latter is not just a mechanic sum of the firm-level wage effects but multiplied by wage competition between firms.

The results on wage competition go hand-in-hand with the increased labour mobility presented in table 6, where the regressands are dummies equal to 1 if a worker changes employer in the next year (column 1 and 2), if he leaves to find employment within its labour market (column 3 and 4) or outside its labour market (column 5 and 6). Table 6 reports OLS and IV estimates for each worker-level outcome side by side.

Results for *Sample 1* show how an increase in a firm's export decreases the probability of a worker leaving the firm. The effect is driven solely by decreased transitions to labour market competitors, which is in line with

[30] Our results are not fully comparable to Hummels et al. (2014) due to differences in sample selection and regression specifications.

Table 5: Worker-level regressions: Wage Competition

Wage	Yearly OLS - (1)	Yearly IV - (2)	Daily OLS - (3)	Daily IV - (4)	Hourly OLS - (5)	Hourly IV - (6)
Sample 1						
Own Export	0.0107***	0.0635***	0.0028***	0.0116**	0.0037*	0.0464*
	(0.0016)	(0.0141)	(0.0005)	(0.0056)	(0.0021)	(0.0238)
Competitors	0.0062***	0.0087***	0.0021***	0.0046***	0.0026***	0.0040***
	(0.0014)	(0.0019)	(0.00052)	(0.0009)	(0.0007)	(0.0010)
R-squared	0.8575	0.0244	0.9465	0.0321	0.8032	0.0034
F-stat.	31.19	21.54	28.02	14.50	10.53	9.214
N. Obs	2,031,989	2,031,989	2,031,989	2,031,989	2,031,989	2,031,989
Sample 2						
Competitors	0.0002	0.0017	-0.0002	0.0015***	-0.0004	0.0005
	(0.0011)	(0.0012)	(0.0003)	(0.0004)	(0.0007)	(0.0008)
R-squared	0.8513	0.0323	0.9444	0.0344	0.7927	0.0151
F-stat.	0.0289	1.952	0.478	12.54	0.392	0.420
N. Obs	859,186	859,186	859,186	859,186	859,186	859,186
IND-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Spell FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

the wage effects, as shown above. On the other hand, a positive shock in competitors' export increases the overall probability that a worker will leave the firm - column (1) and (2). Column (3) to (6) show how this effect exists only within the labour market where the worker belongs. The last two columns can be seen as a placebo test for the correct identification of labour markets, confirming the self-contained nature of the identified clusters. The shock to competitors' export does not affect workers mobility outside of the market defined by our method. Overall, the worker mobility results complement the wage effects above and support the hypothesis that competitors' export boost increase their labour demand and, consequently, the outside option value of workers in firm j.

Finally, note how the "pulling" effect of a firm's export is a level of magnitude larger than the "pushing" effect of competitors, as shown in column (4) for *Sample 1*. As for wages, we observe that the reallocation effects generated by shocks to exporters to be stronger for exporters.

5.1.2 Firm-Market level Analysis

If on the worker-level, we aim to identify forces of labour market competition between firms, on the firm-market level, we shed light on the existence of employment spillovers between labour market competitors. Existence of positive employment spillovers (Helm, 2020) that stems from increasing market's labour force might be a strong counter-force to worker reallocation, so export shocks among competitors end up increasing firm-employment through improving labour market condition.

To study the existence of employment spillovers at firm-market level, our outcome of interest is market-specific employment in a given firm. Table 7 reports first-stage results on export for both samples. Results are in line with the first stage at the worker-level. Specifications at the firm-market level include firm-market fixed effects, 6-digit industry-year fixed effect and municipality-year fixed effects. We cluster errors at the firm-level.

Table 8 shows the results for the firm-market level regression for both samples. The table reports OLS and IV estimates for each sample side by side. Columns (1) and (2) in table 8 suggest that the employment effect caused by positive shocks among competitors is approximately one-third of

Table 6: Worker-level regressions: Reallocation

Mobility	Overall OLS - (1)	Overall IV - (2)	Same OLS - (3)	Same IV - (4)	Different OLS - (5)	Different IV - (6)
Sample 1						
Own Export	-0.0089***	-0.0411**	-0.0056***	-0.0384**	-0.0033***	-0.0027
	(0.0020)	(0.0162)	(0.0015)	(0.0166)	(0.0007)	(0.0046)
Competitors	0.0013***	0.0019***	0.0011***	0.0016***	0.0001	0.0003
	(0.0005)	(0.0006)	(0.0004)	(0.0004)	(0.0001)	(0.0003)
R-squared	0.4023	-0.0033	0.4048	-0.0139	0.3777	0.0024
F-stat.	14.45	8.712	12.41	9.548	10.83	0.675
N. Obs	1,401,783	1,401,783	1,401,783	1,401,783	1,401,783	1,401,783
Sample 2						
Competitors	0.0007	0.0005	0.0009**	0.0010**	-0.0002	-0.0004
	(0.00048)	(0.00058)	(0.00036)	(0.00047)	(0.00030)	(0.00036)
R-squared	0.4346	0.0073	0.4282	0.0043	0.4275	0.0029
F-stat.	2.183	0.885	6.522	4.515	0.583	1.520
N. Obs	462,519	462,519	462,519	462,519	462,519	462,519
IND-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Spell FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

