Do Local Areas Specialize in Activities? Measurement and Exploration of Drivers

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Abstract

This paper uses occupations data to measure specialization of local areas in activities. We use detailed micro data for the Netherlands and find that some urbanized areas, such as Amsterdam and Delft, have a high share of workers involved in R&D and technology development activities, while other urban areas, such as the Zaanstreek and Hilversum, in sales and marketing. Less urbanized areas tend to have a higher share of workers involved in fabrication activities. We examine whether local area changes in occupational employment are related to international re-location of activities and technology investment. The findings suggest only weak significant effects of offshoring lowering demand for administrative and back-office workers. Local area investment in new technologies is significantly related to lower demand for workers involved in fabrication activities.

Keywords: Specialization, Business functions, Offshoring, New Technologies

JEL: F66; J24; R11; R12

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1. Introduction

International fragmentation of production proliferated during past decades, with firms increasingly carrying out specialized activities at specific geographical locations. This allowed local areas to specialize in business functions such as fabrication, research and development, design, branding and distribution (Coe and Hess, 2013). Indeed, Duranton and Puga (2005) show how cities in the U.S. specialize in headquarter functions, while fabrication activities concentrate in less urbanized regions as coordination costs fall. Their analysis was based on U.S. cities and compared the share of management (headquarter) to production workers.

This paper studies specialization in activities across local areas in the Netherlands; a small open economy for which detailed data is available to measure and explore drivers of specialization. We measure specialization in activities using information on the occupations of workers, and aim to move beyond the dichotomous classification of headquarter and fabrication activities across local areas as in Duranton and Puga (2005), by considering trends in eight business functions: R&D; Fabrication; Transport, logistics, and distribution; Sales and marketing; Technology and process development; Administrative and back-office; General and strategic management; and Others.

An 'activity' or 'business function' can be conceived of as a set of tasks carried out by a firm. In theoretical work a 'task' is a narrow stage of production typically modelled as a continuum (Grossman and Rossi-Hansberg, 2008). For empirical analysis we would like to set a level of aggregation that does not preclude measurement. The set of business functions we use appears a relevant level of aggregation as (multinational) firms typically organize their activities around these (Sturgeon and Gereffi, 2009). We define the employment share of an activity in a local area as the number of workers that perform it divided by the total number of workers in that area. This allows us to trace functional specialization across local areas.

Our findings suggest substantial heterogeneity in functional specialization across local areas in the Netherlands. At an aggregate level, where we group occupations into routine and non-routine task-intensive, we find the share of non-routine jobs is higher in urbanized compared to less-urbanized areas and the prevalence of non-routine jobs increased over the period 2006 to 2014. At a more disaggregated level, we uncover substantial cross-area variation in functional specialization, suggesting that grouping activities into headquarter and fabrication hides important differences in local specialization patterns. For example, urbanized areas such as Amsterdam and Delft have a high share of R&D and technology and process development workers, whereas the Zaanstreek and Hilversum have a high share of sales and marketing

workers. Other local areas, such as Delfzijl have a higher share of administrative and back-office workers.

Recent studies suggest that changes on the demand side may affect functional specialization. In particular the impact from globalization and technological change have been emphasized (Autor et al. 2003; Goos et al. 2014; Bramucci et al. 2018).

We explore whether offshoring relates to changes in the workforce composition in local areas. For that, we make use of Global Value Chain (GVC) surveys conducted by the Dutch statistical office. GVC surveys indicate the likelihood to offshore a business function depends on the industry affiliation of the firm as the nature of some industries makes them more prone to offshoring compared to others. In general, manufacturing firms are more likely to offshore compared to services firms (Möhlman and de Groot, 2013). But also within manufacturing, we find substantial differences in the likelihood to offshore. Firms in manufacturing industries like computers, electronic and optical products manufacturing, and motor vehicles and other transport equipment manufacturing are more likely to offshore fabrication activities compared to firms in food, beverages and tobacco manufacturing. In industries like the manufacturing of coke, petroleum, chemical and pharmaceutical products we observe a higher propensity to offshore R&D activities compared to other manufacturing industries.

Local areas in the Netherlands differ in industry specialization. Combining this with the insight that the likelihood to offshore business functions differs across industries, one may argue that workers in local areas are expected to be exposed to offshoring depending on the industry composition of that local area. For example, workers involved in fabrication activities in a local area that manufactures transport products (an industry in which offshoring of fabrication activities is more prevalent, see above) are expected to be more exposed to offshoring compared to fabrication workers in a local area that manufactures processed food and beverages (an industry where offshoring of fabrication activities is less prevalent). To examine the relation between offshoring and demand for workers involved in business functions across local areas, we econometrically exploit cross-area variation in offshoring exposure stemming from local area differences in industry composition.

Contemporaneous to the offshoring of activities has been rapid advancements in information and communications, artificial intelligence and other technologies, which have changed the way in which certain tasks are being performed. Autor et al. (2003) argue that computers and robots tend to displace labor in the performance of routine and non-cognitive tasks. This is typically referred to as routine-biased technological change (Goos et al. 2014) and is expected to lower

employment demand for routine task-intensive occupations, such as fabrication and administrative and back-office occupations, relative to non-routine task-intensive occupations. To capture these effects, we include various measures of technological change in our econometric analysis, where we use data on investment in R&D and investment in information and communication technologies in local areas.

Our findings suggest that offshoring is not significantly related to functional specialization patterns in local areas. Only for administrative and back-office occupations we find a (weakly) statistically significant relation between offshoring and reduced labor demand. In contrast, investments in R&D and information and communication technologies relate significantly to a decline in fabrication jobs. One way to interpret these results is that the effects from technology on employment changes come out stronger compared to the effects from offshoring (see also Michaels et al. 2014; Goos et al. 2014; Bramucci et al. 2017). Offshoring may not significantly relate to reductions in employment (see e.g. Temmink and Lemmers, 2015), or offshoring of fabrication activities may not significantly influence fabrication jobs when the composition of fabrication activities changes, but not its overall size. For example, a firm may offshore its assembly activities but expand other fabrication activities, such as customized work and the provision of critical parts and components such that the overall size of fabrication activities carried out does not change (Berghuis and den Butter, 2013).

This paper is related to several strands of literature. First, it relates to the literature on offshoring and onshore labor market outcomes, which includes industry level studies (Feenstra and Hanson, 1997, 1999; Hsieh and Woo, 2005; Hijzen et al, 2005; Michaels et al, 2014), firm level studies (Biscourp and Kramarz, 2007; Amiti and Davis, 2011; Mion and Zhu, 2013) and the recent matched worker-firm studies (Martins and Opromolla, 2009; Liu and Trefler, 2011; Ebenstein et al, 2014; Hummels et al, 2014). Second, this paper is related to the literature on technological change and the demand for labor. Berman et al. (1994) examine the driving force of changes in the demand for skilled labor in US manufacturing. They find that computerization and R&D account for the demand shift towards high-skilled workers. Machin and van Reenen (1998) provide further empirical evidence for technology and changes in the skill structure in OECD countries, where R&D intensity is strongly related to increased demand for high-skilled workers. Reijnders and de Vries (2017) find that technological change has a stronger effect compared to offshoring in increasing demand for non-routine relative to routine jobs. Third, this paper closely relates to an emerging literature that examine outcomes in local areas (Autor et al. 2013; Gagliardi et al. 2015). Indeed, our measure of local area offshoring exposure is a variant in a

stream of literature initiated by Autor et al. (2013). Fourth, GVC surveys have been used to examine the impact on firm productivity ((Möhlman and de Groot, 2013). In contrast to earlier studies, we examine local area functional specialization patterns and use GVC surveys to examine whether specialization relates to offshoring. This is a novel approach to characterize the sub-national workforce composition and examine the impact of offshoring and technology on occupational employment in local areas.

The remainder of this paper is organized as follows. Section 2 presents trends in functional specialization in local areas in the Netherlands. Section 3 describes the GVC survey and other data used. Section 4 outlines the methodological approach, and section 5 describes empirical results. Section 6 provides concluding remarks.

2. Functional specialization in local areas

This section describes trends and patterns in functional specialization across local areas in the Netherlands. Consider first aggregate trends in the employment share of routine and non-routine task-intensive occupations. Figure 1 presents the employment share of routine and non-routine jobs between 2006 and 2014. In 2006, about 73 percent of jobs were considered non-routine jobs, whereas only 27 percent of occupations were classified as routine task-intensive. Over time, there is a decline in the employment share of routine jobs to 21 percent in 2014.

The rise of non-routine jobs is consistent with the cross-country literature (see e.g. Goos et al. 2014; Reijnders and de Vries, 2017) and country-specific studies of the labor force for the Netherlands (Den Butter and Mihaylov, 2013; Smits and de Vries, 2015). Our findings suggest the share of non-routine jobs in the Netherlands is higher compared to other countries, like Germany which traditionally has had a stronger focus on manufacturing activities (Senftleben and Wielandt, 2014) compared to logistics and other services activities in the Netherlands.

[Insert Figure 1 about here]

The declining employment share of routine jobs is related to a decline in routine task-intensive fabrication and administrative jobs, see Figure 2. In contrast, demand for non-routine task-intensive occupations, like those related to R&D and technology development, sales and marketing, and management activities have grown over time.[3]

[3] The classification of occupations to activities is discussed in section 3.

[Insert Figure 2 about here]

To what extent are these aggregate trends in the job structure also observed across local areas in the Netherlands? The literature mainly focuses on country trends, but studies suggest that aggregate patterns need not be representative of what is observed at the sub-national level (Autor et al. 2013; Gagliardi et al. 2015; Terzidis et al. 2017).

Figure 3 provides a choropleth map of routine and non-routine employment shares across 40 local areas in the Netherlands in 2014. These 40 areas refer to the Nomenclature of Territorial Units for Statistics, level 3, or in short NUTS 3 local areas. For the Netherlands, this local area classification was developed on the basis of commuting flows. If the majority of the population lives and works in an area, this determines the identification of the local area.[4] The areas are considered to be a reasonable approximation for the Netherlands (Groot et al. 2014), but given the small area size of the Netherlands this can be contested (Terzidis et al., 2017), an issue further discussed in section 5.

