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WITHIN AND BETWEEN FIRM TRENDS IN JOB POLARIZATION: ROLE OF GLOBALIZATION AND TECHNOLOGY

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Within and Between Firm Trends in Job Polarization:

Role of Globalization and Technology*

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Abstract

This paper analyzes occupational polarization within and across firms using comprehensive matched employer-employee panel data from Finland. The occupational distribution in Finland has been polarizing over the last few decades, with mid-level production and clerical jobs eroding while low-skill service occupations and high-skill specialist occupations gain share. We find that the phenomenon is taking place within existing firms, as well as due to firm entry and exit. Service jobs are increasing through the entry-exit dynamics, but also via establishment level restructuring among continuing firms. Routine jobs, including mid-level plant operating jobs, are being destroyed both among continuing firms and at the entry-exit margin. The share of high-level occupations increases largely within continuing firms. Within the continuing firms the job polarization appears to be related to the trade of goods and services, as well as the outsourcing of tasks. Firms with high R&D expenditures and ICT use are more prone to lay off process and production workers.

JEL Codes: J24, J31, O33

Keywords: Job polarization, offshoring, international trade, firm, establishment, technology, R&D, ICT

Työpaikkojen polarisaation yritystason mekanismit:

globalisaation ja teknologian merkitys

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Tiivistelmä

Tutkimuksessa tarkastellaan ammattirakenteiden polarisaatiota sekä yrityksissä että yritysrakenteiden muutoksen välityksellä. Aineistona käytetään Suomen yritys-työntekijäaineistoja, jotka ulottuvat pitkälle aikavälille ja kattavat suuren osan yrityksistä. Ammattirakenteiden polarisaatio on jatkunut Suomessa jo vuosikymmeniä. Keskitason tuotantotehtäviä ja toimistotehtäviä sisältävien ammattien osuus on pienentynyt. Samaan aikaan matalan osaamistason palveluammattien ja korkean osaamistason erityisasiantuntija-ammattien osuus on puolestaan ollut kasvussa. Kehityskulut ovat tapahtuneet osin jatkavien yritysten sisällä, mutta osin myös yritysten välillä tapahtuneiden rakennemuutosten kautta. Osa polarisaatiosta johtuu siitä, että kasvavien yritysten ammattirakenteet poikkeavat pienentyvien yritysten ammattirakenteista sekä siitä, että uusien yritysten ammattirakenteet poikkeavat poistuvien yritysten rakenteista. Palveluammattien osuutta on kasvattanut se, että uusissa yrityksissä palveluammattien osuus on ollut suuri ja poistuvissa yrityksissä pieni. Toisaalta palveluammattien osuus on kasvanut myös jatkavissa yrityksissä. Erilaisia keskitason rutiinitehtäviä on kadonnut sekä yritysten sisällä että yritysten vaihtuvuuden kautta. Sen sijaan korkean osaamistason ammattien osuuden kasvu selittyy ennen kaikkea yrityksien sisällä tapahtuneiden muutosten kautta (?). Jatkavissa yrityksissä tapahtunut ammattirakenteiden muutos on kytkeytynyt sekä tavaroiden ja palveluiden ulkomaankauppaan että tehtävien ulkoistamiseen maasta. Paljon T&K:hon panostavat ja ICT:tä käyttävät yritykset vähentävät tuotantotyöntekijöitä

JEL koodit: J24, J31, O33

Avainsanat: Työpaikkojen polarisaatio, ulkoistaminen, kansainvälinen kauppa, yritys, toimipaikka, teknologia, T&K, ICT

I.   Introduction

One of the most pervasive recent labor market trends is the polarization of the job distribution. Those trends have been documented in most western economies and are often found to coincide with the polarization of the income distribution. To date there are numerous papers analyzing the phenomenon, beginning with the Autor, Levy, and Murnane (2003) study which introduced the idea that the skill content of the technological change works as the driver of polarization. Most of the existing work concentrates on estimating the degree of polarization at the aggregate labor market level, and some studies attempt to link the observed polarization of labor markets to other phenomena such as the introduction of ICT, wage inequality or global trade.[1] Conversely, very few studies look at the role of firms in this process, even though it is obvious that the aggregate level trends are generated by individual companies and their production and employment decisions, and thus the micro-level dynamics of the polarization triggered by production and employment decisions of the businesses remain largely uncovered. The current study addresses that gap by bringing the role of firms to the front and center of the polarization debate.

To a large degree the absence of firms in the job polarization literature has simply been caused by the lack of appropriate data. The current study is able to draw from the national level matched employer – employee database on all Finnish companies and their workers, linked to firm-level surveys and administrative data. The core of our data platform covers the entire business sector of Finland and spans the period of 1995-2012.[2] Into that database we bring in firm-level information on global trading activities of goods and services, changes in the use of ICT, investments into internal and external R&D activities, as well as changes in the firm-level pattern of outsourcing. Together these data create a unique opportunity to understand job polarization within and across firms (i.e. at the

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[1] See e.g., Autor, Katz and Kearney (2006), Bockerman et al. (2012), Bockerman et al. (2013), Michaels et al. (2014).
[2] Due to the availability of auxiliary survey data we have chosen to focus our analysis to the period 2000-2009. We report trends covering the years before and after our period of analysis.

intensive and extensive margin) and to evaluate the firm-level mechanisms and forces that may be driving the aggregate patterns.

As most previous studies, we find evidence of labor market polarization at the aggregate level during 2000-2009. We show that the observed trend stems from a within firm destruction of mid-level occupations and a simultaneous increase in the highly skilled jobs and service jobs within existing firms, although a pattern of polarization is also quite evident in the occupational patterns of firm-level restructuring involving reallocation of employment between continuing firms as well as entries and exits of firms. Indeed, the entering firms are showing a much higher job concentration in the service and elementary occupations relative to the exiting firms. Within the continuing firms, those with high-level of job polarization are characterized by a high level of trade of goods and services, as well as some offshoring and outsourcing of tasks, high R&D activity and intensity of ICT use. In that respect, our findings align with other studies analyzing the drivers of polarization. To the extent that is feasible using data on shocks in international trade we instrument for the imports and exports of goods, as well as for the outsourcing of business activities. The instrumental variables regressions are generally in line with the OLS in terms of the export related results, but provide also stronger evidence that firms are replacing in-house production jobs by importing goods from abroad. The 2SLS results for outsourcing reveal interesting differences between domestic and foreign outsourcing. For example, a decline in the share of routine production jobs is related to foreign outsourcing, but firms engaging in domestic outsourcing actually increase those jobs while reducing elementary jobs.

The rest of this paper is organized as follows. The next section discusses the relevant empirical and theoretical literature, and outlines the conceptual framework for our polarization analysis. The third section describes the Finnish register and survey data and presents aggregate level statistics based on the FLEED employer-employee database. The fourth section discusses our empirical decomposition approach in detail, followed by an analysis of aggregate level patterns and the within and between firm decomposition analysis. The fifth section explains our regression approach, including the instrumental variables idea, and provides the results of the regression analysis disentangling the potential drivers of within firm job polarization. The final section concludes the paper by

setting our findings into the larger context of the literature, and suggests several firm-level analysis extensions to the current paper.

II.   Previous Literature and Conceptual Framework

Labor market polarization has been the subject of numerous studies over the last two decades. One of the classics, Autor, Levy and Murnane (2003), shows that computer technology advances were behind the routine-biased technological change that has been driving the employment decline of workers performing routine tasks.[3] Goos and Manning (2007) elaborated on the idea that labor markets are polarizing into "good and bad" jobs, finding evidence for job polarization in the US and in the UK, while Goos, Manning and Salomons (2009) show that the phenomenon extends to the rest of Europe as well. Autor, Katz and Kearney (2006) emphasize the role of IT in complementing the tasks performed by highly educated workers (abstract) and substituting for those tasks typically performed by workers with mid-level education (routine). Writing a comprehensive literature survey is beyond the scope of the current study, but many of the relevant papers are discussed in Acemoglu and Autor (2011), and Oesch and Rodriguz Menes (2010). The careful analysis of firm-level patterns, and the focus on the extensive versus intensive margin of polarization is a key contribution of our work. Below we focus on papers that are particularly relevant to the setting of the current study.

First, while previous studies have looked at job polarization within countries and industries, firms are notoriously absent from most of the literature.[4] One of the exceptions is Bockerman et al. (2013, 2016) who use similar underlying Finnish data to evaluate whether the ubiquitous technology-based explanations are also relevant at the firm level.

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[3] Hynninen, Ojala and Pehkonen (2013) show that technology has historically had impacts on wage premiums already well before the computerization. They utilize the invention of steam engines and argue that it had a polarizing effect on wage patterns.

[4] One bridge study between the aggregate level and firm level literatures is the study by Goos, Manning and Salomons (2014) who analyze polarization at the industry level. They find relatively strong polarization in Finland during 1993-2010, ranking it number 7 among the 16 EU countries analyzed.

They find weak evidence for polarization at the firm level and argue that ICT adoption and R&D efforts by firms may be behind some of the observed patterns. Maliranta (2013) applies a micro-level decomposition of occupational employment changes from the FLEED firm-level data utilized also in the current study and argues that global firms are significantly contributing to the polarization of jobs in Finland.[5] Keller and Hale (2015) use similar data from Denmark, arguing that a large proportion of the mid-wage employment decline can be accounted for by import competition from China. Interestingly, the mid-skilled individuals who lose their jobs can move either up or down in the job hierarchy, depending on their specific skill set.

More recently, firm-level studies have been published using both French data (Harrigan, Reshef and Toubal, 2016) and data from the UK (Cortes and Salvatori, 2015). Harrigan et al. find that international trade and "technology" seem to be connected in explaining job polarization in French firms. Cortes and Salvatori use establishment level data from the UK and find significant specialization across establishments into routine and non-routine tasks. The increase in the number of establishments specializing in non-routine tasks seems to explain much of the job polarization, but adoption of new technologies does not seem to be associated with a low employment growth within an establishment.

The theoretical mechanism behind ICT and job polarization suggests that ICT capital would act as a substitute for middle-skilled labor, whereas it might complement high-skilled labor and have relatively little connection to low-skilled labor. During times of increasing ICT intensity job polarization would ensue. Findings in the empirical literature appear to match the theory. Studies looking at the effects of R&D and ICT include the aforementioned paper by Bockerman et al. (2013), Bockerman et al. (2012), and Michaels et al. (2014). The latter find that industries with faster ICT growth exhibited greater increases in the demand for skilled professionals and faster decline in the demand for medium-skilled workers. Recently, a few studies have also looked at international trade as

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[5] Maliranta finds that mid-wage occupations are declining and low-wage occupations gaining share both via the mechanism of industry and firm level occupational restructuring, while high-wage occupations are gaining share mainly within firms that stay in existence throughout the period 2000-2006.

an explanation for employment polarization.[6] Michaels et al. (2014) find that explanations based on trade openness are not robust to controlling for related factors such as R&D intensity. Van Reenen (2011) argues that international trade does have a role in the polarization of the labor market, but it acts via technological change rather than directly. We specifically contribute to the existing literature by looking at firm-level direct evidence for the hypothesis that these various forces related to technological progress are behind the polarization of jobs.[7]

Our study also contributes to the polarization literature by considering arguably exogenous instruments to deal with the endogeneity of firm-level exports and offshoring of jobs. This follows recent studies using Scandinavian employer-employee data that exploit firm specific trade patterns together with country specific trade patterns in very detailed product categories (Hummels et al., 2014; Nilsson Hakkala & Huttunen, 2014). Those studies focus on the wage and employment effects of offshoring, but a similar instrumental variables strategy can be exploited in the current study. The key assumption is that worldwide shocks in export supply and import demand are exogenous to firms in small countries (e.g. Denmark and Finland), and that they vary by partner country and product. Hummels et al. (2014) claim that controlling for endogeneity in decisions to offshore is crucial for understanding how it affects employment and wages.[8] A similar instrumental variables strategy is used by Nilsson Hakkala and Huttunen (2014) for Finland.[9] The construction of the instrumental variables is discussed in detail in section 4 below.