Table 7: Firm-Market-level regressions - First Stage

	Sample 1		**Sample 2**
	(1)	(2)	(3)
EXPORT	Own	Competitors	Competitors
Own IV	0.0488***	0.0001	
	(0.005)	(0.001)	
Competitors IV	0.0013	1.3375***	1.2824***
	(0.010)	(0.011)	(0.014)
R-squared	0.9479	0.9872	0.9926
F-stat.	48.90	7587	8661
N. Obs	240,927	240,927	251,057
IND-Year FE	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes
Firm-Market FE	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

the employment effect caused by shocks in a firm's export. Moreover, the elasticity of market-specific employment to change in competitors' export is 0.047 for *Sample 1* and 0.026 for *Sample 2*. Thus, employment spillovers are a consistent result across both samples, though higher among exporting firms. However, the difference between samples in the overall results nearly disappears when we later estimate the spillover effect by markets' degree of self-containedness in Section 5.2.1. This result suggests that the lower estimate for *Sample 2* at the firm-market level could be the consequence of differences in market sourcing between exporting and non-exporting firms, as depicted by figure 7.

Ultimately, even though labour market competition among exporters could be more sensitive to export shocks because exporting firms are more similar to each other, we show that export shocks are permeated through the whole economy, benefiting non-exporting firms through positive employment spillovers.

The effect on market-specific employment caused by a positive shock in competitors' export comprises both a negative reallocation effect (captured

Table 8: Firm-Market-level regressions - Firm's within-Cluster Employment

$Log(Emp_{kjt})$	**Sample 1**		**Sample 2**	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
Own Export	0.0378***	0.1382***		
	(0.0027)	(0.0230)		
Competitors	0.0116***	0.0472***	0.0053*	0.0256***
	(0.00306)	(0.00709)	(0.00302)	(0.00759)
IND-Year FE	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes
Firm-Market FE	Yes	Yes	Yes	Yes
R-squared	0.9141	-0.0246	0.8828	-0.0004
F-Stat.	106.5	40.61	3.056	11.38
N. Obs	240,927	240,927	251,057	251,057

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

at the worker level) and a (potentially) positive employment spillovers. The fact that we have identified an unambiguously positive effect of competitors' export shock on firm-market employment implies the existence of positive employment spillovers. Different labour market mechanisms could explain the results: (i) positive export shocks for competitors increase their labour demand. If the boundaries of a labour market are sufficiently permeable, this will trigger the entry of new workers into the market, enlarging the pool of available candidates for a given vacancy. From standard search and matching theory, the increased pool of workers will increase the vacancy filling rate of firms competing in the market and/or increase the quality of each match. The improved matching process potentially benefit firms that have not experienced the direct positive shock; (ii) Another reason, though more of a long-term effect, could be the existence of knowledge spillovers caused by new workers attracted into the market, as suggested by Helm (2020).

Table 9: Firm-level regressions - First Stage

	Sample 1		**Sample 2**
	(1)	(2)	(3)
EXPORT	Own	Competitors	Competitors
Own IV	0.0074***	0.0018	
	(0.0008)	(0.0025)	
Competitors IV	0.0083***	1.4332***	1.4577***
	(0.0007)	(0.0045)	(0.0033)
R-squared	0.9200	0.9964	0.9910
F-stat.	146	51176	189901
N. Obs	42,467	42,467	125,084
Firm FE	Yes	Yes	Yes
IND-Year FE	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.1.3 Firm level Analysis

At the firm level, the outcomes of interest are employment, total turnover, total wage bill and total sales. The outcomes give an overview of a firm's labour demand. The firm-level is essential because it gives us the overall effect of shocks among competitors, taking into account that a firm competes across several markets.

Table 9 reports first-stage results on export for both samples. Results are in line with the first stage at the worker and firm-market level. Specifications at firm-level include firm fixed effects, 6-digit industry-year fixed effect and municipality-year fixed effects. Moreover, we cluster errors at the firm-level.

Table 10 shows the results for the firm-level regression for both samples. The table reports OLS and IV estimates for each sample side by side. An increase in a firm's export benefits a firm's employment through a decrease in total turnover, confirming results at worker level on the decreased probability of leaving. On the other hand, an increase in competitors' export benefit a firm's employment through an increased turnover rate, which means that the firm compensates the increase in separations due to the now

higher attractiveness of competitors through an increase in hiring rate. The boost in hiring is possible due to the improved labour market conditions caused by the higher pool of workers available.