Panel (a) of Figure 3 shows routine employment shares across local areas. Darker shaded areas indicate a higher routine employment share, lighter shaded areas a lower routine employment share. Panel (b) is the mirror image of panel (a) and shows the employment share of non-routine jobs. We find clear differences in the employment share of routine jobs across local areas. Areas in the North, the East and parts of the South have a higher routine employment share compared to areas in the West and the Center of the Netherlands. In these more urbanized areas in the West and the Center of the Netherlands (called the 'Randstad' region, primarily consisting of the four largest Dutch cities and their surroundings) non-routine employment shares are higher, reflected in the darker shaded areas in panel (b) of Figure 3. These findings for the Netherlands are in line with earlier research by Duranton and Puga (2005) for the US. Duranton and Puga (2005) show how cities in the U.S. specialize in non-routine management activities, while routine-intensive fabrication activities tend to concentrate in less urbanized regions.

[Insert Figure 3 about here]

Table 1 characterizes the functional specialization in local areas. The table shows occupational employment shares in eight business functions across local areas in 2014 (Appendix Table 4

[4] The 40 areas are called COROP regions and were developed on the basis of commuting flows by the COördinatiecommissie Regionaal OnderzoeksProgramma (the Coordination Commission Regional Research Program). The COROP classification of 40 local areas lies in between the classification of 12 Dutch provinces and over 400 municipalities.

shows functional employment shares in 2006). The shares sum to 100 percent over the columns. The bottom row shows the functional employment share in the Netherlands, which is a weighted average of the local area functional employment shares.

We document substantial variation in functional specialization across local areas. One measure of specialization, the location quotient, compares the local area functional employment share to the weighted average functional employment share in the Netherlands. A Location Quotient (LQ) above (below) 1 suggests the activity is more (less) concentrated in the local area than average. The employment share of R&D workers is high in Groot-Amsterdam (11,3 percent versus 8,2 on average, so an LQ of 1.4), Agglomeration 's-Gravenhage (LQ is 1.3) and Delft and Westland (1.3), especially in comparison to Oost-Groningen (0.4) and Noord-Friesland (0.6)

In local areas in the North of the Netherlands, like Zuidwest-Friesland and Kop van Noord-Holland, we find higher shares of workers involved in fabrication activities (an LQ of 1.5 and 1.6 respectively). The share of fabrication jobs is lowest in Agglomeration Haarlem (0.5) and in Agglomeration 's-Gravenhage (0.5).

The share of transport, logistics and distribution jobs is high in Delfzijl and surroundings (2.0) and Zaanstreek (1.8). Also, in Zaanstreek about a fifth of workers are involved in sales and marketing activities. The agglomeration 's-Gravenhage has a high share of R&D workers, but also of general and strategic management jobs (an LQ of 1.4). This contrasts to the Zaanstreek that has a high share of transport and logistic jobs as well as sales and marketeers, but a much smaller share of management jobs (an LQ of 0.7).

Overall, our use of information on the occupations of workers reveals substantial differences in functional specialization across local areas. What drives these job structure patterns? Two key explanations that we discussed in the introduction relate to the role of technological change and offshoring of activities (Autor et al. 2003; Michaels et al. 2014). In the remainder of this paper we aim to exploit cross-area differences in industry specialization to examine the role of offshoring and technological change. The next section first describes data sources and documents trends in offshoring of business functions before turning to the econometric analysis in section 4.

[Insert Table 1 about here]

3. Data

For the empirical analysis we make use of three micro data sources from Statistics Netherlands. In section 3.1 we describe the Labor Force Survey (LFS) used to measure functional specialization in local areas, and we describe the data on investment in R&D, computer assets and software by local areas. Section 3.2 describes the regional enterprise database, which we use to obtain information on the industry composition of local areas. In section 3.3, we describe the Global Value Chain survey, which provides information on the offshoring of business functions by firms.

3.1 Labor Force Surveys and investment data

Information on the occupations and other characteristics of individuals are obtained from the Labor Force Survey (LFS). The LFS is a continuous quarterly survey of the Dutch population aged between 15 and 65 years. It is a rotating survey and in principle each individual participates for 5 consecutive quarters in the survey and then drops out.

The sampling framework of the LFS is based on the geographical base register. This register includes all addresses by postal code in the Netherlands. The survey base includes a set of addresses drawn up by postal code in combination with the population register. Only private households are included in the sample. The sampling plan is a two-stage stratified probability sample of addresses: the primary sampling units are the municipalities and the secondary sampling units are the (snail-)mailing addresses. Municipalities are selected with a probability proportional to their population and mailing addresses are selected systematically from a mailing list sorted by postal code. In each quarter, the sample consists of around 50,000 households, which corresponds to a quarterly population sampling rate of about 0.7%. The variables we use from the LFS are information on the occupation, age, gender, education, and location of work for each individual. `

Individuals report on their location of work in the first quarter of the LFS during the years up to 2009 and from 2010 onwards they report the location of work in the second quarter of the LFS. For the construction of our variables, we therefore use information from the first quarter of the LFS for the period up to 2009 and from 2010 onwards from the second quarter of the LFS. This sub-sample selection deals with the issue of missing information of working addresses in the other quarters, and also gets rid of redundant information on the same

individuals over successive quarters. We exclude workers who live in the Netherlands, but work abroad.[5]

An important step in our analysis is the mapping of occupations to particular activities, such as mapping occupations into fabrication, administrative and R&D activities. We map occupations into the set of activities put forth by Sturgeon and Gereffi (2009), itself based on Porter (1985). Our mapping of occupations to these activities is exhaustive. Some occupations are hard to assign to a particular activity. These are put into the category 'others'. Appendix table 2 displays the mapping of each occupation to a particular activity. Consider the following examples. Electro technology engineers are mapped into research and development of products, services, or technology activities. Machinery mechanics and repairers are mapped into fabrication activities. Sales, marketing and public relations professionals are mapped into sales and marketing activities.

We consider eight functions: R&D; Fabrication; Transport, logistics, and distribution; Sales and marketing; Technology and process development; Administrative and back-office; General and strategic management; and Others. Occupations related to fabrication, administrative and back-office activities are considered routine jobs. Jobs in other activities are considered non-routine jobs. This approach differs from other studies that use information on the task composition of occupations to classify jobs as routine or non-routine task intensive, see e.g. Den Butter and Mihaylov (2013) for the Netherlands. However, by mapping activities to routine and non-routine we keep a direct link between both approaches. The descriptive analysis in section 2 suggests that aggregate trends in the employment share of routine jobs thus identified are similar to studies that use alternative classification approaches.

The idea to use occupational data to identify activities is novel but not new, as it has been considered in previous empirical work. Bernard et al. (2017) identify activities by Danish firms and examine functional specialization patterns of firms that switch out of manufacturing into services. Maurin and Thesmar (2004) study the business activity structure of French manufacturing firms using information on the occupations of workers. Duranton and Puga (2005) show how cities in the U.S. specialize in management activities based on the occupational structure of the labor force. For the Netherlands, Berghuis and den Butter (2013) discuss how occupations listed in the standardized classification of occupations may relate to business activities of firms on the basis of their own survey and interviews, although they do

[5] We also exclude individuals who are unemployed or not in the labor force. The final sample size we use is about 30,000 workers annually.

not empirically implement it as we do here.

The LFS data allows us to estimate the functional employment share in each of the 40 local areas. To obtain the number of jobs in business function *b* in local area *a* at time *t*, denoted $Y_t^{a,b}$, we multiply the business function shares we estimate from the LFS for each local area with the number of full-time equivalent (fte) jobs by local area.[6]

Two potential determinants of changes in the functional employment structure are offshoring and technological change. To examine the effect of technological change, we consider two indicators reflecting investments in computer software and innovation in constant prices (identification of the impact of offshoring on local areas is discussed below). The Dutch statistical office collects information on fixed capital formation in computer software and databases, as well as investment in R&D. These data are available annually for each of the 40 local areas. Fixed capital formation measures the value of acquisitions of new or existing fixed assets by the business sector less disposals of fixed assets. Specifically, fixed capital formation of computer software and databases includes investment in computer programs, program descriptions and supporting materials for both systems and applications of software. The initial development and subsequent extensions of software and acquisition of computer software assets are also included. R&D incorporates the value of expenditure on creative work undertaken on a systematic basis in order to increase the stock of knowledge and use of knowledge to devise new applications.

3.2 The regional enterprise database

We use the regional enterprise database to measure the industrial employment composition in local areas (see also Groot et al. 2014). The regional enterprise dataset provides yearly information of all active local business units (LBU). A LBU corresponds to one or more subdivisions of an enterprise (e.g. a factory, warehouse, or office), which is located in a geographically identifiable place. An enterprise may consist of one or more LBUs, and in principle, each of the LBUs can be linked to a different sector. The postal code of the LBU is a full code with six characters, with which regional divisions can easily be made.

In order to measure the industry composition in local areas, we aggregate information from the LBUs. The main variables we take from the regional enterprise database are: 1) The

[6] The number of full-time equivalent (fte) jobs by local area are available from the statistical office at http://statline.cbs.nl/Statweb/.

number of people employed by the enterprise in the relevant statistical year; 2) A distribution key, which is the percentage of persons employed by the LBU with respect to the entire business unit (BU); 3) Industry classification, which is the code for main economic activity of the LBU, according to the 2008 Standard Industrial Classification. Combining the above information, we are able to measure the employment shares by sector in each local area. We will denote this as $Employment\ share_t^{a,s}$, which is the employment share of sector *s* in local area *a* at time *t*, where $\sum_{s=1}^{S} Employment\ share_t^{a,s}=1$.