Böckerman and Maliranta (2013) have studied Finnish linked employer-employee data to see how offshoring activities of firms are associated with perceived well-being of employees. They find indication of "polarization" in job satisfaction as a result of offshoring.

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[6] Keller and Hale (2015) certainly focus on international trade. See also Autor (2010) for a discussion on the role of trade based explanations and offshoring

[7] This hypothesis was put forward by Autor, Levy & Murnane (2003), and elaborated on by Autor, Katz & Kearney (2006).

[8] They find that offshoring significantly reduces the firm's domestic employment, but the reduction mainly takes place among the low-skilled employees. Among the employees that stay, wages are reduced for the low-skilled workers but increased for the high-skilled workers.

[9] They find that firm-level offshoring has a positive impact on overall employment, and especially increases the employment of production workers.

Unsurprisingly, offshoring involves job destruction and worker separation especially when the destination is a low-wage developing country. In these circumstances the job satisfaction of staying employees is found to decrease. Interestingly, offshoring to high-wage countries stimulates the vertical mobility of employees in affected firms and is reflected in improved perceived employee wellbeing in terms of better prospects for promotion. Offshoring to low-wage countries is typically accompanied by increasing shares of knowledge workers[10], who generally have much higher overall job satisfaction and are involved in mostly abstract and non-routine work tasks.

Finally, in the United States, the occupational polarization of employment has also been argued to coincide with the polarization of wages (e.g. Autor et al., 2006; Autor & Acemoglu, 2011), yet the wage polarization does not seem to be equally common in other countries.[11] The current study will present some cursory evidence on changes in the wage distribution, but shows that job polarization and increasing wage inequality do not really move in tandem in Finland. This is likely explained by the very different wage setting institutions in Finland as compared to the United States.

III.   Data and Statistics

Finnish Employer-Employee Data

This paper makes extensive use of the Finnish Longitudinal Employer-Employee Data (FLEED), which is created for research purposes by Statistics Finland and is based on various administrative registers that have been linked together using the unique identification codes for persons, companies and plants. The registers combined to form the FLEED include e.g. employment and wage statistics, educational registers, taxation records, the business register, and financial statement statistics. The FLEED covers the entire labor force of Finnish private enterprises subject to value-added tax (VAT), making it a

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[10] Here knowledge worker refers to a broad category consisting of managers, professionals, technicians and associate professionals and clerks.

[11] There are some contradicting views on the explanatory power of the job polarization phenomenon as the driver of increasing wage inequality (see e.g. Mishel et al., 2013).

representative data source on the whole national economy. The Statistics Finland allowed us to exploit the total FLEED for statistical analyses for the purposes of the current study.

Information on the occupation of individuals, a key variable for our paper, originates from the employment statistics register. The current vintage of the occupation variable is based on the ISCO-88 classification, and it is reported for years 1995, 2000 and 2004-2012. A new classification was introduced in 2010, but it is possible to compare data before and after 2010. The occupational classification before the mid-1990s was not compatible to that used in 1995 and 2000, making it questionable how well one could characterize the shifts in the occupation distribution before 1995. The post-recession period is excluded because the polarization pattern is not identical across different time periods.[12] As many of our key explanatory variables are also measured in the early 2000s we have chosen to focus on the period 2000-2009, and comment on the longer run evolution of the patterns where feasible.

Descriptive statistics for the FLEED data are shown in Table 1a, where we include firms that have at least 10 employees and drop employees who worked for the firm for less than 6 months during the year.[13] In total the data includes over 14 thousand firms per year, with around 750 thousand employees each year. The most prevalent occupations for these employees include technical, professional and service occupations. The level of education and average earnings vary greatly by occupation, managers and professionals being the most highly educated and with the highest earnings. Evident in the data is also a relatively rapid skill upgrading among the employed Finnish labor force, partly caused by the aging out of labor force by the less educated baby-boomer generation.

The auxiliary data sources combined into FLEED include the Finnish customs export and import data for goods and services, the ICT and R&D surveys collected by the Statistics Finland, as well as the survey on the offshoring of business activities. Each of these data sources is described below. Table 1b summarizes the coverage of these data sets.

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[12] For example, the change in the job distribution shows a decrease in the share of service jobs between 2000 and 2012 but not between 2000 and 2009.

[13] The earnings are also winsorized to deal with some extreme outliers (top and bottom 1%), although this winsorizing has little effect on the reported mean.

The Finnish Customs Data

The Finnish Customs data cover both the exports and imports of goods at the level of firms for the period 1999-2013 and include the total values of imports and exports to/from all partner countries, as well as the imports and exports to/from EU countries. Per our specific request we obtained the euro values of trade at the most detailed goods category level (up to 8-digit level). Statistics Finland has also calculated in the data for each firm the number of CN categories (i.e. "combined nomenclature") and the number of countries the firm imports to and exports from. According to the OECD recommendation, the euro values are "free on board" (FOB) for exports, and "cost, insurance and freight" (CIF) for imports.[14] The worldwide exports from Finland and imports to Finland are described in Figure A1 (relative to GDP), along with the exports that remain within the EU and imports than stem from other EU countries.[15] Other than the dip in 2008-9 related to the great recession the level of exports has remained relatively steady over the entire time period.

It should be noted that the import and export data are a census of all importing and exporting firms, and once merged with the FLEED data (census of all private firms operating within Finland) a missing value for exports/imports simply means that the firm was not engaged in these activities. A total of 2,818 of our final regression sample of stayer firms (N=7,091) report that they have imported or exported in at least one goods category in 2000-2009. Also, 668 of our regression sample firms were found in the service import and export survey in 2002.

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[14] Before 2009, the total value of international trade of the firm had to exceed 1,000 euros to be included in the Customs data. After 2009 all firms with very small values of international trade are also included.

[15] In 2010, for example, Finland's GDP was 187 billion euros and goods imports within EU were around 27.9 billion euros and non-EU imports around 24.1 billion euros. Exports external to EU were 28.7 billion euros and imports from outside of EU 24.3 billion euros. Service trading was of a somewhat smaller magnitude, with EU exports around 10.5 and EU imports at 4.6 billion euros, and world exports at 4.9 and world imports at 7.1 billion euros. However, service trade has been growing much faster than goods trade, and Finland exports services particularly to Sweden, USA, UK and China.

Data on service exports and imports

The services exports and imports data cover 2002-2012 and are shown as a separate series in Figure A1, and similar figures are also shown for imports. To put the trade flow magnitudes in context, Finland's GDP in 2010 was 187 billion Euros, while the total goods exports were about 55 billion euros and total good imports around 50 billion euros. The service trading data are based on a survey that covers the census of all large companies that employed at least 100 persons, or had in the previous year reported that they we engaged in international services trade, or were owned by a foreign entity, or owned affiliates in a foreign entity. In addition, the data include a ~16% random sample of medium-sized firms (20-100 employees) and a ~10% random sample of small firms (less than 20 employees). The Great Recession is not as clearly reflected in the international movement of services. The most important categories of services exported include data processing services and international intra-corporate services (including overheads paid by international subsidiaries related to HR- and IT-services), while Finland mostly imports data processing services and services in the category of "other business functions" (e.g. translation and security) (see also Haller et al., 2014).

ICT survey

The ICT surveys are available in a uniform format for the period 2000-2009 and describe the adoption and use of ICT by Finnish private companies, as well as their practices related to e-commerce. The sample includes the universe of large firms (with more than 100 employees) and each year a separate random sample of smaller firms (5-99 employees). The sampling frame excludes the following industries: arts and entertainment, veterinary activities, financial and insurance activities, agriculture, forestry and fishing, and all public sector service activities. Each year roughly 3,000 firms answer the survey. Of our final regression sample of stayer firms 819 were found in the ICT survey in 2000 (i.e. the year we utilize to describe the baseline situation in our sample firms). During the observation period practically all companies surveyed had adopted some basic ICT tools,

but the share of workers using the tools varied from company to company, and on average increased from less than 60 percent (in 2001) to over 70 percent (in 2009) (Figure A2).

R&D survey

The R&D Surveys are available at the firm level in a uniform format for the period 1998-2011. The statistics are based on data obtained from enterprises, universities, central university hospitals, polytechnics and public sector organizations. In each year, the survey covers all large firms (with more than 100 employees), all smaller firms (less than 10 employees) that received public R&D subsidies, and a random sample of medium firms (with 10-100 employees), totaling about 4,000 firms per year. The survey questions cover in detail each firm's R&D activities and expenditures. Of our regression sample firms 1,091 were present in the R&D survey in the baseline year 2000. According to the survey, the overall average R&D expenditures were about 13,000 euros per worker in 2000 and have slightly increased from that level after 2006 (Figure A3). When considering the total firm level R&D expenditure (not shown in the figure) a brief dip was seen in 2007-2008, after which the R&D expenditures have again continued to increase slowly. The number of R&D employees dropped even more sharply in 2006-2007, making the expenditure per worker more or less flat until 2007. Descriptive statistics on the R&D survey are reported in Table 1b.

International sourcing survey

The international sourcing survey is an important globalization-related source of data revealing whether a firm has moved some of its business functions abroad (i.e., offshored certain jobs during a given period).[16] This information pertains to years 2001-2006. The international sourcing survey is a census for those firms that employ more than 100 persons and a random sample for smaller firms (the response rate was 83%). It covers 552

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[16] For more details see Statistics Denmark et al., 2008.

firms (out of 7,091) in our final regression sample of stayer firms. In total 19 percent of firms covered by the sourcing survey reported that they were already sourcing business functions internationally in 2001-2006 (Table 1b). In addition, 7 percent of the firms responded that they were planning to increase their international sourcing, or remain at the same level of offshoring as in the previous 5-year period. The most typical locations for offshoring were the new EU-12 countries, and the most typical tasks included ICT services and production of goods and services (Table 2). Large firms outsource more than smaller firms, both internationally and within Finland (Figure A4).

IV.   Aggregate Level Analysis and Decomposition Results

Decomposing Aggregate Changes

The main goal of this study is to decompose changes in occupational shares to changes taking place within and across Finnish firms, and to relate changes in occupational shares to the various firm characteristics described above. We start with a series of simple analyses of the employment share changes of occupations and continue with the decomposition.[17] Since FLEED allows us to identify individual establishments as well as firms it is interesting to also include a component accounting for that also. Establishment-level analyses have two main advantages: 1) they capture restructuring within firms that takes place as some firms simultaneously increase employment in certain production units and decrease in others, or establish entirely new production units and shut down older ones (Maksimovic and Gordon, 2002), and 2) they are less sensitive to artificial entry and exit of units and allow focusing on organic employment growth that is not confounded e.g. by mergers and acquisitions.

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[17] As we do not have data on the actual hours worked by each employee, the shares are measured simply as percentage of employees in each occupation. We tested the sensitivity of the polarization patterns to this definition by calculating the employment shares as a percentage of total numbers of months worked by all employees associated with the occupation and found that the pattern is essentially unchanged regardless of the measure used.