Results hold for both samples and confirm the existence of positive employment spillovers. In particular, the elasticity of employment to changes in competitors export is 0.005 for Sample 1 and 0.010 for Sample 2. The overall spillover effect is now higher for the non-exporter sample. Differences in firm composition between the two samples could be the main drivers of the results. If small firms benefitted most of the improved labour market conditions generated by the increased exports among competitors, the more substantial share of small firms in Sample 2 would mechanically increase the estimate at the firm-level. We confirm this results in later subsections, studying the heterogeneous effect by firm size.

5.2 Mechanism and Heterogeneity

In the following section, we study how the results presented above depend on firms' and markets' characteristics. In particular, we assess whether labour market competition is fiercer the more rigid the boundaries of a labour market and whether the magnitude of the employment spillovers differs across different firms' sizes. Furthermore, using the estimated markets, we define competitors within and competitors outside a firm's municipality, region and 2-digit industry, discussing the bias caused by using observable units as proxies for labour markets.

5.2.1 Market's Self Containedness

One of the essential features that characterize labour markets is their degree of self-containedness, as described in Section 2. A labour market is self-contained if flows of workers have a high probability of being "contained" in the market.

In Section 2, we show how this measure positively correlates with workers' education, that is how self-contained markets generally cover occupations requiring high skills. It follows that self-contained markets have less permeable boundaries, with more rigid entry barriers for workers.

To test whether labour market competition is fiercer, the higher the

Table 10: Firm-level regressions

	log(Emp)		Turnover		log(Wage)		log(Sales)	
	OLS - (1)	IV - (2)	OLS -(3)	IV -(4)	OLS - (5)	IV -(6)	OLS - (7)	IV -(8)
Sample 1								
Own Export	0.0528***	0.2924***	-0.0067***	-0.0578***	0.0653***	0.3647***	0.12029***	0.4384***
	(0.0027)	(0.0276)	(0.0021)	(0.0193)	(0.0030)	(0.0327)	(0.0098)	(0.0472)
Competitors'	0.0063***	0.0049***	0.0010***	0.0013***	0.0053***	0.0036***	0.0032***	0.0014***
	(0.0003)	(0.0003)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0005)	(0.0005)
R-squared	0.9735	-0.3800	0.5956	-0.0235	0.9760	-0.6909	0.9409	-0.2820
F-stat.	522.5	395.9	58.33	50.12	531.4	461.9	98.66	74.54
N. Obs	42,467	42,467	42,467	42,467	42,467	42,467	42,467	42,467
Sample 2								
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Competitors'	0.0102***	0.0101***	0.0032***	0.0032***	0.0114***	0.0113***	0.0088***	0.0087***
	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
R-squared	0.9359	0.0987	0.6221	0.0072	0.9019	0.0611	0.8835	0.0284
F-stat.	2286	2325	627.5	615.2	2228	2198	1177	1123
N. Obs	125,084	125,084	125,084	125,084	125,084	125,084	125,084	125,084
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IND-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

degree of self-containedness, we split markets into two groups, at the median of the self-contained distribution. Thus, we split the sample and estimate coefficients of wage competition, reallocation effort and employment spillover separately at the worker and firm-market level. Figure 9 plots the coefficients for each group, below and above the median of the self-containedness distribution for both samples. Each graph reports the p-value obtained testing the difference between coefficients.

From figure 9 a clear pattern emerges: (i) panel (a) and (b) show how wage competition is fiercer and significantly different from 0 only in self-contained markets, where boundaries are rigid, and firms mainly compete for a fixed pool of workers. The same holds for reallocation intensities, as shown by panels (c) and (d). In other words, the more rigid the entry barriers to a market, the more intense the wage competition and the reallocation of workers to firms that experience positive export shocks.

On the other hand, employment spillovers are possible and statistically different from 0 in markets where boundaries are loose, as shown in panel (e) and (f).

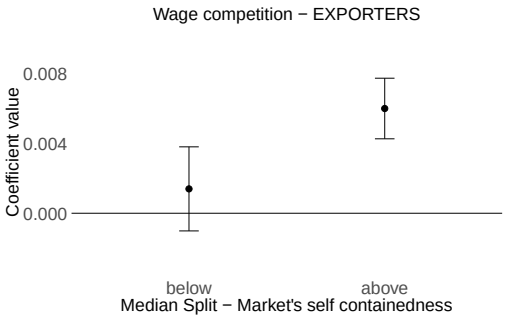
In general, this evidence supports the hypothesis that a combination of wage competition between firms and employment spillovers from changing market size drives our main results.