Local areas differ substantially in their industry composition. For example, the East-Groningen area (in the North East of the Netherlands) has a different employment composition compared to the Greater Amsterdam area. The share of workers employed in manufacturing is 19.43 percent in East-Groningen compared to 4.98 percent in Amsterdam. Vice versa, Amsterdam has a much bigger business service sector compared to East-Groningen, e.g. the employment share of information and communication services is about 8.5 percent in Great-Amsterdam but only 1 percent in Eastern-Groningen.[7] We will exploit these cross-area variations in industry specialization in our empirical analysis below.

3.3 Global value chain surveys

The third source of data are the Global Value Chain (GVC) surveys. In this study, we use the 2007 and 2012 GVC survey. These surveys provide unique information on the international sourcing of business activities by Dutch firms. For the GVC survey, Statistics Netherlands surveys firms with 100 or more persons employed, which results in a target population of about 4,600 enterprises. The 2007 (2012) GVC survey includes a representative set of responses from 1,002 (1,370) enterprises.

The relevant question in the GVC survey that we use to approximate offshoring is: *did your enterprise group internationally source a certain business activity in the period <2001-2006> (2007 GVC survey) or <2009-2011> (2012 GVC survey)?*[8] The survey defines international sourcing as the total or partial movement of business functions currently performed in-house or currently domestically sourced by the resident enterprise to enterprises within or outside of the enterprise group located abroad. If the answer on offshoring is yes, enterprises are further asked

[7] Employment shares by sector for each local area are not shown, but available from the authors upon request.
[8] The period refers to 2001 to 2006 in the 2007 GVC survey and 2009 to 2011 in the 2012 GVC survey. See Sturgeon et al. (2013) for more information on the GVC survey.

about what type of business function(s) they offshored. Here, the GVC survey distinguishes between core and support functions. The core business function is the main business activity of the enterprise, related to the production of a final good or service. Support functions are conducted by enterprises in order to facilitate production of final goods or services, these include activities such as distribution and logistics; marketing, sales and after sales services; ICT services; administration and management; research and development, engineering and related technical services, and other support functions. Note these business functions closely correspond to the characterization of the functional specialization in local areas. This is no coincidence as the same literature on business functions (Porter, 1985; Sturgeon and Gereffi, 2009) was used to guide these questions in the GVC survey.[9]

The measure of offshoring that we obtain from the GVC surveys is imperfect, since it is a binary measure and it is measured over a relatively large time frame. From the 2007 GVC survey (2012 GVC survey), we only know whether a firm offshored between 2001 and 2006 (between 2009 and 2011), but not when it actually happened and by how much. In addition, one cannot observe whether a firm outsources only once or multiple times during this period. These limitations affect identification of effects from offshoring on functional specialization.

The shares of firms that offshored internationally are shown for each business function in Table 2. Not surprisingly, most international sourcing was in fabrication activities (9.7 percent of firms in the 2007 GVC survey, 4.5 percent in the 2012 GVC survey). But 4 percent of firms report they internationally sourced ICT services in the 2007 wave of the GVC survey (3.2 percent in the second wave). 3.4 percent of firms engaged in offshoring reported offshoring of administrative and management services in the first wave of the GVC survey (3.1 percent in the second wave). It suggests that international sourcing of fabrication activities is still the most important among all sourcing activities, but non-negligible offshoring of other activities also occurs.

[Insert Table 2 about here]

The GVC surveys allow us to construct a measure of the likelihood of firms to offshore a particular business function. This likelihood, or propensity, to offshore a business activity, $Offshoring\ propensity_t^{b,s}$, is calculated as the number of firms in sector *s* that reported in the GVC survey they offshored business function *b* divided by the total number of firms in this

[9] An exception is administrative and back-office activities, which are not distinguished from management activities. In our empirical analysis we measure the likelihood to offshore these combined activities, but separately examine their effects on demand for administrative and back-office jobs and management jobs.

industry *s*.[10] We use the total number of firms in industry *s* that report in the GVC survey. So if 5 out of 20 firms in sector *s* report they offshored business activity *b*, the offshoring propensity of that activity in sector *s* is 5/20=0.25. This is an unweighted offshoring propensity measure. In what follows we consider a weighted offshoring propensity measure, where we weigh by firm's employment size for our baseline estimates and examine whether results are different from unweighted. For several services sectors and also for agriculture and mining we do not observe information on offshoring propensity, because no firms active in these sectors were included in the GVC survey. These sectors of the economy are excluded from the analysis.[11]

Table 3 shows the offshoring propensity by industry and business activity based on the 2007 GVC survey (see Appendix Table 3 for offshoring propensity based on the 2012 GVC survey). The propensity to offshore differs across industries, as the nature of some industries makes them more prone to offshoring compared to others. For example, using the 2007 GVC survey, Möhlmann and de Groot (2013) show that outsourcing by firms that provide business services is lower compared to manufacturing firms (reported in column 1 of Table 3), which is somewhat unsurprising since manufacturing firms are able to offshore fabrication activities and their products tend to be more internationally contestable.[12] However, within manufacturing industries we find substantial variation in offshoring propensity. For the 2007 GVC survey we find that firms in industries like manufacturing of computers, electronic and optical products (a weighted offshoring propensity measure of 0.577), manufacturing of machinery and equipment (0.417) and manufacturing of motor vehicles and other transport equipment (0.401) have the highest propensity to offshore fabrication activities.[13] In other industries, such as the manufacturing of coke, petroleum; chemical and pharmaceutical products we observe a higher

[10] The GVC survey only covers large enterprises. This may lead to an overestimation of the sourcing propensity because of a positive correlation between firm size and international sourcing behavior (Hummels et al. 2014). Note however that in the empirical analysis below we will compare the effects of international sourcing on employment across local areas, and therefore instead of using absolute international sourcing propensity (which is biased upwards due to the coverage of only large firms), we compare relative exposure to international sourcing across local areas (which is less likely to be biased).

[11] Sectors not included in the analysis are: Agricultural; Mining and quarrying; Financial institutions; Public administration, Public services and compulsory social security; Education; Human health and social work activities; Culture, sports and recreation; Other service activities; Private households with employed persons; and Extraterritorial organisations and bodies.

[12] Column 1 in Table 3 suggests that services firms also offshore fabrication activities. Note that fabrication activities refer to the core activity of the firm, which in this case is the provision of a service.

[13] If we do not weight by firm size, offshoring propensity of motor vehicles and other transport equipment manufacturers (0.435) tops all other sectors. Offshoring propensity of computers, electronic and optical products (0.278) and manufacturing of machinery and equipment (0.288) are lower compared to the weighted measure, but still rank in the top 3.

propensity to offshore R&D activities (0.422). These offshoring propensity estimates are much higher compared to what is observed for most other industries shown in Table 3.

[Insert Table 3 about here]

The next sections use the differences in the propensity to offshore business activities across industries. Local areas differ in terms of their industry composition, which we discussed in section 3.2. Since the propensity to offshore a business activity differs across industries, this will result in differential exposure of local areas to offshoring depending on their industry composition.

4. Methodology

To examine the exposure of local areas to offshoring, we follow the methodological approach developed in Autor et al. (2013) and Gagliardi et al. (2015) and adapt it to our context. Local areas specialized in industries that face a higher likelihood that activities are re-located are relatively more exposed to offshoring. Formally, we measure local exposure to offshoring of a business function as follows:

$$Offshoring\ Exposure^{a,,b,t0} = \sum_s \left(Employment\ share^{a,s,t0} * Offshoring\ propensity^{b,s} \right), \qquad (1)$$

where $Offshoring\ Exposure^{a,b,t0}$ is our preferred measure of local area *a*'s exposure to offshoring a certain business function *b* at initial time t_0. This measure is constructed as an interaction term. It takes into account the conditional effect of the initial industry composition of local areas *a*, $Employment\ share^{a,s,t0}$, on offshoring propensity by industry *s* and business function *b* ($Offshoring\ propensity^{b,s}$).

Since we have two editions of the GVC survey, we estimate initial local exposure to offshoring for t_0=2006 using offshoring propensity from the 2007 GVC survey and for t_0=2011 using offshoring propensity from the 2012 GVC survey. In our econometric analysis we examine whether this initial exposure is associated with changes in the local functional employment structure in subsequent years. We relate the 2006 initial exposure to occupational employment changes for the years 2006 to 2008, and the 2011 initial exposure to changes in the period from 2011 to 2013.

Constructed this way, the variable meets certain exogeneity conditions. That is, it attributes a national trend (offshoring propensity identified using the GVC surveys) to local

areas on the basis of their initial industry composition. This limits simultaneity concerns between industry composition and offshoring. However, it is possible that the identification of effects is driven by omitted variables. To alleviate this concern, we include local are investments in ICT or R&D and control variables.

Our econometric estimation strategy follows Gagliardi et al. (2015) and takes the following reduced form regression:

$$\Delta Y^{a,b,t} = \alpha + T^t + \beta * Offshoring\ Exposure^{a,b,t0} + \theta * Tech\ inv^{a,t0} + \gamma * X^{a,t0} + \varepsilon^{a,b,t}. \quad (2)$$

$\Delta Y^{a,b,t}$ is the dependent variable that measures the average annual growth rate of jobs involved in business function *b* in local area *a*. We pool the average annual growth rate of jobs in activity *b* in area *a* during the period t=2006-2008 and t=2011-2013, and include a time dummy T^t. Standard errors are conservatively clustered at the provincial level, since errors are potentially correlated within provinces due to agglomeration of activities. Initial $Offshoring\ Exposure^{a,b,t0}$ is the exposure of region *a* to the offshoring of a particular activity *b* at the start of the period examined. The effect from *Technology investment* is measured using information on (the log) investment by local areas in computer assets, software and databases or (the log) R&D investment in the initial year of the period considered (t_0=2006 or t_0=2011).