Specifically, using a formula originally proposed by Vainiomäki (1999), we decompose the change of aggregate occupation share of occupation j, ΔS_j (measured by number of persons) into four components:

$$\Delta S_j = \sum_{i \in C} \Delta S_{ij}^C \overline{W}_i^C + \sum_{i \in C} \bar{S}_{ij}^C \Delta W_i^C + W^N(S_{jt}^N - S_{jt}^C) + W^D(S_{j,t-1}^C - S_{j,t-1}^D), \qquad (1)$$

for j = 1, ..., 8 occupation groups. Superscript C denotes continuing establishments (i.e. those appearing both in $t-1$ and t), N the entrants (i.e. those appearing in t but not in $t-1$), and D the exiting establishments (i.e. those that exist in $t-1$ but not in t). $\Delta S_{ij}^C = \frac{L_{ijt}}{L_{it}} - \frac{L_{ij,t-1}}{L_{i,t-1}}$ is the change of employment share of occupation j from year $t-1$ to t in continuing establishment i. $\overline{W}_i^C = 0.5\left(\frac{L_{i,t-1}}{L_{t-1}} - \frac{L_{it}}{L_t}\right)$ is the average employment share of establishment i in years t and $t-1$ among continuing establishments, and $\bar{S}_{ij}^C = 0.5\left(\frac{L_{ij,t-1}}{L_{i,t-1}} - \frac{L_{ijt}}{L_{it}}\right)$ is the average employment share of occupation j in continuing establishment i in years t and $t-1$. $\Delta W_i^C = \frac{L_{jt}}{L_t} - \frac{L_{j,t-1}}{L_{t-1}}$ is the change of employment share of establishment i from year $t-1$ to t among continuing establishments. $W^N = \frac{L_t^N}{L_t}$ is the employment share of new /entering establishments (in year t) and $W^D = \frac{L_{t-1}^D}{L_{t-1}}$ the employment share of exiting establishments (in year $t-1$). S_{jt}^N and S_{jt}^C are the shares of occupation group j among new establishments and continuing establishments in year t, respectively. $S_{j,t-1}^C$ and $S_{j,t-1}^D$ are the shares of occupation group j among exiting establishments and continuing establishments in year $t-1$, respectively.

The first term on the right-hand side of Equation (1) gauges the change of aggregate employment share of occupation j within establishments. To put differently, it is a weighted average change of the employment shares in the continuing establishments, where each establishment is weighted by its average employment share in year t-1 and t. The second term measures the change of aggregate employment share of occupation j attributable to shifts in employment shares between continuing establishments with varying occupation structures. The sum of the two first components is the aggregate change of employment

share of occupation *j* among continuing establishments. The third component indicates the contribution of entries, which is positive when the employment share of occupation *j* in new establishments is higher than in continuing establishments (i.e. $S_{jt}^N > S_{jt}^C$). The fourth component indicates the contribution of exits, which is positive when the employment share of occupation *j* in exiting establishments is lower than in continuing establishments. Note that according to Equation (1) the net effect of entries and exits on the employment share change of occupation *j* is the difference of the change among all establishments and the change among the continuing establishments only. In other words, the net entry is equal to $\Delta S_j - \Delta S_j^C$.

Aggregate Level Patterns

It is interesting to first look at the aggregate level trends in job polarization using descriptive analysis and techniques that are prevalent in the literature. To begin with, we utilize the earliest years of available data that have a consistent occupational classification (1995 and 2000) to see whether there is any evidence of job polarization in the late 1990s. This analysis does not reveal any consistent pattern of polarization (Figure A5). Splitting the data into surviving firms versus entering and exiting firms shows some minor peaks and dips (not shown here), but overall the pattern is quite stagnant and does not resemble the U-shaped curves found in many other studies. In a stark contrast, if we instead look at the 2000-2009 period the overall pattern of job polarization becomes evident regardless of the level of occupational classification used. Figure 1 shows the change in the share of jobs between 2000 and 2009 by occupation using the 1-digit ISCO88-classification. The increase (~2%) in professional occupations corresponds to around 30 thousand jobs, while the change (~2%) in services translates roughly to 20 thousand jobs. The occupations that have lost the most jobs are related to industrial and clerical tasks.

An alternative way to characterize the polarization of job distribution is to rank occupations based on their initial wage (i.e. annual earnings in 2000), and then look at changes in employment across those occupations. Figure 2b show this at the 2-digit

occupational level.[18] Notably, when analyzing the data at this 2-digit (or finer) occupational classification it is clear that the polarization patterns are not identical across occupations that are quite similar in terms of their initial wage, but instead the pattern shows peaks and troughs. The largest peaks are associated with occupations 51 ("Personal and Protective Service Workers"), 34 ("Other Associate Professionals"), and 12 ("Corporate Managers"), whereas the biggest dips represent occupations 82 ("Machine Operators and Assemblers") and 72 ("Metal, Machinery and Related Trades Workers"). Occupations 51 and 34 are relatively large (accounting for 4.9% and 8.1% of the total jobs in the non-agricultural business sector in 2000), and cover a wide variety of professions including child-care workers, hairdressers, police officers (in occupation 51), as well as finance dealers, insurance reps and sales reps (in occupation 34).

A description of the characteristics of workers by occupation in 2000 and 2009 is shown in Table 3. The relative skill content ranking of the occupations has remained unchanged although the share of workers with a lower or upper tertiary degree and the average years of education have increased in every occupation. There is a considerable degree of gender segregation across occupation, which, if anything, appears to be increasing over time. All occupations except services seem to be aging, and managers have the highest average age among the occupations. There are large differences in the average monthly earnings across occupations and the salaries are growing fastest in the highest earning occupations. The relative wage increases are smallest in those occupations whose share of total employment has been declining over time, but the differences are not very large.

Decomposition Results

Figures 3a and 3b show the results of the decomposition in Equation (1). Figure 3a displays the total change in the occupation share, along with the proportion of the total change that can be attributed to the within-establishment component among the stayer firms. The difference between these two lines is then examined in figure 3b, where the

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[18] The smoothed changes are created using the nonparametric LOWESS-method, i.e. the locally weighted scatterplot smoothing. Mitrunen (2013) also performed similar analyses with Finnish data for period 1995-2008.

between-establishment component is shown along with the entry and exit components. Importantly, the figures demonstrate that the "left-hand side of polarization" is essentially a within-establishment phenomenon, i.e. the share of high-wage occupations has increased within continuing establishments. However, a comparison of the aggregate and within-establishments patterns reveals that less than half of the "right-hand side of the polarization" can be attributed to changes within establishments and a significant part to is related to establishment-level restructuring that include shifts in employment share among continuing establishments (i.e. the between component) as well as entries and exits of establishments. These figures also show that a sizeable part of the increase in employment share of the service occupations can be attributed to entries, i.e. the employment share of service occupations is typically larger among new establishments than (older) continuing establishments. The exit of establishments has played an insignificant role. On the other hand, the between-component has also contributed to the pattern by having a negative effect on the employment change of plant operators and craft employees. This indicates that that there is a negative correlation between the employment share of those occupations and the growth of establishments in terms of total employment. On the other hand, establishments that had a relatively large share of elementary and service occupations increased their total employment share among continuing establishments. [19, 20]

Finally, earlier studies have used occupational tasks to group them into more versus less skill-intensive occupations.[21] Here we classify occupations into four main groups based on the typical tasks they involve: abstract, routine, service and elementary. Just like the

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[19] This analysis is done using all firms if they had at least one employee in 2000 and/or 2009. The firm level regression analysis uses only those firms that had at least 10 workers during the year of observation. We re-calculated the employment shares by occupation and firm type to see if the overall pattern is sensitive to the size limitation. The pattern is quite robust to excluding the smallest firms, even though the number of firms is reduced quite dramatically (from about 28 thousand to 6 thousand firms per year).

[20] Figure A6 plots the occupational distribution in the 2000 firms that stay until 2009 versus those that exit after 2000. 2009 occupational distribution is shown for firms that continued to exist since 2000 versus those entering after 2000. This shows that exiting firms had a similar job distribution as surviving firms, although some more jobs in craft occupations. Entering firms were more concentrated on service and elementary jobs relative to existing firms that had a larger share of jobs in technical and professional occupations, as well as in clerical occupations.

[21] Specifically, earlier studies typically characterize occupations as mostly involving abstract, routine or service tasks (Acemoglu and Autor, 2010). Some studies derive task intensity measures for 2-digit ISCO occupation using ONET data and converting the ISCO classification to the SOC classification used in the US-based ONET (e.g. Goos, Manning and Salomons, 2010).

more detailed graphs above, this analysis (in Table 4) demonstrates how occupations associated with routine tasks have declined in share while both abstract and service occupations have increased. The decline in routine occupations is driven both by the within and between components (among the continuing firms), while firm entry and exit have had a much smaller role. For abstract occupations the within-component dominates, while the between-component is most important in the growth of service occupations. These results are largely in line with earlier studies (e.g. Bockerman et al., 2016; Goos et al., 2010).

To summarize, based on the various descriptive analyses and decompositions, regardless of the approach taken to characterize or group occupations, we reach the same conclusion: mid-level jobs are disappearing while top- and bottom-level jobs are growing. Interestingly, unlike in the United States, this polarization of employment shares is not really reflected in the wage distribution (Figure A7). Mean earnings have exhibited steady growth across the board, although the gap between top- and bottom-occupations has slightly risen. There does not appear to be any declining trend in earnings associated with mid-level occupations.

V. Regression Approach: OLS and 2SLS

Next we estimate a model for the occupational share changes using the FLEED data by occupation group at the firm level, where the dependent variable is the change in the share of occupation group j within the firm i from 2000 to 2009. The model includes the 2000 average log wage of employees in firm i, average age of employees in the firm and industry dummies. The latter are intended to capture any economy-wide shifts that are taking place in the industry. The estimated equation is of the general form:

$$\Delta S_{ijt+1,t} = \alpha + \beta_1 F_{it} + \beta_2 \log(w_{ijt}) + \beta_3 age_{it} + \beta_4 I_{it} + \varepsilon_{it}, \qquad (2)$$

where S is the employment share, w is the average annual salary of j workers in firm i, age is the average age of employees in the firm in 2000, and I is a vector of industry dummies. Firm level factors of interest captured in F will include measures related to import and export activity, outsourcing, R&D expenditures and ICT use.

One potential identification concern is related to firm-level shocks (e.g. in product or service demand, or firm-level productivity) that might have a simultaneous impact on the firm's trading activities and its occupational employment decisions. Dealing with this concern requires an instrumental variable that impacts the firm's international activities (in particular exports, imports and outsourcing) but is uncorrelated with the employment decisions. We use the instrumental variables approach utilized in recent studies by Hummels et al. (2014), and Nilsson Hakkala and Huttunen (2014, 2016). To be more specific, we create a firm-product-country level measure of exposure to increased world supply using very detailed data from the Finnish Customs and the UN Comtrade database. The Comtrade data is a comprehensive register of all export and import flows between each country pair and includes goods classifications all the way to the most detailed 6-digit HS2002 level. From those data we calculate for each good – reporting country pair the total imports from the world market minus the imports from Finland, and the total exports to the world market minus the exports to Finland. The Finnish customs data is at the firm – goods classification – partner country level, and allows us to characterize the exact import and export pattern of each trading firm at the most detailed (8-digit) goods category level.[22] The customs data allow us to calculate the share of the specific good – partner country as a percentage of the firm's total imports and exports that can be then used as a weight to take into account how significant any world import or export shock is to any specific firm. Any shocks in the world trading environment (such as the China WTO membership in 2001) would have firm-specific effects depending on how much each Finnish firm is engaged in trade within the specific goods category affected.