5.2.2 Competitors' Heterogeneity

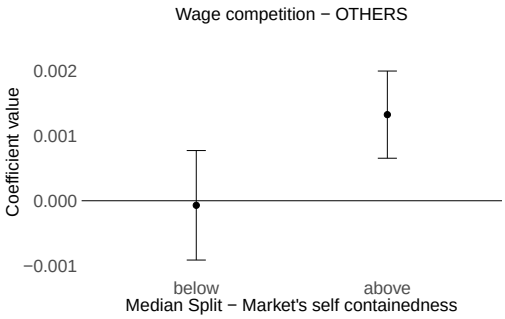
In the following, we test whether the effect of competitors' export differs between different groups of competitors. This analysis has two different aims. Firstly, by splitting competitors, we show that the broadly used definitions of labour markets along the spatial and industrial dimensions are prone to missing relevant labour market competitors. Secondly, we investigate how alternative mechanisms (like product competition and housing market transmission) are likely to affect our interpretation of the results.

In particular, we define competitors within and competitors outside a firm's municipality, region and 2-digit industry, comparing our labour market definition to usual proxies employed in the literature. For each proxy, we split competitors in a given market into two groups: competitors within and competitors outside the set. That is, we take a market and

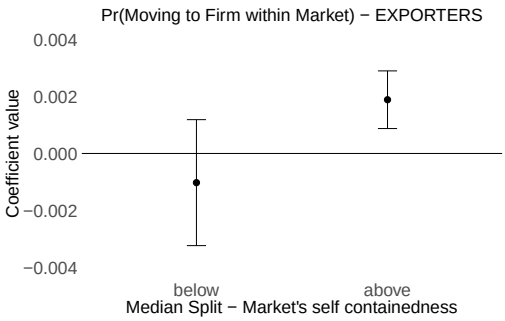
Figure 9: Results by Market Self-Containedness



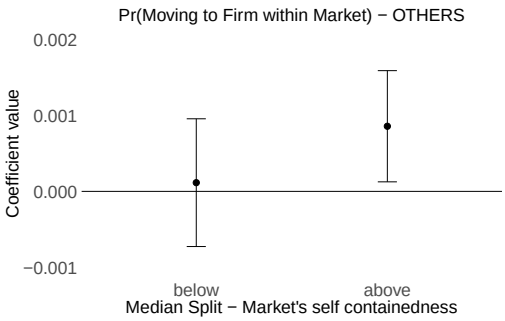
(a) Wage Competition - Sample 1



(b) Wage Competition - Sample 2

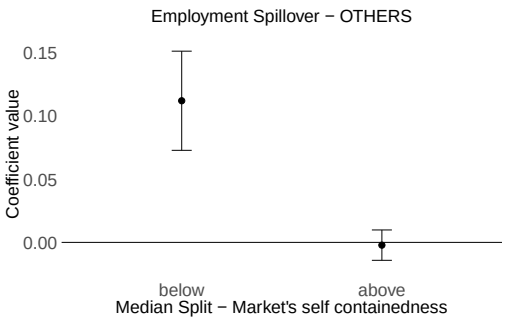


(c) Reallocation - Sample 1



(d) Reallocation - Sample 2

(e) Employment Spillover - Sample 1



(f) Employment Spillover - Sample 2

construct the set of competitors in this market within a firm's municipality/region/industry and the set of competitors outside. Table 11 reports results at the firm level where the competitors' export term has been split in two, as described above. The results confirm that: (i) what we capture is indeed labour market competition and not competition between firms producing the same products. This conclusion is possible because the effect of competitors outside a firm's industry is large and strongly significant; (ii) using geographical proxies to identify labour markets is misleading because competitors outside the geographical area happen to be as crucial as competitors within, columns (3)-(6). Differences between the two competitors groups are significant for all proxies and both samples, as shown by the p-values in the table. Finally, note how *Sample 2*, which is crowded with small, local firms is much more sensitive to competitors within a given region/municipality than *Sample 1*. However, significance for competitors outside the region/municipality is maintained even in this case, meaning that exclusion of those competitors would lead to misleading results.

Our findings confirm that labour markets are extremely heterogeneous. The regional proxies employed by Helm (2020), Greenstone et al. (2010)[31], and Gathmann et al. (2020)[32], or the estimated local markets in Manning and Petrongolo (2017) could potentially misclassify important non-regional outside options for a broad set of workers. Similarly, the industrial proxy employed by Neffke et al. (2017) would not capture the truthful labour market for a wide set of low-skill occupations, whose job-to-job transitions are usually across-industry and within-region. Any simplification that anchors labour markets to a too narrow geographical/industrial entity would lead to a misclassification of the workers' correct outside options and a biased estimate of the effect of interest, be it agglomeration or labour market competition.