X includes a set of local area control variables. In Gargliardi et al. (2015), the share of young and high-skilled workers positively and significantly correlate with the number of non-routine jobs but insignificantly correlate with routine occupations. This suggests experience and education of workers matter for the occupational employment composition. We include these control variables in our econometric analysis. The variable for young workers is measured as the share of young workers (aged between 15 and 35) in the working population; the share of high-skilled workers is measured as the number of workers with high educational attainment divided by the working population. These shares are local-area specific.

Table 4 shows descriptive statistics of the variables used in the econometric analysis. Our dependent variable is the local area annual employment growth in a business activity during the period 2006-2008 and 2011-2013. This growth rate shows substantial variation across local areas and was on average positive in (non-routine) activities like R&D, sales and marketing,

and management activities. The average growth rate was negative for (routine) fabrication and administrative activities. Our estimate for offshoring exposure also differs across local areas and is highest for fabrication activities (0.055), and is also high for R&D activities (0.046). ICT investment and R&D investment shows substantial variation across local areas. For example, R&D investment is 1,352 million euros in Groot-Amsterdam in 2011 and only 26 million in Delfzijl and surroundings in 2011. Our control variables, the share of young and high-skilled workers, also show substantial variation across local areas where it is noticeable that the share of high-skilled workers is higher in the more urbanized areas in the West and Center of the Netherlands.

[Insert Table 4 about here]

5. Results

5.1 Basic results

Table 5 shows regression results based on equation 2, where we distinguish between the local area growth rate in routine and non-routine jobs. Offshoring exposure is measured on the basis of the offshoring propensity of routine business functions (in columns 1 to 3) or offshoring propensity of non-routine business functions (columns 4 to 6). We find no statistically significant relation between the initial exposure of local areas to offshoring and subsequent changes in routine jobs (the first three columns in Table 5). Our findings do suggest that initial offshoring exposure negatively and significantly relates to demand for non-routine jobs (see column 5). This is suggestive evidence on the employment effects from offshoring support activities. For example, Amiti and Wei (2009) have pointed at the small but rapid expansion of support services offshoring and studied their implications for employment in the US. However, it should be noted that this effect from initial offshoring exposure is insignificant in alternative model specifications (e.g. in column 6). The offshoring effect is also insignificant when we do not weigh offshoring propensity by firm size. This suggest offshoring is only weakly related to routine and non-routine employment changes across Dutch local areas.

The level of initial investment in R&D is significant and negatively related to demand for routine jobs. Vice versa, initial investment in R&D is positively and significantly related to subsequent changes in the employment share of non-routine jobs. Our other proxy for investment in new technologies (ICT investment, see column 4) also suggests a positive relation

to the share of non-routine jobs.[14] These findings are in line with other studies that emphasize the role of investment in new technologies in relation to the demand for non-routine relative to routine task-intensive occupations (see e.g. Autor et al. 2003; Michaels et al. 2014; Goos et al. 2014).

[Insert Table 5 about here]

In Table 6 we report regression results where the change in jobs by business function is the dependent variable. Note that offshoring exposure is measured here using offshoring propensity by business function, so this analysis examine the relation between initial exposure to offshoring of a business function and subsequent changes in the demand for jobs involved in that function. For most activities, we do not find a significant relation between changes in jobs and offshoring. An exception appears administrative activities, where we find that a higher initial local exposure to offshoring administrative activities relates negatively and significantly to subsequent employment changes for administrative jobs. This finding, however, is only significant at a 10 percent level of significance.

The limited significant results on the relation between offshoring and functional employment changes could imply that offshoring is not related to a decrease or increase in jobs (for this, see also Temmink and Lemmers (2015) with firm-level findings for the Netherlands). When firms offshore activities, they may lower costs and thereby improve their competitiveness, resulting in an initial reduction in employment but a later expansion of production and employment (Grossman and Rossi-Hansberg, 2008). Offshoring an activity may also induce a change in the composition within that activity, but no overall change in jobs involved in the activity. For example, the composition may shift away from assembly towards other fabrication activities, such as customized work and the provision of critical parts and components (Berghuis and den Butter, 2013).

Local areas with a higher share of young workers tend to have higher growth in R&D jobs as well as in jobs related to technology development, administrative and management activities. The share of high-skilled workers does not appear to relate significantly to changes in business function jobs, except for administrative jobs.

Investment in R&D significantly relates to reduced demand for fabrication jobs. This finding is in line with our finding in table 5, suggesting that R&D investment is thus related to reduced demand for routine fabrication activities. The predicted effect from R&D investment

[14] The positive relation between ICT investment and demand for non-routine jobs remains statistically significant, also if we include the control variables.

on changes in fabrication jobs is higher in local areas that invested more in R&D, such as Groot-Amsterdam and Utrecht. Less urbanized areas, such as Oost-Groningen and Zuid-west Friesland, where we documented higher shares of jobs involved in fabrication activities (see section 3) invest less in R&D and therefore the predicted effect is smaller in these areas. This suggests functional specialization patterns across local areas tend to be amplified by investments in new technologies.

[Insert Table 6 about here]

5.2 Extensions

In Table 7 we consider several extensions of the empirical analysis. Columns 1 and 2 regress offshoring exposure and initial R&D investment on local area employment growth rates of low- and high-skilled workers. We do not find significant effects, also in specifications where we consider initial ICT investment instead of R&D investment (not shown, results available upon request). Empirical findings for a dichotomous classification of workers by skills in Table 7 suggest recent technological change has a stronger effect on occupations with a higher routine task-intensity (see Table 5), which is not picked up when characterizing workers by educational attainment. This suggests that the approach put forth here is a fruitful avenue to better understanding the labor market impacts of automation and other new technologies.

[Insert Table 7 about here]

The final columns in Table 7 examine the effect of offshoring and technological change on unemployment and the working age population in local areas. For the effects of unemployment, we do not have strong a priori expectations, although recent research suggests that offshoring and technological change may contribute to an increase in unemployment in local areas (Autor et al. 2015). We do not find statistically significant relations.[15]

In section 2 we discussed the use of local areas for our empirical analysis. The classification of the 40 local areas in the Netherlands were developed on the basis of commuting flows. However, given the small area size of the Netherlands and its well-developed infrastructure, part of the workforce commutes and lives in a different area as to where they work (Terzidis et al. 2017). As a result, local employment effects from exposure to offshoring and technological change may diffuse across space when workers relocate to a different local area after layoff. To explore whether COROP regions provide a reasonable approximation, we

[15] We obtain similar results if we use percentage points changes in unemployment across local areas.

regress offshoring and investment in new technologies on the size of the working-age population in local areas. If offshoring and technological change do not relate to the size of the working-age population, local employment effects are less likely to spatially diffuse. Offshoring exposure and R&D investment are not significantly related to the working-age population in local areas. This suggests that employment effects due to offshoring and technology investment do not lead to a significant relocation of labor across local areas.

6. Concluding remarks

This paper examined functional specialization patterns across local areas in the Netherlands. We measured specialization in activities using information on the occupations of workers, and provided trends for eight business functions: R&D; Fabrication; Transport, logistics, and distribution; Sales and marketing; Technology and process development; Administrative and back-office; General and strategic management; and Others. We documented substantial heterogeneity in functional specialization across local areas in the Netherlands.

Measuring specialization in activities in local areas is relevant as it provides policy insights into the type of occupations demanded as well as reflecting the potential for growth and job dynamics. For example, R&D activities are more knowledge-intensive which will have implications for the jobs demanded and the potential for productivity growth in a local area. We then used cross-area variation in industry composition such that local areas are differentially exposed to offshoring trends and investments in new technologies. We did not find a statistically significant relation between offshoring and functional employment changes, apart from weak significant effects that offshoring relates to lower demand for administrative and back-office activities. Technological change appears significantly related to lower demand for routine jobs, in particular fabrication jobs.

Our measurement of specialization in local areas and the econometric approach to investigate the drivers is exploratory. The Netherlands is geographically small and therefore there are few local areas, which limited the degrees of freedom and scope for alternative econometric identification strategies. The measurement and analysis can be extended to other countries as the global value chain survey was conducted by various statistical offices across Europe (see Sturgeon et al. 2013). Extending the scope may improve upon identification and allow capturing other determinants that drive certain activities to cluster geographically, such as spillovers and

returns to scale (Gervais et al. 2016).

Further, cross-area variation in industry specialization may be used to examine the effects of activity re-location and technological change on other socio-economic and political outcomes. A recent wave of research has started to use cross-area variation in offshoring exposure and import competition to examine its impact on elections (Autor et al. 2016; Colantone and Stanig, 2016) or uses information on the routine task-intensity of occupations to examine preferences for redistribution (Thewissen and Rueda, 2017). These are promising areas for further research.