The instrument for firm-level imports is based on the world export supply measure, WES_{ckt}, which is country c's total supply of product k to the world market in year t, excluding the supply to Finland. To create the instrument, we weight each firm i's product k from country c at time t with the share of c - k product in the firm's total material imports

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[22] One difference between the Comtrade and Finnish Customs data is related to the country classification. While Comtrade reports the trade flows between each individual country pair, Finnish Customs data only reports individual countries to the extent that they are among the major export and import partners of Finland. Outside of those, countries are aggregated by continent. This needs to be accounted for in the generation of the instrumental variable. The amount of trading that takes place between Finnish companies and the non-major trading countries is relatively small: less than 5 percent of total imports and exports in 2000.

in 2000. We then generate the firm-level measure by aggregating across all products from all countries, and weighting each product c-k with its share in firm's imports in the first period the firm is observed in the trade data. The time-varying instrument for each firm i in year t is as follows:

$$IV^E_{it} = \Sigma s_{ick} WES_{ckt}. \tag{3}$$

Since our regression analysis is looking at first-differences (i.e. comparing the firm-level change in 2000-2009) we use the 2000-2009 change in the IV^E_{it} as our instrumental variable. We would expect the WES-based instrument to have a positive impact on the firm's imports, as an increase in the world export supply should encourage additional importing by Finnish firms within the specific goods category. Like Hummels et al. (2014), we assume that firms have pre-existing trading relationships that make it advantageous to source specific goods and services from specific countries, and likewise to export specific goods and services to specific countries. To some extent, these trading relationships are pre-determined. Over time, external shocks in the international environment impact the extent to which such trading relationships remain advantageous.

Again, following Hummels et al. (2014), we create a similar instrument based on the world import demand (WID) to be used for the firm level exports. The instrument is calculated as follows:

$$IV^I_{it} = \Sigma s_{ick} WID_{ckt}, \tag{4}$$

where WID_{ckt} is the world import demand. It is calculated as country c's total purchases of good or service k from the world market (minus any purchases from Finland) at time t. In general, WID might increase / decrease because of a shock to demand such as consumers' change of tastes or firms change of their use of the specific product). A change in WID might also results from a loss in country c's comparative advantage in product k. We would expect the WID-based instrument to have a positive impact on the firm's exports, as an increased world import demand should encourage additional exporting by Finnish firms within the specific goods category. We report the first stage results for our instruments in the regression tables discussed in the next section.

VI.   Role of Globalization and Technology: Regression Results

Description of the Firm Sample Across Data Sets

This section first shows some descriptive statistics and coverage analysis for the sample of firms included in the regressions. We estimated the regressions using the total FLEED that covers all firms and all of their workers in the employment register and follows them over time. It should be noted that the definition of entry, exit and stayer is done using the business register and therefore excludes any workers of entities that are not considered to be private firms. This includes, for example, public sector entities such as municipalities, towns and other large public sector employers. We acknowledge that the job distribution is rather different in those entities than in private sector firms, but including public sector jobs is outside the scope of the current analysis due to the very different decision making process in those entities and their exclusion from all firm surveys and customs data utilized below for the regression analyses. [23] Below we first characterize the final firm sample and the various data sets that are combined into the total FLEED. For estimation, we include firms that had at least 10 employees in the focal year, and exclude employees who worked for the firm for less than 6 months during the year or had zero earnings from the firm during the year. These selection criteria do not affect the results markedly.[24]

As the FLEED covers all private sector employees and firms it includes a large number of observations both at the worker and firm level. Customs data on trade of goods can also be considered a census of importing and exporting firms, and the absence of a firm from those data simply indicates that the firm is not engaged in international trade of goods or services (i.e. the value of the goods imported and exported by those firms is zero). Of the 7,091 firms that are observed in the business register with an entry date before 2000 and either no exit date or an exit date later than 2009 a total of 2,818 (40%) report a positive amount of imported or exported goods in 2000 or 2009. In addition, 668 report a positive

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[23] Appendix figure A8 shows the change in the occupational distribution in the public sector between 2000 and 2009, and figure A9 the overall polarization chart that includes both the public and private sector jobs. Very interestingly, the public sector exhibits a slightly U-shaped job distribution, and hence including the public sector into the private sector analysis mitigates the polarization pattern.

[24] Upon request we will provide robustness checks using only firms that have at least 20 employees, or where we drop persons whose earnings are in the top or bottom 1% of the FLEED earnings distribution.

value of service imports or exports.[25] The average size of firms in those groups is 105 employees in 2000 (111 employees in 2009) for goods exporters / importers and 282 employees in 2000 (272 employees in 2009) for service exporters / importers, respectively.[26]

Coverage related to the three other sets of auxiliary survey data is more limited, although large firms are generally covered by every survey. Of the 7,091 firms 978 are covered by the 2001 ICT survey and the average size of the covered firms is about 140 in 2000 (and 152 in 2009). The firms not covered are much smaller on average, about 36 employees in 2000 (41 in 2009). Similarly, the international sourcing survey covers only 552 of the firms and is heavily focused on larger companies. The average size of covered firms in that survey is 313 employees in 2000 (320 in 2009). Again, the firms not covered have on average 38 employees in 2000 (44 in 2009). Finally, the R&D survey also oversamples large firms and covers 1,061 of the regression sample firms in 2000 with an average size of 131 employees (134 in 2009). The firms not part of the 2000 R&D survey have an average of 41 employees in 2000 (49 in 2009). The part of the sample that is covered by all three surveys contains just 322 firms with an average size of 381 employees in 2000 (380 in 2009). These limitations and their implications for the regression analysis are discussed below.

Continuing Firms: Ordinary Least Squares Results

Analyses that follow focus only on continuing firms, i.e. those that exist both in 2000 and 2009. Exiting and entering firms are described separately below. Before commencing with the regression analysis it is worth reminding that employment polarization is taking place also within the sample of continuing firms (Figures 3a and 3b).[27] The first set of

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[25] In some sense, the service import and export data can also be considered "a census" because the sample attempts to include all firms with known or suspected service import or export. We test for the sensitivity of our findings to the treatment of the service trade data in the regression analysis discussed below.

[26] The average size of a non-importing and non-exporting firm was 19 employees in 2000 and 23 employees in 2009. For the service imports and exports, the firms not engaged in those activities had an average of 25 employees in 2000 and 29 employees in 2009.

[27] In additional analyses (not shown here) we confirm that polarization among continuing firms is evident both at the 1-digit as well as the 2-digit level.

regressions uses data at the firm level and combines occupations into four broad groups: 1) managers, professionals and technical personnel (i.e. abstract occupations), 2) plant operators, craft and clerical occupations (i.e. routine occupations), 3) service occupations, and 4) elementary occupations. We should keep in mind that the regressions look at changes in occupation shares within firms (i.e. firm employment composition), and not changes in the number of employees. Since the next several tables provide a complex set of regression results and specification checks, the simple summary below will outline the main findings that survive the inclusion of additional controls and other robustness checks.

Summary: Relationship of Different Factors to Change in Occupation Share (2000 to 2009)

	Abstract	Routine	Service	Elementary
Δ(Goods imports)		-	0/+	
Δ(Goods exports)	-	+		
Δ(Service imports)	0/-	+		-
Δ(Service exports)	0/+	+		-
Δ(ICT use)		-		
Δ(R&D spending)		-	+	+
Δ(Domestic outsourcing)	-	+		
Δ(Foreign outsourcing)		-		

*Note: Empty cells indicate results that are not statistically significant, or are not robust.

We first focus on the international trade of goods and services. In Panel A of Table 5a bivariate regressions are estimated separately by occupation group and each explanatory variable is introduced one at a time. The number of workers in the firm in 2000 is used as a weight. Panel B adds the basic controls (firm average wage level, firm average employee age, and industry dummies), and in Panel C all trade variables are included simultaneously, as it is likely that the same firms that export a large amount of final goods also import a large number of intermediate goods, making the interpretation of the bivariate relationships difficult. While no causal interpretation should be placed on these estimates, the pattern in Panel C proves both interesting and intuitive. Firms that increase the amount

of traded goods are more likely to increase the share of production occupations (group 2) and reduce the share of professional occupations (group 1). The share of service (group 3) occupations are not really affected by the changes in exports and imports, while the elementary occupations (group 4) are increased particularly in firms that increase the amount of goods imported.

In the alternative polarization specification (last column) we attempt to create a single index to characterize the relative polarization at the firm level, and use that index as the dependent variable in our regressions. Here, occupations are grouped into 3 groups, combining service and elementary occupations into a single category (G3). The index is calculated as

$$PI = 0.5 * (d_{G1} + d_{G3}) - d_{G2}, \tag{5}$$

where d signals the percentage share change of the occupation group between 2000 and 2009, and the groups are as follows. G1 includes managers, professionals and technical, G2 contains plant operators, craft and clerical occupations, and G3 has elementary and service occupations. The OLS results using the single polarization index as the dependent variable are in line with the findings by occupation group. Most importantly, increase in trade of goods is negatively associated with the overall pattern of job polarization at the firm level.

Table 5b focuses on the international trade of services. The service imports and exports do not play a large role in most cases, although firms increasing their service exports and imports tend to somewhat reduce the share of elementary occupation workers. Conversely, firms increasing their trade in services seem to increase their production and clerical worker share. For the other occupations, especially once we include the other firm-level controls, the estimated effects are essentially zero (Panel B). In Panel C we include controls for the firm's changes in the imports and exports of goods, which does not significantly impact the finding related to elementary occupations or the production and clerical occupations. Finally, Panel D shows estimations where we include also those firms that were not part of the survey asking about the international service trade activities. As we explained above, it is reasonable to assume that most of the non-interviewed firms had

zero imports and exports of services, given how the sample frame was formed. When we use polarization index as the outcome variable, we find that increase in firms' trade in services tend to diminish the job polarization pattern in those firms.

Table 6a looks at the firm characteristics reported in the various survey data sets, and similarly starts with bivariate regressions in Panel A, adds the basic firm level controls in Panel B, and further explores splitting the sourcing survey (Panel C) and the R&D survey (Panel D) into more detailed components. The results from these regressions are somewhat harder to compare across specifications as each survey covers a somewhat different sample of firms. Also, while interpreting the results one should not be assigning a cause-and-effect relationship for these variables, and the estimated coefficients are not always statistically significant. With that in mind, there are some interesting relationships that emerge from the results. For example, in Panel B, firms where a large share of employees use ICT at the beginning of the period are more likely to reduce the share of production and clerical workers (group 2) who perform routine tasks. In that sense, our results line up with those reported by Bockerman et al. (2016). Similarly, firms investing a lot in R&D tend to reduce the share of routine workers, although that result is very different depending on whether we look at internal versus external R&D spending (Panel D): firm with more external R&D spending actually increase the share of the routine occupation group and reduce managerial, professional and technical employment share. The results regarding R&D are robust to the use of polarization index as the outcome variable. We are also able to split outsourcing activities more finely, resulting in some interesting observations. Elementary worker (group 4) share falls in firms that are planning to outsource activities, but the change in the service worker (group 3) share shows no significant correlation with any kind of outsourcing. Interestingly, routine worker share is increased in firms that outsource domestically, but reduced in those firms that outsource tasks abroad. This may be related to the type of tasks that are being outsourced. Domestic outsourcing tends to be related to tasks such as cleaning services, while production tasks may be outsourced to foreign locations. Below we attempt to provide a more causal interpretation for some of these findings. The results using the single polarization index as the dependent variable are in line with these findings. In particular,

the overall occupational polarization pattern is positive (negative) in firms that outsource domestically (abroad). The results using the single polarization index as the dependent variable are in line with these findings. In particular, the overall occupational polarization pattern is positive (negative) in firms that outsource domestically (abroad).

Two-Stage Least Squares Results

When modeling firm-level choices on employment and engagement in trading activities we generally need to resort to an instrumental variables approach to deal with the fact that many firms are importing intermediate goods and exporting the final goods, and it is therefore difficult to disentangle each of these separate effects without more detailed goods category level data. Using data from the Finnish Customs we can separate out the imports and exports by goods category, and continue with the instrumental variables estimation. We take the firm-product-country-level Customs data and combine it with Comtrade trade flow data to form instrumental variables (as explained in more detail above).