5.2.3 Firm Size

To study differences in effect by firm size, we split firms in two based on 2009 employment. We define a firm as large if it has more than 100

[31] Greenstone et al. (2010) study how the opening of large plants affects total factor productivity of incumbent plants located in the same region.

[32] Gathmann et al. (2020) study the effect of mass layoffs on regional labour markets.

Table 11: Firm-level regressions - Splitting Competitors

			Sample 1			
OWN	2-digit IND		REGION		MUNICIPALITY	
	OLS - (1)	IV - (2)	OLS - (3)	IV - (4)	OLS - (5)	IV - (6)
Own Export	0.0527***	0.2915***	0.0528***	0.2925***	0.0528***	0.2925***
	(0.0027)	(0.0276)	(0.0027)	(0.0276)	(0.0027)	(0.0276)
Competitors WITHIN	0.0133***	0.0115***	0.0066***	0.0051***	0.0060***	0.0040**
	(0.0014)	(0.0017)	(0.0004)	(0.0005)	(0.0014)	(0.0017)
Competitors OUTSIDE	0.0055***	0.0042***	0.0061***	0.0047***	0.0063***	0.0050***
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
R-squared	0.9736	-0.3740	0.9735	-0.3806	0.9735	-0.3809
P-value COMP.	0	0	0	0	0	0
N. Obs	42,467	42,467	42,467	42,467	42,467	42,467
			Sample 2			
OWN	2-digit IND		REGION		MUNICIPALITY	
	OLS	IV	OLS	IV	OLS	IV
Competitors WITHIN	0.0141***	0.0131***	0.0112***	0.0109***	0.0144***	0.0151***
	(0.0013)	(0.0014)	(0.0003)	(0.0004)	(0.0010)	(0.0011)
Competitors OUTSIDE	0.0100***	0.0099***	0.0091***	0.0091***	0.0097***	0.0095***
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
R-squared	0.9360	0.0987	0.9360	0.0989	0.9360	0.0990
P-value COMP.	0	0	0	0	0	0
N. Obs	125,802	125,802	125,802	125,802	125,802	125,802
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
IND-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

employees in 2009 and small otherwise. Table 12 reports firm-level results by firm size, where we interacted both own and competitors' export with a size dummy. Results show how an increase in a firm's export has more substantial effects for large firms, both in terms of employment and output. On the other hand, the employment spillovers generated by an increase in competitors' export benefits more small firms. In particular, only small firms increase output due to the higher activity of exporting firms in a given market. The finding confirms firm-level results that show a larger spillover effect for firms in Sample 2, which is crowded with small, local companies. The difference in effect between small and large firms is, in fact, even sharper for Sample 2.

6 Conclusion

We use a detailed administrative linked employer-employee dataset from Denmark to study how labour market interactions between firms transmit export shocks through the economy.

The first issue we address is the definition of what a labour market is. We depart from the main approaches taken by the literature, that define labour markets through occupational/industrial/geographical proxies, and propose a novel way to tackle the matter. We cluster interconnected labour markets using observed worker transitions between occupation-municipality cells. The method is simple and delivers results that are both geographically and economically sensible. We use the identified labour markets to study the diffusion of export shocks at three different levels of analysis (worker, firm-market and firm level).

We find the existence of two main effects. Firstly, at the worker level, we provide evidence confirming that a surge in competitors' export leads to the increase in competitors' labour demand and, consequently, improves worker's outside options, intensifying labour market competition.

Intuitively, positive shocks to a firm's export drive a firm to increase wages and make their workers' less likely to move to one of the competitor firms. However, we show how the effect transcends a firm's boundaries, affecting firms that employ similar workers as well. We find that positive export shocks among competitors push firms to increase wages to retain