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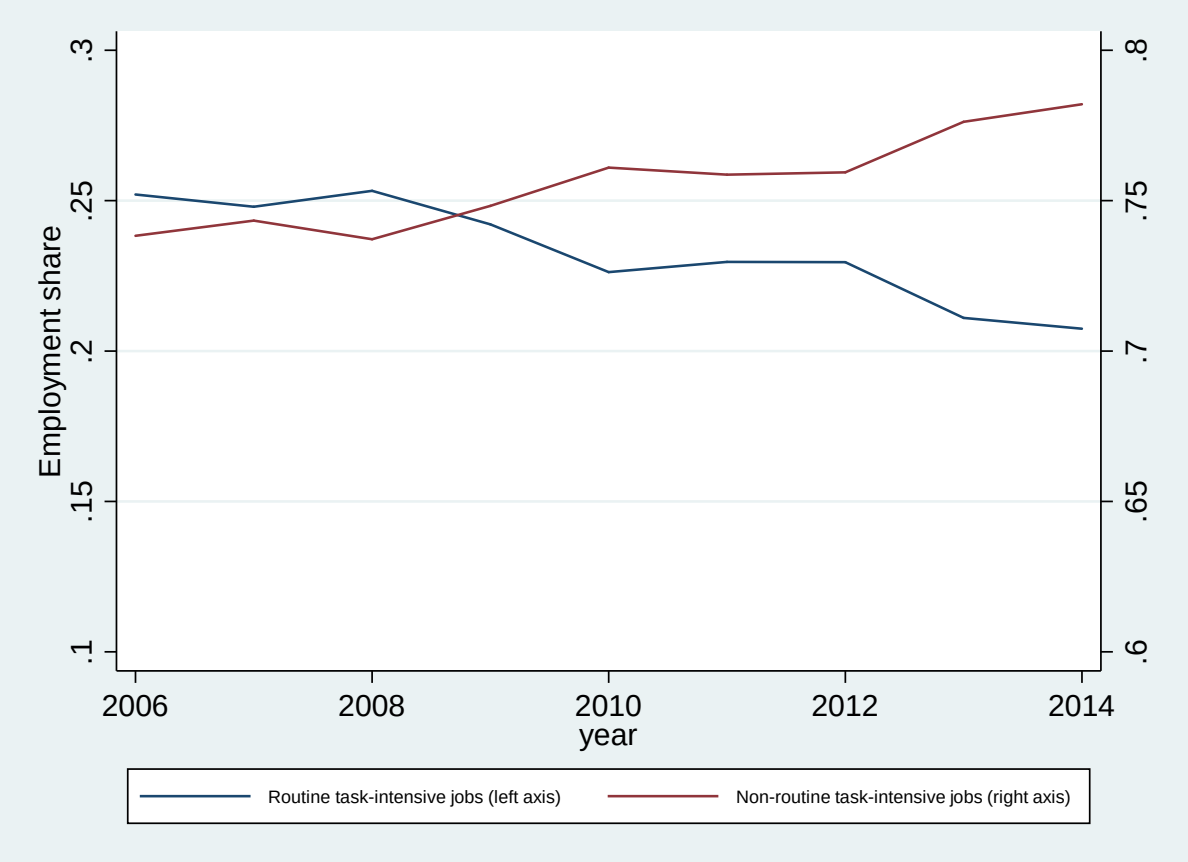
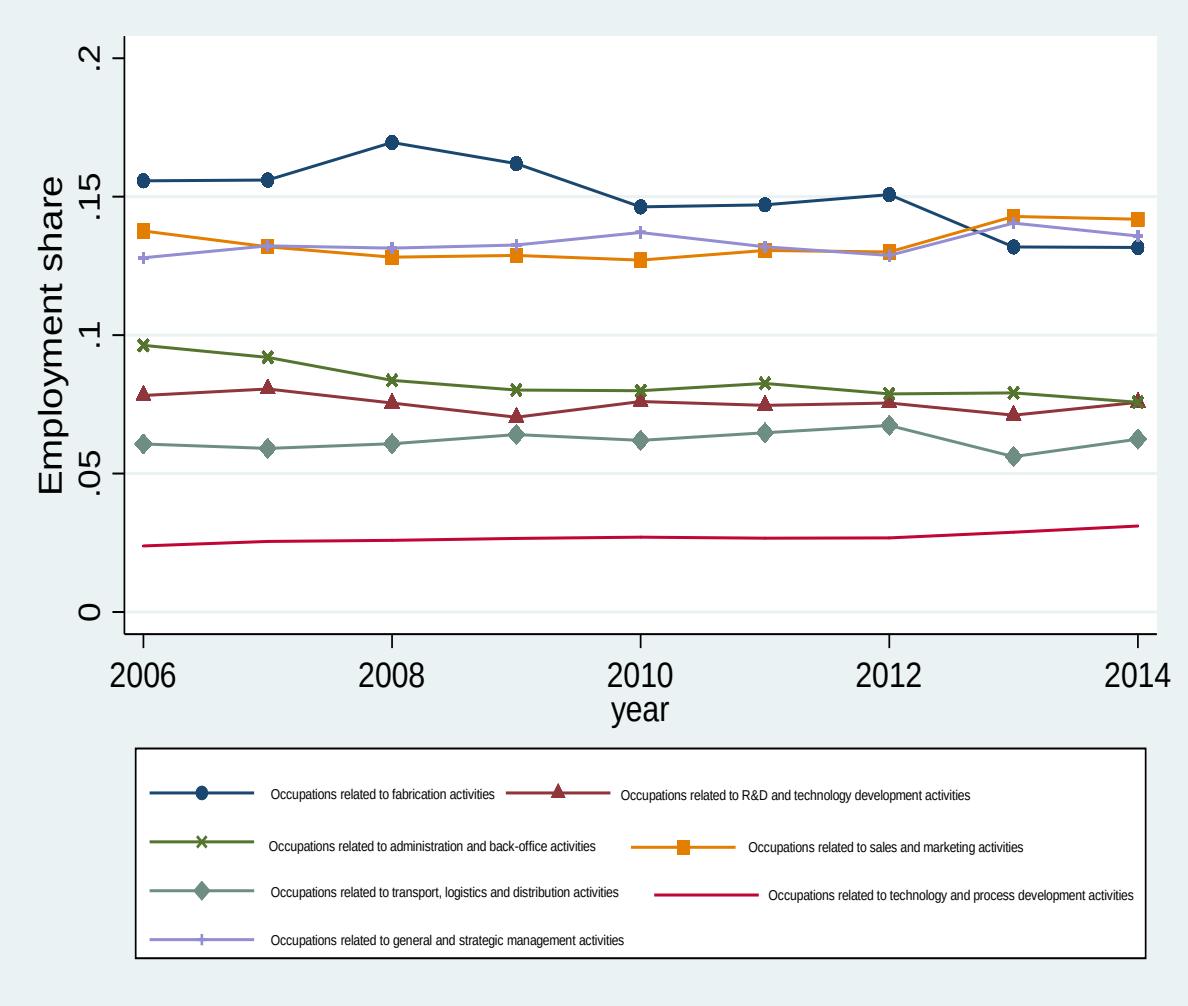
Figure 1. Employment share of routine and non-routine jobs in the Netherlands, 2006-2014



Notes: Occupations grouped in routine and non-routine task-intensive jobs, see section 3 for details. *Source*: authors' calculations using Dutch labor force surveys.

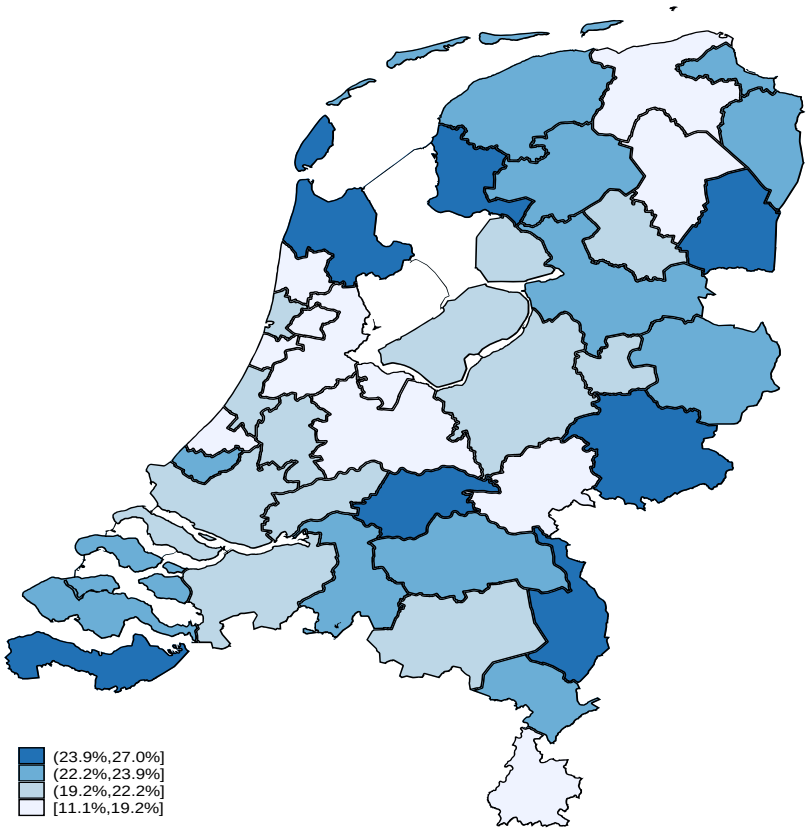
Figure 2. Business function employment shares in the Netherlands, 2006 to 2014.



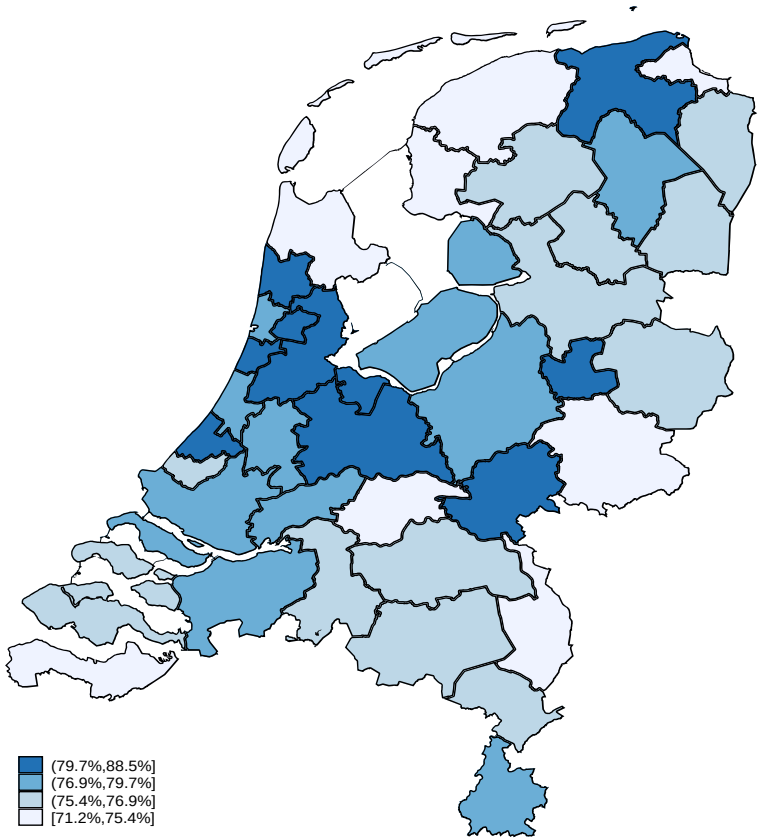
Notes: Occupational employment shares by business function, see section 3 for classification. *Source*: authors' calculations using the Dutch labor force surveys.