Table 5a reports the results of the 2SLS regressions for the goods imports and exports, and table 6b for the offshoring and outsourcing related variables. The results are generally in line with the OLS analysis discussed above, although the estimates are less precise and point estimates somewhat smaller. The only exception is the single polarization index for which we find larger and statistically significant point estimates. For the goods imports and exports (bottom panel), the 2SLS results verify the OLS conclusion that managerial and professional jobs are declining in firms that increase their goods exports, while those same firms appear to increase their share of routine workers. Conversely, routine worker shares are declining as firms increase the imports of goods from abroad. These results seem quite consistent with our expectations. Finally, changes in the share of elementary workers and service workers are largely unrelated to the goods imports and exports, apart from the positive relationship between service worker share and good importing.

For the outsourcing / offshoring model that pertains to the firm's activities and plans in the early-2000s we obtained from the Comtrade data for an earlier time period (1999-2002) to better fit the timing related to the decision of the firm to begin offshoring (table

6b). The instrument performs reasonably well, with F-statistics often exceeding 10. We would nevertheless view these results as less robust than those related to goods and service trading. Based on these findings, it appears that all forms of outsourcing (domestic, foreign and planned) are unrelated to changes in managerial occupations and service occupations. Outsourcing abroad is negatively related to the occupation share change in production related occupations, while domestic and planned outsourcing seem positively related to those occupations. Conversely, elementary occupations see shrinking shares with domestic and planned outsourcing. We view these results as plausible, but somewhat tentative given the smaller sample size and less powerful first stage in the 2SLS. Further research into the role of outsourcing could be done, especially related to the specific tasks and functions that the firms have outsourced.

VII.   Conclusions

This paper analyzes the extent of job polarization in Finland using a unique firm level data platform where firm-worker panel data have been augmented to include measures of goods and service imports and exports, outsourcing and offshoring, and technology intensity and usage (e.g. R&D and ICT). We begin by comparing the polarization patterns in the 1990s and 2000s and note that there was very little evidence of the U-shaped pattern in the 1990s, whereas polarization became quite evident in the 2000s. We then analyze the degree to which the polarization in the 2000s stems from changes within existing surviving firms versus via firm-level restructuring involving employment reallocation between continuing firms as well as   entries and exits of firms. In this analysis we make use of establishment data that is less prone to artificial entries and exits due to ownership or other organizational changes over time plagued in company data. We find that the source of the changes varies across occupations: while the increase in managerial and professional occupations is coming essentially from changes within firms, the entries and reallocation of employment between continuing firms substantially contribute to increase in service

occupations. The craft occupations are likewise declining both within firms and through reallocation of employment between firms, whereas the entry and reallocation of employment between firms account for a large share in the decline of plant operator occupations.

Simple descriptive regressions show that firms with increasing exports are more likely to increase the share of production occupations and reduce the share of professional occupations within the continuing firms. On the other hand, the share of service and elementary occupations are reduced particularly in firms that import a lot of goods. Firms that outsource globally are more likely to reduce workers in elementary occupations, whereas firms outsourcing domestically reduce the number of workers in service occupations. Following recent studies by Hummels et al. (2014) and Hakkala and Huttunen (2014, 2016) we develop an instrumental variables approach to deal with the endogeneity between occupational employment changes and the outsourcing decisions and import/export choices that the firms make.

This paper demonstrates the importance for including the firm in analyses of aggregate labor market trends. While it is true that job polarization exists at the level of the labor market, the mechanisms and driving forces are quite different for each occupation. This is especially important if we try to consider policy measures and other potential responses to these polarization patters that are pervasive in most developed countries. This paper has taken the first step at describing the firm- and establishment level patterns underlying the aggregate level labor market polarization, and in establishing a link between firm-level polarization and the various international activities that the firms engage in. Much work is still required to fully understand the specific mechanisms and links at the firm level, and the data available in Finland (and other Nordic countries) provides opportunities for future research to delve into those questions.

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Table 1a: Descriptive Statistics for Total FLEED, Firms with at Least 10 Employees (2000 and 2009)

	2000	2009
Number of firms	10,599	11,305
Number of employees	460,432	519,583
Mean earnings per year, €	33,870	34,447
Primary education only, %	20%	12%
Secondary education, %	42%	43%
Tertiary education (lowest level), %	20%	15%
Tertiary education (lower degree, BA), %	8%	14%
Tertiary education (higher degree, MA or above), %	10%	15%
Managers, %	4%	5%
Professionals, %	17%	21%
Technicals, %	20%	21%
Clerks, %	10%	9%
Services, %	17%	19%
Craft, %	11%	8%
Plant-operators, %	11%	8%
Elementary ccupations, %	10%	10%

Table 1b: Descriptive Statistics of the Survey Data Sets and Customs Data

	Data Source	Mean	Median	Std.Dev.	Obs.	Firms
Firms that use ICT, 2001-2009	ICT Survey	99%	100%	0.11	30,322	15,281
Share of workers that use ICT, 2001-2009	ICT Survey	65%	80%	0.36	29,379	15,281
R&D expenditure, 2000-2009 (millions €)	R&D Survey	1.06	0.006	27.98	38,982	13,792
R&D expenditure per employee, 2000-2009 (€)	R&D Survey	12,281	165.7	46,927	38,982	13,792
Number of R&D employees per firm, 2000-2009	R&D Survey	9.8	0	186.2	38,982	13,792
Total export, 2000-2009 (millions €)	Customs data	2.75	0	69.44	213,745	76,197
Export inside the EU, 2000-2009 (millions €)	Customs data	1.49	0	0	213,745	76,197
Total services export, 2002-2009 (millions €)	Services data	1.38	0.038	28.52	64,985	8,202
Total services import, 2002-2009 (millions €)	Services data	0.57	0.017	8.09	125,042	8,202
Share of firms outsourcing abroad, 2001-2006	Sourcing survey	19%	0%	40%	1,407	1,407
Share of firms outsourcing, 2001-2006	Sourcing survey	53%	100%	50%	1,407	1,407
Share of firms planning to outsource, 2006-	Sourcing survey	7%	0%	26%	1,407	1,407

Table 2: International Sourcing by Business Function and Firm Size

	Firms < 100 empl.	Firms > 100 empl.
Production of goods and services	44%	42%
Distribution and logistic	90%	80%
Marketing and sales	29%	26%
Information and ict services	62%	59%
Administrative services	29%	33%
Engineering and technical services	29%	21%
R&D	18%	14%
Other services	7%	13%
Number of firms	147	594

Table 3: Characteristics of workers by occupation, 2000 and 2009

	Share of highly educated, %		Mean years of education		Share of women, %		Mean age		Mean monthly earnings, €		
	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009	Change
Managers	48%	51%	14.8	14.90	26%	29%	44	45.7	4,667	5,175	11%
Professionals	64%	68%	15.5	15.70	37%	39%	39.7	41.3	3,483	3,839	10%
Technicals	17%	34%	13.2	13.90	46%	53%	40.4	41.4	2,741	2,942	7%
Clerks	7%	21%	12.4	13.10	80%	80%	40.5	41.6	2,173	2,374	9%
Services	2%	7%	11.6	11.90	73%	76%	35.8	35.4	1,721	1,774	3%
Craft	1%	2%	11.4	11.60	10%	8%	39.6	40.5	2,403	2,617	9%
Plant-operators	1%	2%	11.0	11.30	28%	23%	38.9	41.5	2,334	2,548	9%
Elementary	1%	3%	10.8	11.20	49%	49%	36.8	38.1	1,721	1,828	6%

Table 4: Decomposition of Employment Share Change by Occupation Group (2000 to 2009)

Occupation Group	ΔEmp. Share	Within	Between	Entry	Exit
Abstract	0.053	0.062	0.005	-0.130	-0.001
Routine	-0.086	-0.450	-0.031	-0.010	0.000
Service	0.037	-0.002	0.029	0.012	-0.002
Elementary	-0.003	-0.015	-0.003	0.012	0.003

* Notes: Occupations are grouped as 1) Abstract = Managerial, Professional & Technical, 2) Routine = Clerical, Plant Operators & Craft Workers, 3) Service Occupations, 4) Elementary Occupations.

Table 5a: Firm-level OLS and 2SLS Regressions for Change in Occupation Share Between 2000 and 2009: Firms with at Least 10 Employees in 2000 & 2009. Export and Import Variables.

		Dependent Variable: Change in the Occupation Group Share				Dependent Variable
		Group 1: Man, Pro & Tech	Group 2: Pri, Craf & Cler	Group 3: Service	Group 4: Elementary	Polarization
Explanatory variable						Index
Panel A: Bivariate regressions						
Change in export of goods	OLS	-0.0128	0.0070	0.0004	0.0053	-0.0105
		(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
	2SLS	-0.0070	0.0047	-0.0008	0.0030	-0.0071
		(.0025)	(.0024)	(.0013)	(.0031)	(.0036)
	iv_exp	-0.6277				
	1st Stage F-stat	224.99				
Change in import of goods	OLS	-0.0088	0.0008	0.0006	0.0074	-0.0013
		(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
	2SLS	0.0000	0.0005	0.0027	-0.0032	-0.0007
		(.0044)	(.0039)	(.0021)	(.0032)	(.0058)
	iv_imp	-0.8167				
	1st Stage F-stat	83.84				
Panel B: Add Basic Firm Level Controls						
Change in export of goods	OLS	-0.0130	0.0069	0.0006	0.0055	-0.0103
		(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
	2SLS	-0.0080	0.0084	0.0013	-0.0018	-0.0126
		(.0026)	(.0025)	(.0014)	(.0020)	(.0037)
	iv_exp	-0.6040				
	1st Stage F-stat	36.48				
Change in import of goods	OLS	-0.0086	0.0006	0.0005	0.0074	-0.0009
		(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
	2SLS	0.0032	-0.0098	0.0038	0.0028	0.0147
		(.0045)	(.0043)	(.0024)	(.0033)	(.0065)
	iv_imp	-0.7793				
	1st Stage F-stat	14.82				
Panel C: Include Import and Export Variables in the Same Regression						
Change in export of goods	OLS	-0.0113	0.0076	0.0004	0.0033	-0.0113
		(.0005)	(.0004)	(.0002)	(.0003)	(.0006)
Change in import of goods		-0.0048	-0.0019	0.0004	0.0068	0.0029
		(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
Change in export of goods	2SLS	-0.0092	0.0116	0.0002	-0.0027	-0.0175
		(.0029)	(.0028)	(.0024)	(.0025)	(.0042)
Change in import of goods		0.0040	-0.0108	0.0037	0.0031	0.0163
		(.0044)	(.0043)	(.0016)	(.0034)	(.0064)
First-Stage Regression Statistics						
Change in export of goods	iv_exp	-0.6052				
	iv_imp	0.0314				
	1st Stage F-stat	32.84				
Change in import of goods	iv_exp	-0.1521				
	iv_imp	-0.7542				
	1st Stage F-stat	14.54				
Number of Firms		7,091	7,091	7,091	7,091	7,091

* Notes: Each cell in Panels A and B refers to a separate regression. Panel C includes all regressors in the same regression. Sample of firms includes a total of 7,091 companies. Total number of employees in the firm in 2000 is used to weight the observations. 2SLS regressions use changes in the world export supply (WES) and world import demand (WID) as instruments for changes in exports and imports, respectively. The polarization index is calculated as PI=[0.5*(d_{G1}+d_{G2})-d_{G3}], where d indicates the share change. G1 includes managers, tehnicals and professionals, G2 includes primary, craft and clerical, and G3 includes elementary and services.

Table 5b: Firm-level OLS Regressions for Change in Occupation Share Between 2000 and 2009. Service Export and Import Variables.