Table 12: Firm-level regressions - by 2009 Firm Size

		log(Emp)		Turnover		log(Wage)		log(Sales)	
		OLS - (1)	IV- (2)	OLS- (3)	IV- (4)	OLS- (5)	IV- (6)	OLS- (7)	IV - (8)
Sample 1									
Own Export	Small	0.0524***	0.2971***	-0.0051**	-0.0378*	0.0576***	0.3026***	0.1174***	0.3762***
		(0.0034)	(0.0338)	(0.0024)	(0.0205)	(0.0035)	(0.0367)	(0.0135)	(0.0524)
	Large	0.0885***	0.3570***	0.0103**	0.0201	0.0956***	0.3777***	0.1829***	0.5765**
		(0.0149)	(0.1114)	(0.0044)	(0.0247)	(0.0175)	(0.1226)	(0.0382)	(0.2883)
Competitors'	Small	0.0065***	0.0051***	0.0014***	0.0015***	0.0057***	0.0044***	0.0037***	0.0026***
		(0.0002)	(0.0003)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0004)
	Large	0.0047***	0.0037***	0.0002*	0.0003**	0.0032***	0.0021***	0.0014	-0.00005
		(0.0005)	(0.0006)	(0.0001)	(0.0001)	(0.0003)	(0.0004)	(0.0009)	(0.0011)
R-squared		0.9745	-0.3620	0.5780	-0.0057	0.9800	-0.4741	0.9425	-0.1676
P-value	OWN	0.0187	0.598	0.00166	0.0581	0.0339	0.547	0.105	0.483
	COMP	0.0007	0.0197	0	0	0	0	0.0123	0.0164
N. Obs		30,689	30,689	30,689	30,689	30,689	30,689	30,689	30,689
Sample 2									
		OLS	IV	OLS	IV	OLS	IV	OLS	IV
Competitors'	Small	0.0081***	0.0080***	0.0030***	0.0030***	0.0068***	0.0068***	0.0056***	0.0056***
		(0.0003)	(0.0003)	(0.0001)	(0.0001)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
	Large	0.0034***	0.0034***	0.0006***	0.0005**	0.0029***	0.0030***	0.0030***	0.0033***
		(0.0007)	(0.0007)	(0.0002)	(0.0002)	(0.0005)	(0.0005)	(0.0006)	(0.0007)
R-squared		0.9481	0.0909	0.6055	0.0139	0.9572	0.0725	0.8799	0.0149
P-value.	COMP	0	0	0	0	0	0	0.0003	0.0032
N. Obs		47,326	47,326	47,326	47,326	47,326	47,326	47,326	47,326
Firm FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IND-Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

attractiveness in the market. Symmetrically, we also find that they increase workers' mobility through a boost in workers' outside options. In other words, labour market competition drives the reallocation of workers towards firms experiencing export growth and amplifies firms' effects of export shocks making their competitors increase wages for their workers.

Secondly, at the firm-market and firm-level we identify what we label as positive employment spillovers: the boost in competitors' labour demand, caused by positive export shocks, triggers entry of new workers in the market, improving vacancy filling rate and match quality. We show that positive employment spillovers from competitors act as a counterforce to the adverse reallocation effects. While shocks in a firm's export increase its employment through a decrease in turnover rate (fewer people leave), shocks among competitors end up benefiting the firms through an increase in turnover rate. Thus, firms end up compensating the increased separation rate with an increase in the hiring rate.

To find further supporting evidence of the mechanism driving the main results, we show how these effects depend on how permeable boundaries in a given market are. Specifically, we show how labour market competition is fiercer in self-contained markets, where entry of new workers is limited, and firms mainly compete for a fixed pool of workers. On the other hand, employment spillovers are more significant, the higher the degree of permeability of a given market. Moreover, we find small firms to be more sensitive to shocks among competitors, and to be the ones that benefit the most in terms of improved labour market conditions.

Dividing competitors into the same region/municipality/industry competitors and different region/municipality/industry we show that some conventional definitions of labour markets among spatial and industrial lines miss relevant part of the actual labour markets. Moreover, the revealed character of the effects shows that our results are unlikely to be driven by alternative mechanisms like product market competition and housing market externalities.

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A Appendix: Data

A.1 Municipality reform - 2007

On Monday January 1, 2007, the number of municipalities in Denmark was reduced from 271 to the current 98. Further, the Structural Reform abolished counties and five large regions were created instead. We translated old municipalities to new, re-coding the LAU-1 codes, so to have everything expressed in terms of the new 98 Danish municipalities even in pre-reform years. The Aerø municipality was allowed to merge already on January 2006, while the Bornholm Regional Municipality from January 2003. All remaining mergers took place in January 2007.

A.2 DISCO codes structural break in 2009

The classification of DISCO codes changed at the beginning of 2010. To identify our labour markets we used years between 1999 and 2008. In order to be able to impose the identified clusters upon individuals in years after the DISCO codes structural break, we create an empirical mapping between codes using full time workers that stay in the same establishment between 2009 and 2010. The most frequent transition between DISCO codes is than used to create a crosswalk, see Frandsen et al. (2018) for a technical note on the matter.

B Appendix: Defining Labour Markets

We start with a yearly panel of the population of full-time employed workers for years 1999-2008. For each worker we define main employment for a given year as an employment with highest annual earnings. Next we restrict the sample to observations with non-missing occupation and municipality of employment. We use occupational information on the 3-digit level, discarding all missing and occupational codes that are miscoded ("999" and codes defined only on 1-digit level) or imputed.

Furthermore, we focus on events in workers history where s/he changes the municipality-occupation cell. In other words, event where a worker

changes 3-digit occupation and/or municipality of work. Additionally, we keep only transitions which coincide with both a firm change and a workplace change.

From this we calculate total amount of workers moving between each 2 cells and total amount of workers leaving each cell in our sample window. We keep cells with outflow not less than 10 workers.