Figure 3. Routine and non-routine jobs shares across NUTS 3 local areas in the Netherlands, 2014.

(a) Routine job shares



(b) Non-routine job shares



Notes: Darker shaded areas indicate a higher employment share of routine jobs (in panel a) and non-routine jobs (in panel b). Data underlying this figure is reported in Appendix Table 1. See Appendix Figure 1 for the names of each local area. *Source*: authors' calculations using the Dutch labor force surveys.

Table 1. Functional specialization in local areas, 2014

#	Local area	RD	FAB	TRA	MAR	TECH	ADM	MGT	OTH
1	Oost-Groningen	3.1	17.1	4.7	16.2	0.9	5.9	12.1	39,9
2	Delfzijl en omgeving	6.1	14.0	11.4	12.3	1.8	8.8	11.4	34,2
3	Overig Groningen	9.9	9.6	4.9	15.4	2.5	7.1	14.9	35,8
4	Noord-Friesland	5.1	16.2	6.1	11.5	2.6	7.9	14.4	36,2
5	Zuidwest-Friesland	5.8	19.1	6.5	12.9	3.7	5.2	10.2	36,6
6	Zuidoost-Friesland	6.5	15.8	6.7	15.6	3.0	7.7	11.3	33,5
7	Noord-Drenthe	9.3	12.7	4.2	11.1	3.4	6.9	16.7	35,7
8	Zuidoost-Drenthe	6.6	17.7	8.4	13.5	2.7	6.6	14.4	30,0
9	Zuidwest-Drenthe	8.8	15.3	7.7	11.8	1.2	6.5	10.6	38,1
10	Noord-Overijssel	5.5	15.3	7.2	12.8	2.4	8.0	13.0	35,8
11	Zuidwest-Overijssel	8.6	11.8	7.4	13.9	3.0	8.0	12.4	34,8
12	Twente	7.8	14.7	4.8	13.4	3.1	7.9	13.4	34,9
13	Veluwe	7.5	13.8	5.4	14.8	4.5	7.4	13.3	33,2
14	Achterhoek	5.1	15.6	7.2	15.2	2.5	9.2	12.9	32,3
15	Arnhem/Nijmegen	8.9	8.0	5.7	14.9	3.7	7.6	15.3	35,9
16	Zuidwest-Gelderland	6.5	17.5	8.2	13.7	3.2	8.2	13.9	28,9
17	Utrecht	9.8	7.9	4.3	15.7	6.2	8.2	16.4	31,6
18	Kop van Noord-Holland	7.3	20.6	4.6	12.3	2.0	6.9	13.5	32,8
19	Alkmaar en omgeving	8.1	9.5	5.5	16.1	3.2	8.1	13.4	36,0
20	IJmond	7.7	13.5	5.8	11.1	2.1	6.3	15.6	37,8
21	Agglomeratie Haarlem	9.0	6.1	2.7	17.8	4.3	5.0	17.8	37,1
22	Zaanstreek	7.8	9.6	10.2	19.8	3.1	7.8	9.9	31,7
23	Groot-Amsterdam	11.3	6.6	4.2	16.5	5.1	8.4	15.8	32,0
24	Het Gooi en Vechtstreek	7.4	7.6	3.9	15.1	4.8	5.6	16.4	39,2
25	Agglomeratie Leiden en Bollenstreek	9.6	12.5	4.5	13.5	3.5	7.3	13.3	36,0
26	Agglomeratie 's-Gravenhage	11.1	6.5	3.6	14.3	5.9	7.3	20.0	31,2
27	Delft en Westland	11.0	15.3	5.7	15.8	3.9	8.4	11.7	28,3
28	Oost-Zuid-Holland	5.5	12.6	8.1	15.2	3.8	7.0	13.9	33,9
29	Groot-Rijnmond	8.6	11.1	5.8	14.4	3.5	9.2	14.4	32,9
30	Zuidoost-Zuid-Holland	7.2	12.7	6.6	12.9	2.8	9.1	16.9	31,9
31	Zeeuwsch-Vlaanderen	6.5	17.2	9.0	12.9	2.2	8.2	11.8	32,3
32	Overig Zeeland	7.1	14.8	6.2	12.6	1.4	7.7	14.8	35,5
33	West-Noord-Brabant	7.7	13.4	7.4	17.0	2.5	8.0	12.5	31,5
34	Midden-Noord-Brabant	8.5	13.3	8.3	13.5	2.0	9.3	12.3	32,8
35	Noordoost-Noord-Brabant	6.6	14.4	6.6	14.7	3.0	9.0	13.2	32,4
36	Zuidoost-Noord-Brabant	9.0	15.3	5.4	14.8	4.6	7.1	13.7	30,1
37	Noord-Limburg	6.0	18.8	8.0	13.2	2.8	8.2	13.1	30,0
38	Midden-Limburg	7.6	14.1	7.2	14.6	2.2	8.9	12.4	33,1
39	Zuid-Limburg	8.0	11.5	5.1	14.6	2.7	8.0	13.4	36,6
40	Flevoland	6.6	13.0	7.4	16.0	3.9	8.2	12.2	32,6
Weighted average for the Netherlands		8.2	13.0	5.7	14.5	3.6	7.9	14.2	32.9

Notes: Employment shares by local area of occupations related to R&D (RD); Fabrication (FAB); Transport, logistics, and distribution (TRA); Sales and marketing (MAR); Technology and process development (TECH); Administrative and back-office (ADM); General and strategic management (MGT); and Other activities (OTH) in 2014. *Source*: authors' calculations using the 2014 Dutch labor force survey.

Table 2. Offshoring shares by business function

	2007 GVC survey	2012 GVC survey
Core business function:		
Production of goods and services for the market	9.7 (97)	4.5 (61)
Support business functions:		
Distribution and logistics	3.1 (31)	1.2 (17)
Marketing, sales and after sales services, including help desks and call centers	2.3 (23)	1.9 (26)
ICT services	4.0 (40)	3.2 (44)
Administrative and management functions	3.4 (34)	3.1 (43)
Research and development, engineering and related technical services	3.4 (34)	0.9 (12)
Other types of business functions	0.4 (4)	1.3 (18)

Notes: percentage share of firms that report offshoring a business function. Number of firms that report offshoring a business function in brackets. Numbers include offshoring of multiple business functions by a firm. *Sources*: 2007 and 2012 GVC survey.

Table 3. Offshoring propensity by industry and business function, 2007 GVC survey

Industry	FAB	TRA	MAR	ICT	R&D	ADM&MGT	OTH
Mfr of food, beverages and tobacco products	0.059	-	0.016	0.019	-	0.013	-
Mfr of textiles, wearing apparel, footwear and leather	0.049	0.000	-	-	-	-	-
Mfr of wood, paper, printing and recorded media	0.084	0.058	0.048	0.252	0.078	0.111	-
Mfr of coke, petroleum; chemical and pharmaceutical products	0.076	0.189	0.058	0.422	0.191	0.168	-
Mfr of rubber and plastic products; other non-metallic mineral products	0.120	-	0.025	0.154	-	0.154	-
Mfr of basic and fabricated metals, except machinery and equipment	0.244	0.115	0.012	0.010	-	0.105	-
Mfr of computers, electronic and optical products; electrical equipment	0.577	0.387	0.009	0.100	0.073	0.396	-
Mfr of machinery and equipment n.e.c.	0.417	0.049	0.044	0.289	0.244	0.038	0.024
Mfr of motor vehicles and other transport equipment	0.401	0.025	0.067	0.122	0.024	0.000	0.000
Mfr of furniture and other products n.e.c.; repair and installation of machinery and equipment	0.066	0.009	-	0.027	0.027	0.007	0.010
Electricity, gas and water supply	-	-	-	-	-	-	-
Construction	0.013	0.008	0.000	0.000	-	0.008	-
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.048	0.026	0.010	0.071	0.017	0.034	-
Transportation and storage services	0.024	0.053	0.000	0.007	-	0.015	-
Accommodation and food services	-	-	0.018	0.119	0.119	-	-
Information and communication services	0.033	0.039	0.020	0.111	0.011	0.204	-
Renting, buying and selling of real estate	-	-	-	-	-	-	-
Consultancy, research and other specialized business services	0.063	0.002	0.024	0.040	0.015	0.042	0.002
Renting and leasing of tangible goods and other business support services	0.002	-	-	0.025	-	0.009	0.004

Notes: The propensity to offshore a business function is calculated as the number of firms in industry *s* that internationally sourced business function *b* divided by the total number of firms in this industry *s*. We weight by firm size based on the number of persons employed. R&D (RD); Fabrication (FAB); Transport, logistics, and distribution (TRA); Sales and marketing (MAR); Technology and process development (TECH); Administrative and back-office (ADM); General and strategic management (MGT); and Other activities (OTH). See Appendix Table 3 for results based on the 2012 GVC survey. *Source*: 2007 Global Value Chain survey.