Explanatory variable	Firms with at Least 10 Employees in 2000 & 2009				
	Group 1: Man, Pro & Tech	Group 2: Pri, Craf & Cler	Group 3: Service	Group 4: Elementary	Polarization Index
Panel A: Bivariate regressions					
Change in export of services	0.0003	0.0030	0.0003	-0.0037	-0.0046
	(.0010)	(.0008)	(.0002)	(.0006)	(.0013)
Change in import of services	-0.0019	0.0051	0.0002	-0.0034	-0.0076
	(.0010)	(.0009)	(.0002)	(.0007)	(.0013)
Panel B: Add Basic Firm Level Controls					
Change in export of services	0.0013	0.0021	0.0002	-0.0036	-0.0031
	(.0009)	(.0008)	(.0002)	(.0006)	(.0012)
Change in import of services	-0.0004	0.0038	0.0001	-0.0036	-0.0058
	(.0010)	(.0009)	(.0002)	(.0006)	(.0013)
Panel C: Include All Import and Export Variables in the Same Regression					
Change in export of goods	-0.0181	0.0134	0.0008	0.0039	-0.0202
	(.0014)	(.0013)	(.0003)	(.0008)	(.0019)
Change in export of services	0.0013	0.0016	0.0003	-0.0032	-0.0024
	(.0009)	(.0008)	(.0002)	(.0005)	(.0013)
Change in import of goods	-0.0038	-0.0070	-0.0007	0.0115	-0.0105
	(.0014)	(.0013)	(.0003)	(.0009)	(.0021)
Change in import of services	-0.0014	0.0031	0.0000	-0.0017	-0.0047
	(.0009)	(.0009)	(.0002)	(.0006)	(.0014)
Number of Firms	668	668	668	668	668
Panel C: Include All Firms in the Regression, Change is Zero if Not Surveyed					
Change in export of goods	-0.0110	0.0076	0.0005	0.0030	-0.0114
	(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
Change in export of services	0.0014	0.0013	0.0003	-0.0030	-0.002
	(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
Change in import of goods	-0.0045	-0.0021	0.0004	0.0062	0.0032
	(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
Change in import of services	-0.0021	0.0038	0.0001	-0.0017	-0.0056
	(.0004)	(.0004)	(.0002)	(.0003)	(.0006)
Number of Firms	7,091	7,091	7,091	7,091	7,091

* Notes: Each cell in Panels A and B refers to a separate regression. Panel C includes all regressors into the same regression. The overall sample of firms with data on the export and import of services (at least 10 employees) includes a total of 668 companies. The total number of employees in the firm in 2000 is used to weight the observations. See also notes for Table 4a.

Table 6a: Firm-level OLS Regressions for Change in Occupation Share Between 2000 and 2009. Variables from ICT, R&D and Sourcing Survey.

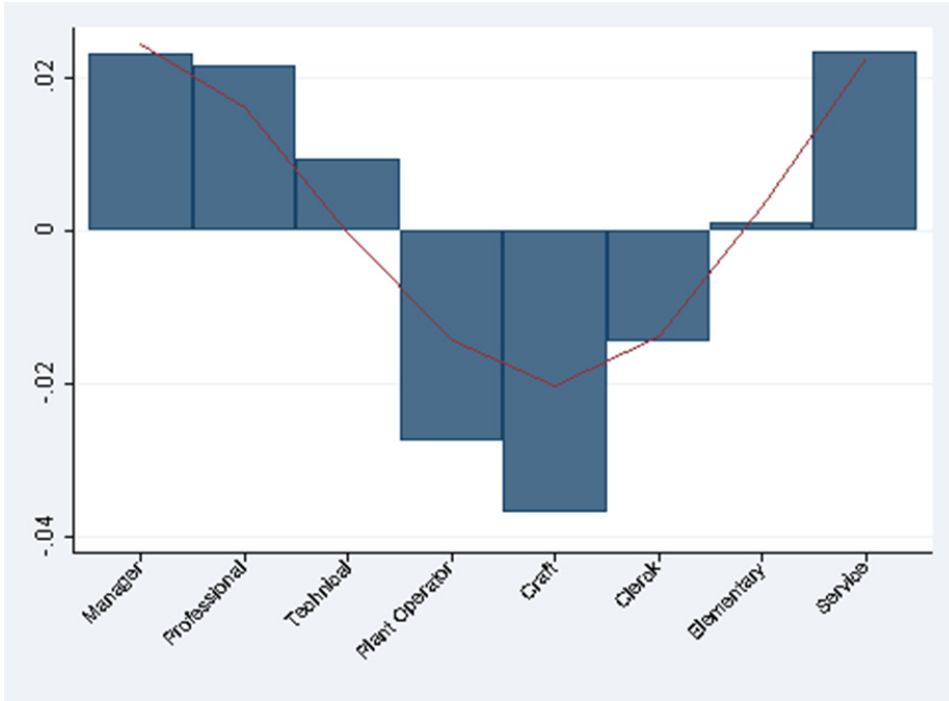| Explanatory variable	Group 1: Man, Pro & Tech	Group 2: Pri, Craf & Cler	Group 3: Service	Group 4: Elementary	Polarization Index
	Firms with at Least 10 Employees in 2000 & 2009				
Panel A: Separate Bivariate Regressions					
Outsourcing / Offshoring	-0.0033	-0.0036	-0.0046	0.0115	0.0054
	(.0134)	(0.0123)	(.0045)	(.0119)	(.0184)
% Workers use Computer 2001	-0.0237	0.0070	-0.0030	0.0198	-0.0105
	(.0182)	(.0153)	(.0055)	(.0091)	(.0230)
Ln(Total R&D expenditure)	0.0013	-0.0045	0.0006	0.0025	0.0067
	(.0015)	(.0012)	(.0003)	(.0008)	(.0019)
Panel B: Add Basic Firm Level Controls					
Outsourcing / Offshoring	-0.0042	0.0091	-0.0043	-0.0006	-0.0137
	(.0135)	(0.0121)	(.0046)	(.0114)	(.0183)
% Workers use Computer 2001	0.0146	-0.0320	0.0023	0.0151	0.0480
	(.0211)	(.0180)	(.0066)	(.0109)	(.0271)
Ln(Total R&D expenditure)	0.0013	-0.0047	0.0011	0.0022	0.0070
	(.0017)	(.0014)	(.0003)	(.0009)	(.0021)
Panel C: Outsourcing in Finland, Abroad versus Planned (Include Basic Controls)					
Outsourcing in Finland	-0.0358	0.0349	-0.0067	0.0077	-0.0523
	(.0130)	(0.0116)	(.0045)	(.0110)	(.0174)
Outsourcing Abroad	0.0204	-0.0376	0.0075	0.0097	0.0565
	(.0153)	(.0136)	(.0052)	(.0129)	(.0204)
Plan to Oursource 2007-	0.0276	0.0129	-0.0094	-0.0311	-0.0194
	(.0199)	(.0178)	(.0069)	(.0168)	(.0266)
Panel D: Internal versus External R&D (Include Basic Controls)					
LN(Internal R&D Spending)	0.0038	-0.0079	0.0013	0.0027	0.0118
	(.0017)	(.0015)	(.0003)	(.0010)	(.0022)
LN(External R&D Spending)	-0.0088	0.0115	-0.0005	-0.0022	-0.0172
	(.0021)	(.0018)	(.0004)	(.0012)	(.0027)

* Notes: Each cell in Panels A and B refers to a separate regression. Panels C and D include all listed regressors into the same regression. The size of the sample varies from survey to survey. All regressions are for the sample of firms with at least 10 employees. For the Sourcing survey: N=552. For the ICT survey: N= 978. For the R&D Survey: N=1,060. See also notes for Table 4a.
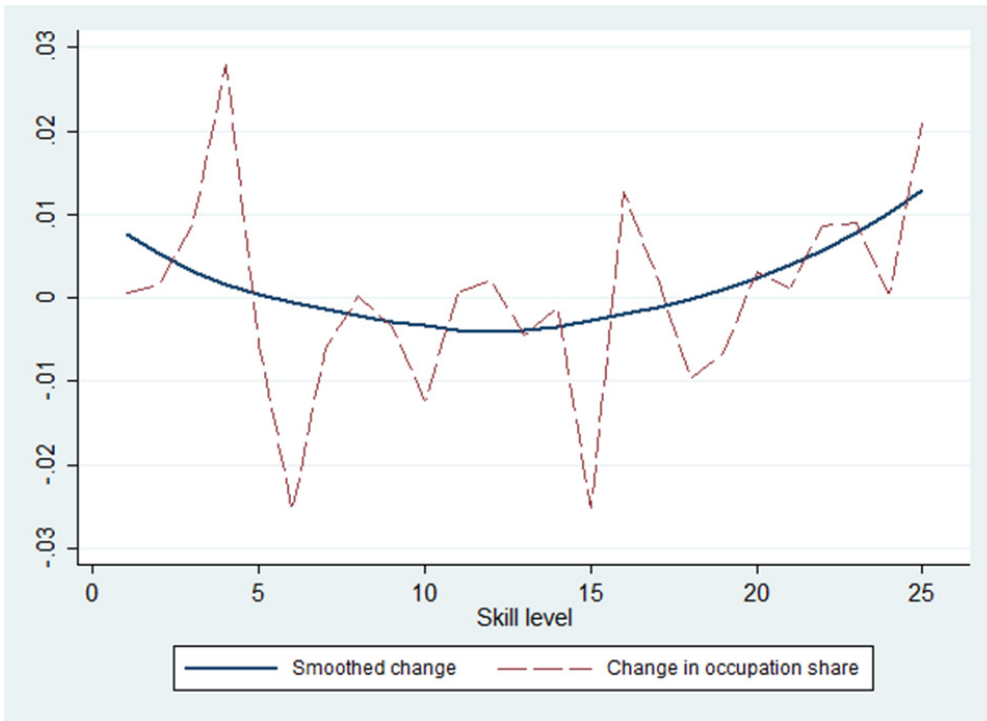
Table 6b: Firm-level 2SLS Regressions for Change in Occupation Share Between 2000 and 2009. Variables from Sourcing Survey.