The exclusion of certain miscoded occupations, meant that 2,799,144 worker-year observations could not be assigned to a specific cluster and were removed from the sample.

C Appendix: Commuting Zones

Using a similar approach to that employed in Section 2, we constructed commuting zones in Denmark using flows between municipality of residence and municipality of work, proxy for labour markets widely used in the literature. Figure 10 plots commuting zones in 1999 and 2008 using the same cut-off. Noticeably, commuting zone got bigger in time, testifying the increased mobility of Danish society over the years.

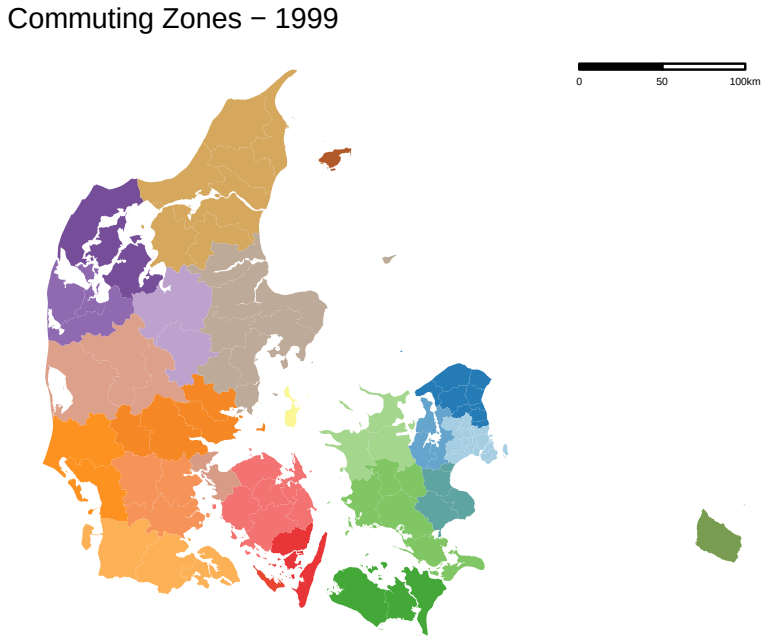
D Appendix: Other Markets Control

If labour competition in a given market exhausts or pushes a firm to reallocate resources, it could create cross-effects between markets even though workers are not direct substitutes. To control for possible cross-effects between markets, we define a control for activities across non-k markets where firm j sources workers as:

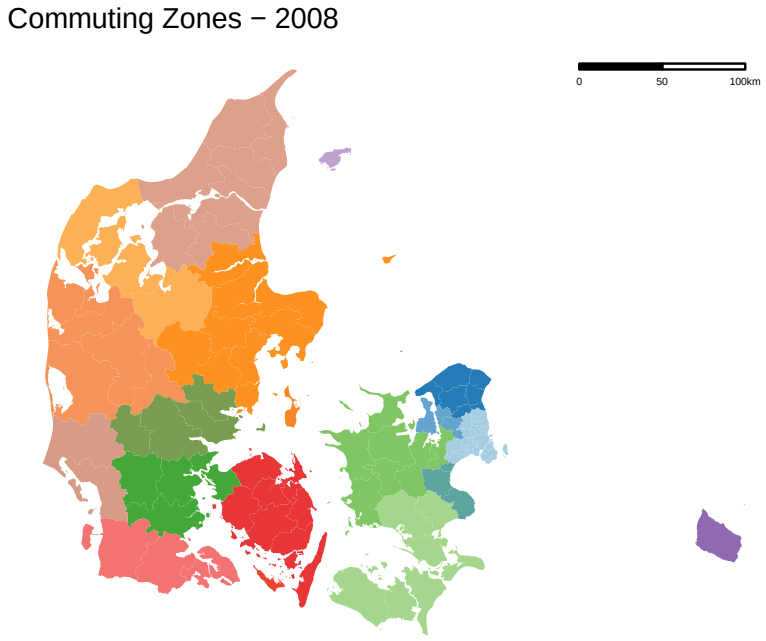
$$\overline{\Omega}_{j\bar{k}t} = \sum_{\varphi \neq k} \omega_{\varphi j} \overline{log(Exp_{-i\varphi t})} 1\left[\varphi \in K\right] \tag{16}$$

where $\omega_{\varphi j}$ is the ratio of of workers in cluster φ employed by firm j over all workers employed in firm j, also pre-determined in 2009. We use this term as control in worker-level and firm-market-level regressions and instrument it as:

Figure 10: Commuting Zones in Denmark - 1999/2008



(a) Commuting Zones in 1999



(b) Commuting Zones in 2008

$$\bar{l}og(WID_{i\bar{k}t})^{IV} = \sum_{\varphi \neq k} \rho_{\varphi i} \overline{log(WID_{-ikt})} 1\left[\varphi \in K\right] \tag{17}$$

The following reports worker and firm-market level results including the control for activity in other markets.