Table 4. Descriptive statistics of variables included in the regression analysis

Variable	# obs	Mean	St. Dev.	Min	Max
Average annual employment growth in:					
R&D activities	80	0.006	0.017	-0.034	0.040
Fabrication activities	80	-0.001	0.097	-0.218	0.303
Administrative and back-office activities	80	-0.042	0.099	-0.438	0.208
Management activities	80	0.030	0.086	-0.191	0.231
Technology and process development activities	79	0.006	0.017	-0.034	0.040
Sales and marketing activities	80	0.009	0.072	-0.199	0.174
Transportation, logistics, and distribution activities	80	-0.027	0.127	-0.361	0.350
Other activities	80	0.015	0.038	-0.094	0.109
Offshoring exposure in business function:					
R&D activities	80	0.046	0.008	0.032	0.079
Fabrication activities	80	0.055	0.015	0.033	0.128
Transportation, logistics, and distribution activities	80	0.019	0.013	0.003	0.073
Sales and marketing activities	80	0.016	0.006	0.009	0.037
Technology and process development activities	80	0.043	0.009	0.028	0.084
Administrative and back-office activities	80	0.011	0.010	0.001	0.039
Other activities	80	0.019	0.008	0.007	0.042
Investment in computer assets and software (mln of euros)	80	343.33	404.50	23	2373
R&D investment (mln of euros)	80	266.89	275.68	26	1352
Share of young workers	80	0.340	0.024	0.264	0.395
Share of high-skilled workers	80	0.283	0.061	0.151	0.439

Notes: average annual employment growth is calculated for the period 2006-2008 and 2011-2013.

Table 5. OLS regression results, routine and non-routine jobs

	Dependent variable is average annual growth rate of:					
	Routine jobs			Non-routine jobs		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial Offshoring exposure	-0.030	-0.025	-0.012	-0.007	-0.011*	-0.012
	(0.032)	(0.031)	(0.032)	(0.006)	(0.005)	(0.007)
Initial R&D investment		-0.011*	-0.013		0.006***	0.008***
		(0.005)	(0.008)		(0.001)	(0.002)
Initial ICT investment	-0.011*			0.005***		
	(0.005)			(0.001)		
Initial share of young workers			0.151**			-0.014
			(0.057)			(0.016)
Initial share of high-skilled workers			0.009			-0.016*
			(0.034)			(0.008)
Constant	-0.004	0.008	0.229	-0.019	-0.030*	-0.078**
	(0.077)	(0.079)	(0.148)	(0.014)	(0.014)	(0.030)
Observations						
Adjusted R^2						

Notes: Dependent variables is the local area average annual growth rate of routine jobs (in columns 1-3) and non-routine jobs (in columns 4-6) during the period 2006-2008 and 2011-2013. A period dummy is included in all regressions. Independent variables are in logs. Robust standard errors in parentheses are clustered at the provincial (NUTS 2) level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. OLS Regression results business functions

	Dependent variable is average annual growth rate of jobs in:							
	RD	FAB	TRA	MAR	TECH	ADM	MGT	OTH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial Offshoring exposure	-0.219	-0.246	-2.571	-3.869	-0.194	-9.746**	-0.380	0.118
	(0.179)	(0.576)	(1.560)	(2.640)	(0.176)	(4.344)	(4.268)	(0.537)
Initial R&D investment	0.003***	-0.021	-0.0002	0.017*	0.003***	0.009	0.006	0.002
	(0.001)	(0.013)	(0.020)	(0.009)	(0.001)	(0.022)	(0.013)	(0.006)
Initial share of young workers	0.050	0.267	-0.652	-0.362	0.059*	0.691**	-0.164	0.244
	(0.030)	(0.274)	(0.767)	(0.283)	(0.033)	(0.272)	(0.550)	(0.259)
Initial share of high-skilled workers	-0.001	0.056	-0.127	0.054	0.002	0.187	-0.125	-0.033
	(0.016)	(0.213)	(0.293)	(0.137)	(0.019)	(0.241)	(0.223)	(0.057)
Constant	-0.002	0.080	0.362	0.0492	-0.008	-0.371***	0.099	-0.055
	(0.012)	(0.093)	(0.277)	(0.138)	(0.013)	(0.109)	(0.193)	(0.093)
Observations	80	80	80	80	79	80	80	80
Adjusted R^2	0.793	0.505	0.209	0.228	0.788	0.128	0.013	0.175

Notes: Dependent variables is the local area average annual growth rate of occupations related to R&D (RD); Fabrication (FAB); Transport, logistics, and distribution (TRA); Sales and marketing (MAR); Technology and process development (TECH); Administrative and back-office (ADM); General and strategic management (MGT); and Other activities (OTH) during the period 2006-2008 and 2011-2013. A period dummy is included in all regressions. Independent variables are in logs. Robust standard errors in parentheses are clustered at the provincial (NUTS 2) level. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. OLS Regression results, extensions

	Dependent variable is average annual growth rate of			
	Low-skilled workers	High-skilled workers	Unemployment	Working age population
	(1)	(2)	(3)	(4)
Initial offshoring exposure	0.041	-0.023	-0.003	0.003
	(0.034)	(0.054)	(0.010)	(0.002)
Initial R&D investment	-0.012*	0.012	0.001	-0.001
	(0.005)	(0.008)	(0.004)	(0.001)
Initial share of young workers	0.125	0.348*	0.062*	0.004
	(0.134)	(0.177)	(0.034)	(0.015)
Initial share of high-skilled workers			-0.006	0.013***
			(0.014)	(0.002)
Constant	0.418*	0.392	-0.109	0.054**
	(0.191)	(0.218)	(0.066)	(0.020)
Observations	80	80	80	80
Adjusted R^2	0.749	0.358	0.983	0.511

Notes: Dependent variables is the local area average annual growth rate of dependent variable described in each column, during the period 2006-2008 and 2011-2013. A period dummy is included in all regressions. Independent variables are in logs. Robust standard errors in parentheses are clustered at the provincial (NUTS 2) level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Tables and Figures

Appendix Table 1. employment shares by local area, 2014

NUTS 3 local area	Routine			Non-routine						
	Total	FAB	ADM	Total	RD	MAR	TRA	TECH	MGT	OTH
Achterhoek	0.25	0.15	0.09	0.74	0.05	0.15	0.07	0.02	0.13	0.32
Agglomeratie 's-Gravenhage	0.14	0.06	0.07	0.85	0.11	0.14	0.04	0.06	0.20	0.31
Agglomeratie Haarlem	0.11	0.06	0.05	0.89	0.09	0.18	0.03	0.04	0.18	0.37
Agglomeratie Leiden en Bollenstreek	0.19	0.12	0.07	0.79	0.09	0.13	0.04	0.03	0.13	0.36
Alkmaar en omgeving	0.18	0.09	0.08	0.82	0.08	0.16	0.05	0.03	0.13	0.36
Arnhem/Nijmegen	0.16	0.08	0.08	0.83	0.09	0.15	0.06	0.04	0.15	0.35
Delft en Westland	0.23	0.15	0.08	0.76	0.11	0.16	0.06	0.04	0.12	0.28
Delfzijl en omgeving	0.22	0.14	0.09	0.75	0.06	0.12	0.11	0.02	0.11	0.33
Flevoland	0.21	0.13	0.08	0.78	0.07	0.16	0.07	0.04	0.12	0.32
Groot-Amsterdam	0.15	0.07	0.08	0.84	0.11	0.16	0.04	0.05	0.16	0.32
Groot-Rijnmond	0.20	0.11	0.09	0.79	0.09	0.14	0.06	0.03	0.14	0.32
Het Gooi en Vechtstreek	0.13	0.08	0.06	0.86	0.07	0.15	0.04	0.05	0.16	0.39
IJmond	0.20	0.13	0.06	0.79	0.08	0.11	0.06	0.02	0.15	0.37
Kop van Noord-Holland	0.27	0.20	0.07	0.71	0.07	0.12	0.05	0.02	0.13	0.32
Midden-Limburg	0.23	0.14	0.09	0.77	0.08	0.15	0.07	0.02	0.12	0.33
Midden-Noord-Brabant	0.22	0.13	0.09	0.77	0.08	0.13	0.08	0.02	0.12	0.32
Noord-Drenthe	0.19	0.13	0.07	0.79	0.09	0.11	0.04	0.03	0.16	0.35
Noord-Friesland	0.24	0.16	0.08	0.75	0.05	0.11	0.06	0.03	0.14	0.36
Noord-Limburg	0.26	0.18	0.08	0.72	0.06	0.13	0.08	0.03	0.13	0.30
Noord-Overijssel	0.23	0.15	0.08	0.76	0.05	0.13	0.07	0.02	0.13	0.35
Noordoost-Noord-Brabant	0.23	0.14	0.09	0.76	0.07	0.15	0.07	0.03	0.13	0.32
Oost-Groningen	0.23	0.17	0.06	0.76	0.03	0.16	0.05	0.01	0.12	0.40
Oost-Zuid-Holland	0.20	0.13	0.07	0.80	0.05	0.15	0.08	0.04	0.14	0.34
Overig Groningen	0.17	0.10	0.07	0.83	0.10	0.15	0.05	0.03	0.15	0.35
Overig Zeeland	0.22	0.15	0.08	0.77	0.07	0.12	0.06	0.01	0.15	0.35
Twente	0.22	0.15	0.08	0.77	0.08	0.13	0.05	0.03	0.13	0.35
Utrecht	0.16	0.08	0.08	0.83	0.10	0.15	0.04	0.06	0.16	0.31
Veluwe	0.21	0.14	0.07	0.78	0.07	0.15	0.05	0.04	0.13	0.33
West-Noord-Brabant	0.21	0.13	0.08	0.78	0.08	0.17	0.07	0.02	0.12	0.31
Zaanstreek	0.17	0.09	0.08	0.81	0.08	0.19	0.10	0.03	0.10	0.31
Zeeuwsch-Vlaanderen	0.25	0.17	0.08	0.74	0.06	0.13	0.09	0.02	0.12	0.32
Zuid-Limburg	0.19	0.11	0.08	0.80	0.08	0.14	0.05	0.03	0.13	0.36
Zuidoost-Drenthe	0.24	0.18	0.07	0.75	0.07	0.13	0.08	0.03	0.14	0.30
Zuidoost-Friesland	0.23	0.16	0.08	0.76	0.06	0.15	0.07	0.03	0.11	0.33
Zuidoost-Noord-Brabant	0.22	0.15	0.07	0.77	0.09	0.15	0.05	0.05	0.14	0.30
Zuidoost-Zuid-Holland	0.22	0.13	0.09	0.77	0.07	0.13	0.07	0.03	0.17	0.32
Zuidwest-Drenthe	0.21	0.15	0.06	0.77	0.09	0.12	0.08	0.01	0.10	0.37
Zuidwest-Friesland	0.24	0.19	0.05	0.75	0.06	0.13	0.06	0.04	0.10	0.36
Zuidwest-Gelderland	0.25	0.17	0.08	0.73	0.06	0.14	0.08	0.03	0.14	0.29
Zuidwest-Overijssel	0.20	0.12	0.08	0.80	0.09	0.14	0.07	0.03	0.12	0.35

Notes: R&D (RD); Fabrication (FAB); Transport, logistics, and distribution (TRA); Sales and marketing (MAR); Technology and process development (TECH); Administrative and back-office (ADM); General and strategic management (MGT); and Other activities (OTH). *Sources:* author's calculations using the Dutch labor force survey.