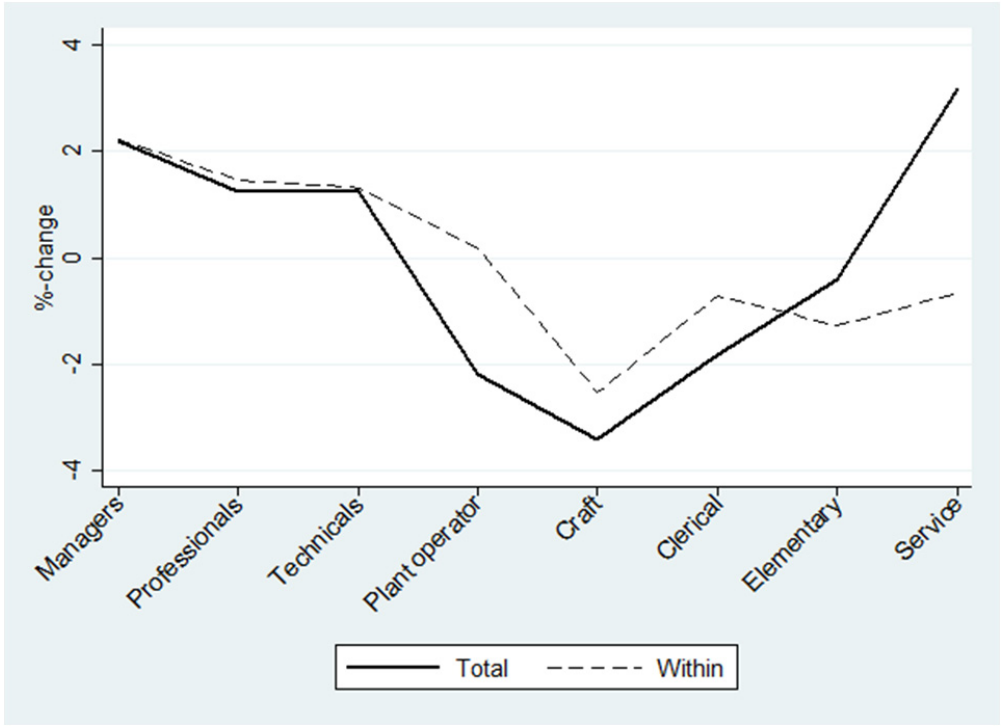| Explanatory variable		Group 1: Man, Pro & Tech	Group 2: Pri, Craf & Cler	Group 3: Service	Group 4: Elementary	Polarization Index
		Firms with at Least 10 Employees in 2000 & 2009				
Panel A: Separate Bivariate Regressions						
Outsourcing / Offshoring	2SLS	-0.1080	0.1200	-0.0015	-0.0107	-0.18
		(.0696)	(.0662)	(.0223)	(.0591)	(.0992)
	iv_exp	-0.1203				
	iv_imp	0.0727				
	1st Stage F-stat	11.67				
Panel B: Add Basic Firm Level Controls						
Outsourcing / Offshoring	2SLS	-0.0512	0.2742	0.0032	-0.2262	-0.4114
		(.0985)	(.1199)	(0.0333)	(.1078)	(.1799)
	iv_exp	-0.0830				
	iv_imp	0.0865				
	1st Stage F-stat	5.23				
Panel C: Outsourcing in Finland, Abroad versus Planned (Include Basic Controls)						
Outsourcing in Finland	2SLS	-0.0456	0.2077	0.0028	-0.1649	-0.3116
		(.0736)	(.0786)	(.0252)	(.0751)	(.1179)
	iv_exp	-0.1105				
	iv_imp	0.0988				
	1st Stage F-stat	8.82				
Outsourcing Abroad	2SLS	-0.0481	-0.1625	0.0019	0.2087	0.2438
		(.0709)	(.0673)	(.0238)	(.0705)	(.1009)
	iv_exp	0.0793				
	iv_imp	-0.2944				
	1st Stage F-stat	8.60				
Plan to Oursource 2007-	2SLS	0.0149	0.1754	-0.0003	-0.1900	-0.2631
		(.0666)	(.0635)	(.0227)	(.0607)	(.0953)
	iv_exp	-0.1025				
	iv_imp	0.2481				
	1st Stage F-stat	16.38				

* Notes: The size of the sample (firms with 10 employees) in the Sourcing Survey that also have import and export IV data: N=552.
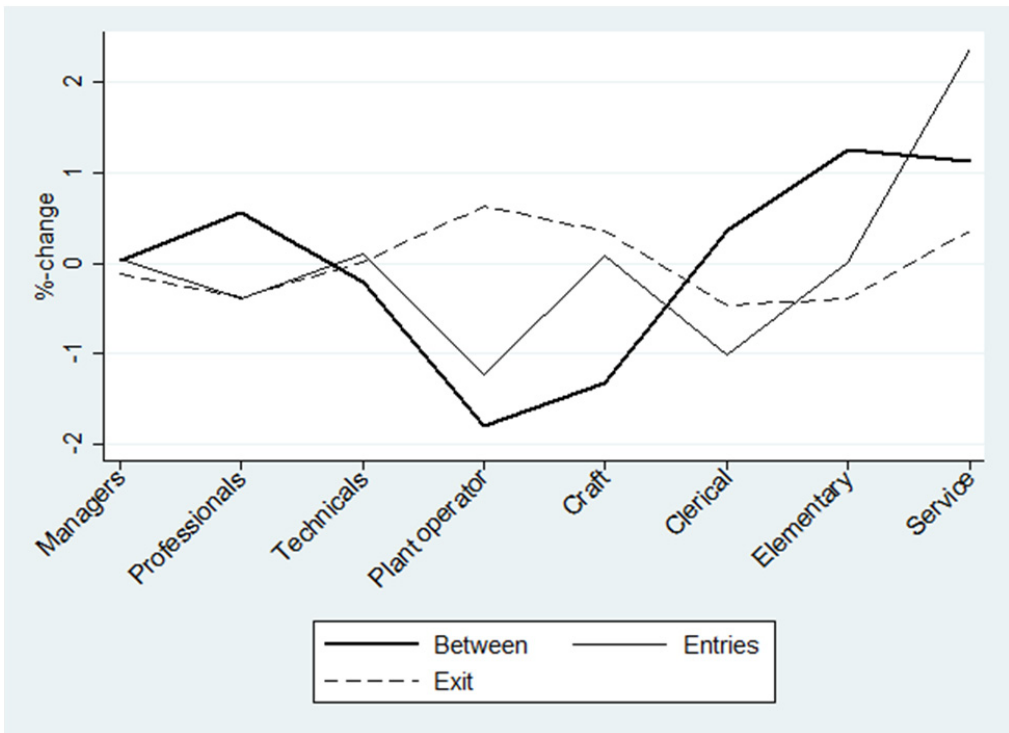
Figure 1: Employment Share by Occupation (2000 vs. 2009 %-Change)

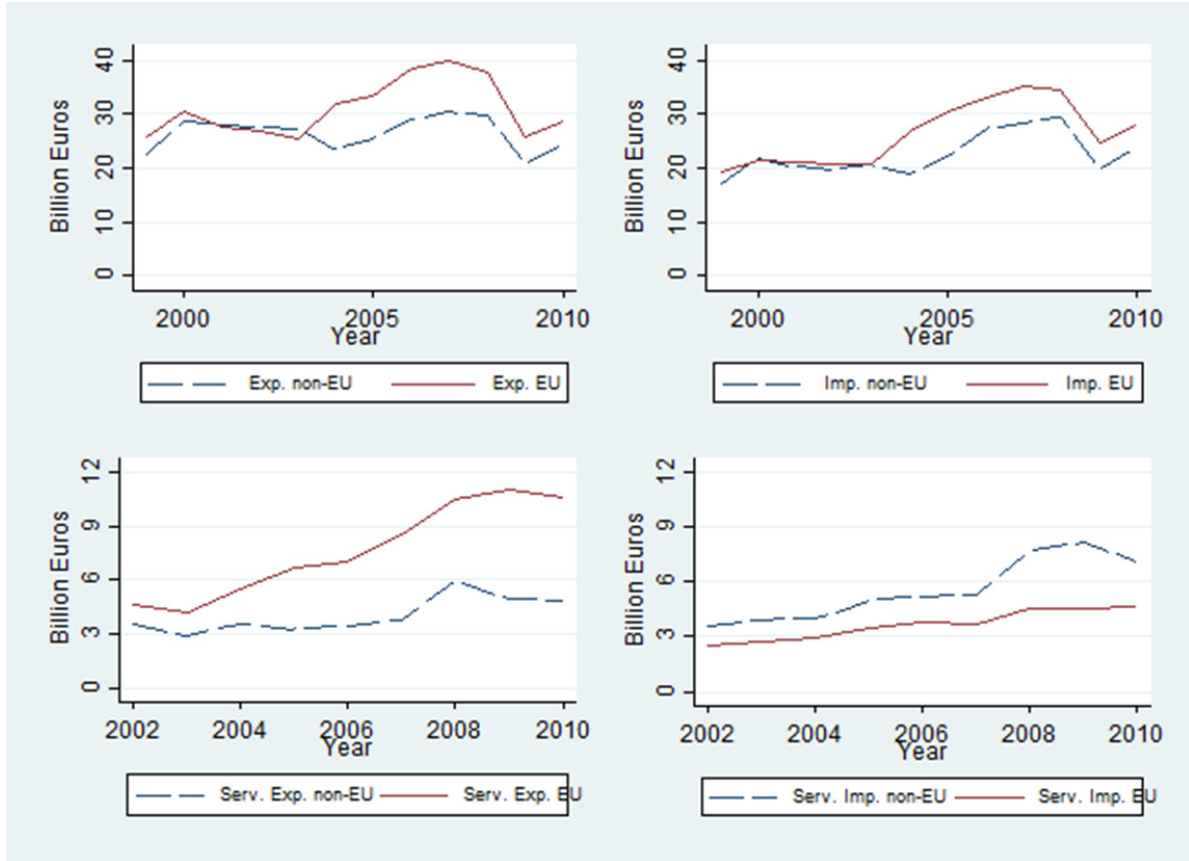**Figure 2: Change of Occupation Share vs. Initial Wage, 2-Digit Level**

Figure 3a: Within-Between Firm and Establishment Decomposition, Total & Within

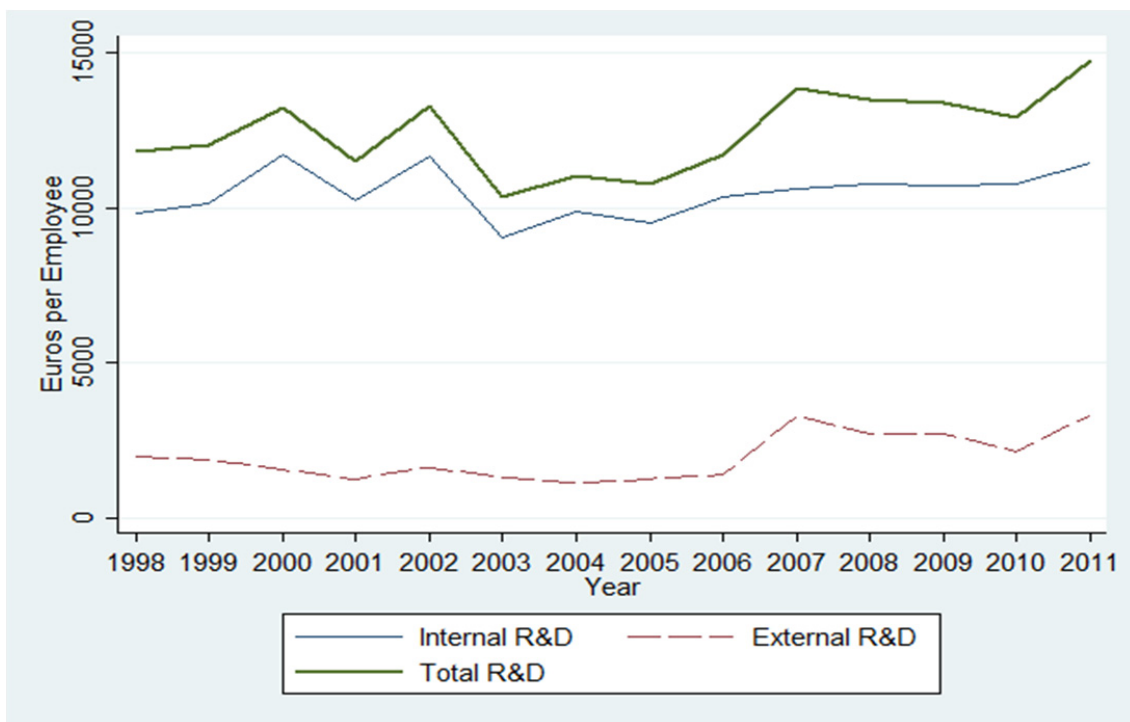**Figure 3b: Within-Between Firm and Establishment Decomposition, Other Components**
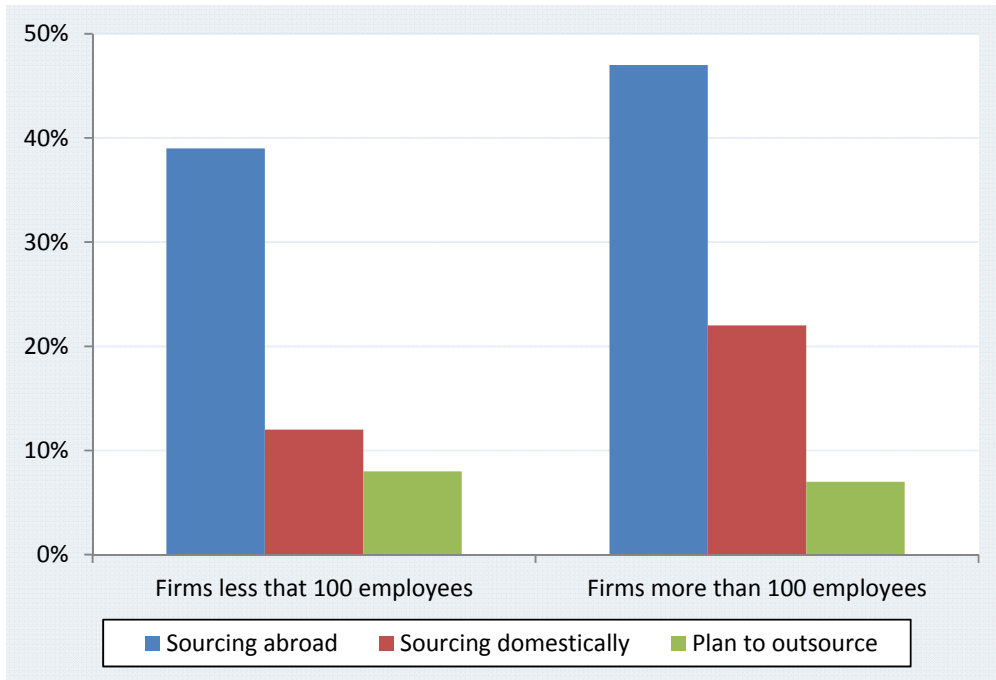
Appendix Figures:

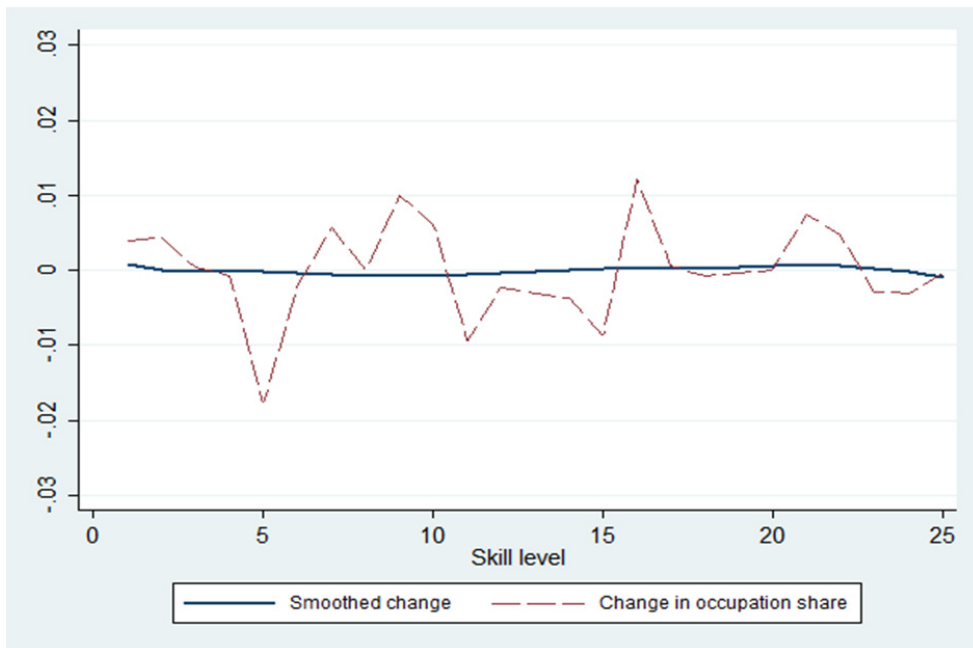**Figure A1: Imports and Exports of Goods and Services (in Billions of Euros)**

Figure A2: Average Share of Employees Using ICT in firms Answering the ICT Survey, 2001-2009

Figure A3: Average R&D Spending per Employee in Firms Answering the R&D Survey, 1998-2011

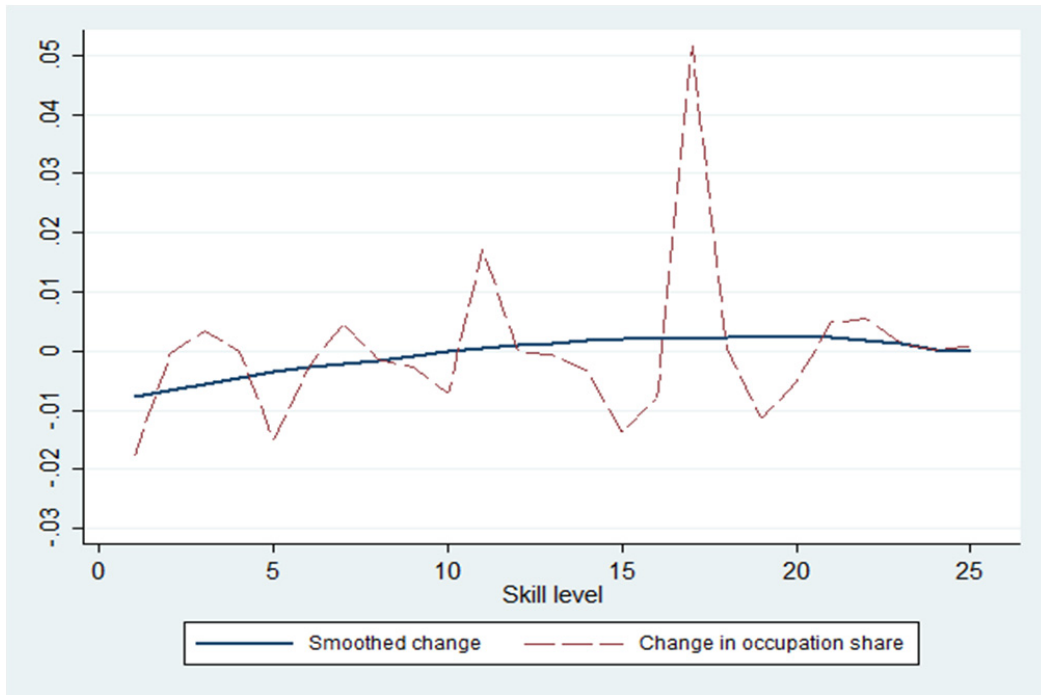**Figure A4: International Sourcing by Location and Firm Size: Actual and Intended**

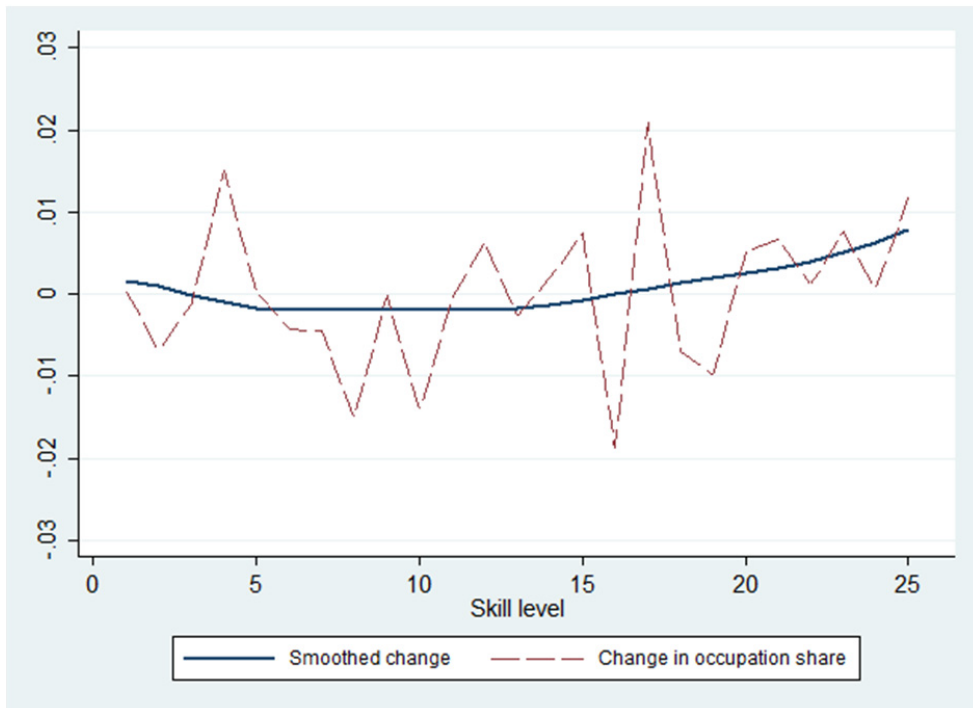**Figure A5: Change of Occupation Share vs. Initial Wage, 1995 to 2000, 2-Digit Level**

Figure A6: Job Distribution by Firm Type in 2000 and 2009

Figure A7: Median monthly wage (2009 euros) by Occupation, 2000-2009
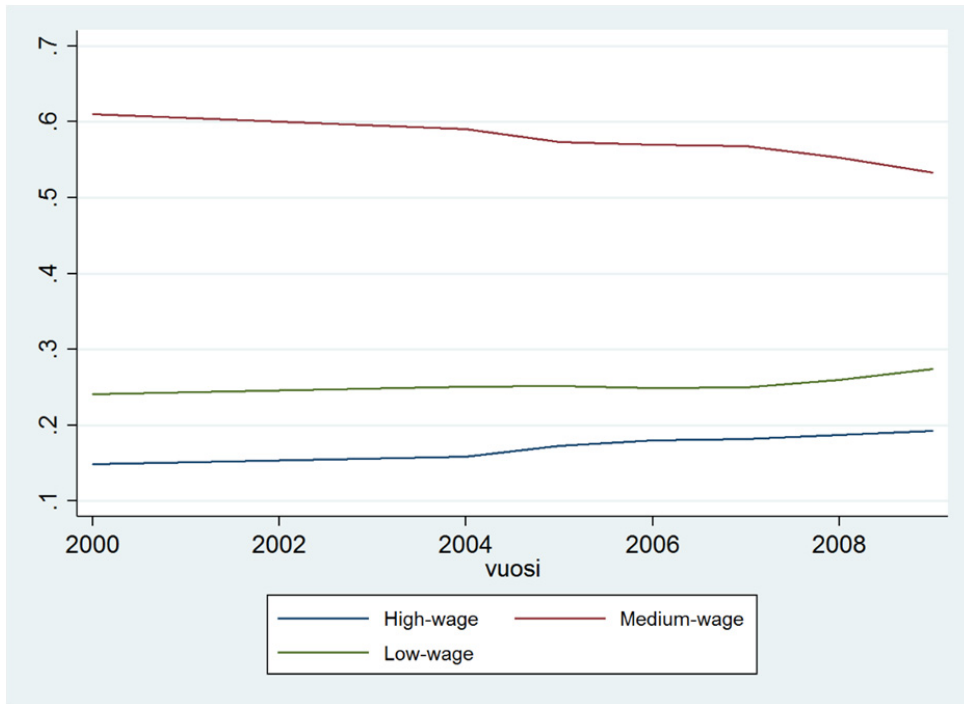**(NOTE: No data available by occupation in 2001-2003)**

Figure A8: Polarization in the Public Sector Between 2000 and 2009, 2-Digit Level

Figure A9: Polarization for Entire Economy (Public and Private Sectors) Between 2000 and 2009, 2-Digit Level

Figure A10: Employment Share by Wage Group, 2000-2009 (Groups Defined by 2000 Earnings)