D.1 Worker Level Analysis

Tables 13 and 14 report results on wages and reallocation at worker level. Results are qualitatively and quantitative in line with our baseline specification. The inclusion of the control term for activity in other markets slightly reduce the magnitude of the coefficients.

D.2 Firm-Market Level Analysis

Table 15 shows the results for the firm-market level regression including the control term for activity in other markets. Here, similarly to the worker level, the results are preserved overall. However, the contraction of the magnitude of the coefficient is sharper.

D.3 Market's Self Containedness

Figure 11 plots the coefficients of the main effects we identify by degree of markets' self-containedness. Contrary to figure 9, we included a control for activity in other markets in the estimation. All results are preserved. The magnitude of the coefficients is slightly smaller.

Table 13: Worker-level regressions: Wage Competition

Wage	Yearly OLS	Yearly IV	Daily OLS	Daily IV	Hourly OLS	Hourly IV
Sample 1						
Own Export	0.0108***	0.0629***	0.0028***	0.0112**	0.0037*	0.0461*
	(0.0016)	(0.0142)	(0.0005)	(0.0056)	(0.0021)	(0.0239)
Competitors	0.0045***	0.0063***	0.0010**	0.0032***	0.0017**	0.0029***
	(0.0014)	(0.0018)	(0.0005)	(0.0009)	(0.0007)	(0.0011)
R-squared	0.8576	0.0247	0.9465	0.0325	0.8032	0.0036
F-stat.	59.53	47.19	33.83	25.28	15.28	11.53
N. Obs	2,031,989	2,031,989	2,031,989	2,031,989	2,031,989	2,031,989
Sample 2						
Competitors	-0.0020	-0.0019	-0.0006*	0.0011**	-0.0011	-0.0006
	(0.0012)	(0.0014)	(0.0003)	(0.0004)	(0.0008)	(0.0009)
R-squared	0.8513	0.0323	0.9444	0.0344	0.7927	0.0151
F-stat.	57	89.59	5.524	10.04	7.087	12.31
N. Obs	859,186	859,186	859,186	859,186	859,186	859,186
IND-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Spell FE	Yes	Yes	Yes	Yes	Yes	Yes
Ω Control	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

Table 14: Worker-level regressions: Reallocation

	Sample 1					
Mobility	Overall OLS	Overall IV	Same OLS	Same IV	Different OLS	Different IV
Own Export	-0.0089***	-0.0411**	-0.0056***	-0.0384**	-0.0033***	-0.0027
	(0.0020)	(0.0162)	(0.0015)	(0.0166)	(0.0007)	(0.0046)
Competitors	0.0013***	0.0019***	0.0011***	0.0016***	0.0001	0.0003
	(0.0005)	(0.0006)	(0.0004)	(0.0004)	(0.0001)	(0.0003)
R-squared	0.4023	-0.0033	0.4048	-0.0139	0.3777	0.0024
F-stat.	14.45	8.712	12.41	9.548	10.83	0.675
N. Obs	1,401,783	1,401,783	1,401,783	1,401,783	1,401,783	1,401,783
	Sample 2					
Competitors	0.0007	0.0005	0.0009**	0.0010**	-0.0002	-0.0004
	(0.00048)	(0.00058)	(0.00036)	(0.00047)	(0.00030)	(0.00036)
R-squared	0.4346	0.0073	0.4282	0.0043	0.4275	0.0029
F-stat.	2.183	0.885	6.522	4.515	0.583	1.520
N. Obs	462,519	462,519	462,519	462,519	462,519	462,519
IND-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Spell FE	Yes	Yes	Yes	Yes	Yes	Yes
Ω Control	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

Table 15: Firm-Market-level regressions - Firm's within-Cluster Employment

$Log(Emp_{kjt})$	Sample 1		Sample 2	
	OLS	IV	OLS	IV
Own Export	0.0374***	0.1372***		
	(0.0027)	(0.0229)		
Competitors	-0.0021	0.0172**	-0.0071**	0.0026
	(0.0032)	(0.0077)	(0.0031)	(0.0078)
IND-Year FE	Yes	Yes	Yes	Yes
Mun-Year FE	Yes	Yes	Yes	Yes
Firm-Market FE	Yes	Yes	Yes	Yes
Ω Control	Yes	Yes	Yes	Yes
R-squared	0.9141	-0.0246	0.8831	0.0016
F-Stat.	106.5	40.61	100.3	123
N. Obs	240,927	240,927	251,057	251,057

Robust standard errors in parentheses - *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sample 1 consists of exporters present in the UHDI register before 2010; Sample 2 consists of all remaining firms;

Figure 11: Identified Labour Markets