Appendix Table 2. Mapping occupations to activities

Occupation	ISCO 08 code	Routine(1)/non-routine(0)	Business activity
Physical and earth science professionals	211	0	Research and development of products, services, or technology
Mathematicians, actuaries and statisticians	212	0	,,
Life science professionals	213	0	,,
Engineering professionals (excluding electro technology)	214	0	,,
Electro technology engineers	215	0	,,
Architects, planners, surveyors and designers	216	0	,,
University and higher education teachers	231	0	,,
Finance professionals	241	0	,,
Legal professionals	261	0	,,
Physical and engineering science technicians	311	0	,,
Life science technicians and related associate professionals	314	0	,,
Financial and mathematical associate professionals	331	0	,,
Librarians, archivists and curators	262	1	Production
Building and housekeeping supervisors	515	1	,,
Market gardeners and crop growers	611	1	,,
Animal producers	612	1	,,
Mixed crop and animal producers	613	1	,,
Forestry and related workers	621	1	,,
Fishery workers, hunters and trappers	622	1	,,
Subsistence crop farmers	631	1	,,
Subsistence livestock farmers	632	1	,,
Subsistence mixed crop and livestock farmers	633	1	,,
Subsistence fishers, hunters, trappers and gatherers	634	1	,,
Building frame and related trades workers	711	1	,,
Building finishers and related trades workers	712	1	,,
Painters, building structure cleaners and related trades workers	713	1	,,
Sheet and structural metal workers, moulders and welders, and related workers	721	1	,,
Blacksmiths, toolmakers and related trades workers	722	1	,,
Machinery mechanics and repairers	723	1	,,
Handicraft workers	731	1	,,
Printing trades workers	732	1	,,
Electrical equipment installers and repairers	741	1	,,
Electronics and telecommunications installers and repairers	742	1	,,
Food processing and related trades workers	751	1	,,
Wood treaters, cabinet-makers and related trades workers	752	1	,,
Garment and related trades workers	753	1	,,
Other craft and related workers	754	1	,,
Mining and mineral processing plant operators	811	1	,,

Metal processing and finishing plant operators	812	1	,,
Chemical and photographic products plant and machine operators	813	1	,,
Rubber, plastic and paper products machine operators	814	1	,,
Textile, fur and leather products machine operators	815	1	,,
Food and related products machine operators	816	1	,,
Wood processing and papermaking plant operators	817	1	,,
Other stationary plant and machine operators	818	1	,,
Agricultural, forestry and fishery labourers	921	1	,,
Mining and construction labourers	931	1	,,
Manufacturing labourers	932	1	,,
Assemblers	821	1	,,
Sales, marketing and development managers	122	0	Sales and marketing
Sales, marketing and public relations professionals	243	0	,,
Sales and purchasing agents and brokers	332	0	,,
Street and market salespersons	521	0	,,
Shop salespersons	522	0	,,
Cashiers and ticket clerks	523	0	,,
Other sales workers	524	0	,,
Locomotive engine drivers and related workers	831	0	Transportation, logistics, and distribution
Car, van and motorcycle drivers	832	0	,,
Heavy truck and bus drivers	833	0	,,
Mobile plant operators	834	0	,,
Ships' deck crews and related workers	835	0	,,
Transport and storage labourers	933	0	,,
Sports and fitness workers	342	0	Customer and after-sales services
Client information workers	422	0	,,
Travel attendants, conductors and guides	511	0	,,
Software and applications developers and analysts	251	0	Technology and process development
Database and network professionals	252	0	,,
Information and communications technology operations and user support technicians	351	0	,,
Telecommunications and broadcasting technicians	352	0	,,
General office clerks	411	1	Administration and back-office services
Secretaries (general)	412	1	,,
Keyboard operators	413	1	,,
Tellers, money collectors and related clerks	421	1	,,
Numerical clerks	431	1	,,
Material-recording and transport clerks	432	1	,,
Other clerical support workers	441	1	,,
Commissioned armed forces officers	11	0	General and strategic management
Non-commissioned armed forces officers	21	0	,,
Armed forces occupations, other ranks	31	0	,,
Legislators and senior officials	111	0	,,
Managing directors and chief executives	112	0	,,

Business services and administration managers	121	0	,,
Production managers in agriculture, forestry and fisheries	131	0	,,
Manufacturing, mining, construction, and distribution managers	132	0	,,
Information and communications technology service managers	133	0	,,
Professional services managers	134	0	,,
Hotel and restaurant managers	141	0	,,
Retail and wholesale trade managers	142	0	,,
Other services managers	143	0	,,
Administration professionals	242	0	,,
Mining, manufacturing and construction supervisors	312	0	,,
Regulatory government associate professionals	335	0	,,
Legal, social and religious associate professionals	341	0	,,
Medical doctors	221	0	Others
Nursing and midwifery professionals	222	0	,,
Traditional and complementary medicine professionals	223	0	,,
Paramedical practitioners	224	0	,,
Veterinarians	225	0	,,
Other health professionals	226	0	,,
Vocational education teachers	232	0	,,
Secondary education teachers	233	0	,,
Primary school and early childhood teachers	234	0	,,
Other teaching professionals	235	0	,,
Social and religious professionals	263	0	,,
Authors, journalists and linguists	264	0	,,
Creative and performing artists	265	0	,,
Process control technicians	313	0	,,
Ship and aircraft controllers and technicians	315	0	,,
Medical and pharmaceutical technicians	321	0	,,
Nursing and midwifery associate professionals	322	0	,,
Traditional and complementary medicine associate professionals	323	0	,,
Veterinary technicians and assistants	324	0	,,
Other health associate professionals	325	0	,,
Business services agents	333	0	,,
Administrative and specialized secretaries	334	0	,,
Artistic, cultural and culinary associate professionals	343	0	,,
Cooks	512	0	,,
Waiters and bartenders	513	0	,,
Hairdressers, beauticians and related workers	514	0	,,
Other personal services workers	516	0	,,
Child care workers and teachers' aides	531	0	,,
Personal care workers in health services	532	0	,,
Protective services workers	541	0	,,
Domestic, hotel and office cleaners and helpers	911	0	,,

Vehicle, window, laundry and other hand cleaning workers	912	0	,,
Food preparation assistants	941	0	,,
Street and related service workers	951	0	,,
Street vendors (excluding food)	952	0	,,
Refuse workers	961	0	,,
Other elementary workers	962	0	,,

Appendix table 3. Offshoring propensity using the 2012 GVC survey

Industry	FAB	TRA	MAR	ADM & MGT	ICT	R&D	OTH
Mining of minerals	-	-	-	0.086	0.161	-	-
Mfr of food, beverages and tobacco products	0.059	-	0.021	0.113	0.060	-	-
Mfr of textiles, wearing apparel, footwear and leather	0.502	-	-	-	-	-	-
Mfr of wood, paper, printing and recorded media	0.079	-	-	-	0.066	0.033	-
Mfr of coke, petroleum; chemical and pharmaceutical products	0.205	0.160	0.181	0.208	0.476	0.268	0.160
Mfr of rubber and plastic products; other non-metallic mineral products	0.132	0.162	0.000	0.064	0.092	-	0.030
Mfr of basic and fabricated metals, except machinery and equipment	0.210	0.015	0.010	-	0.014	-	0.010
Mfr of computers, electronic and optical products; electrical equipment	0.587	-	0.440	-	0.702	0.351	-
Mfr of machinery and equipment n.e.c.	0.130	0.088	0.080	-	0.021	-	-
Mfr of motor vehicles and other transport equipment	0.105	-	-	-	0.014	0.014	0.015
Mfr of furniture and other products n.e.c.; repair and installation of machinery and equipment	-	-	0.030	0.030	-	-	-
Electricity, gas and water supply	-	-	0.051	-	0.051	-	-
Construction	0.004	-	0.004	0.054	0.044	0.031	-
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.004	0.002	0.002	0.021	0.019	0.002	0.023
Transportation and storage	0.015	0.014	0.009	0.073	0.038	-	0.005
Accommodation and food service activities	-	-	0.009	0.007	0.096	-	0.038
Information and communication	0.296	0.003	0.007	0.139	0.243	0.003	0.092
Renting, buying and selling of real estate	0.000	-	-	-	-	-	-
Consultancy, research and other specialised business services	0.040	0.002	0.050	0.104	0.106	0.010	0.046
Renting and leasing of tangible goods and other business support services	0.028	-	0.004	0.021	-	-	0.002

The propensity to offshore a business activity, the international sourcing propensity, is calculated as the number of firms in industry *s* that internationally sourced business activity *b* divided by the total number of firms in this industry *s*. We weight by firm size based on the number of employed persons. R&D (RD); Fabrication (FAB); Transport, logistics, and distribution (TRA); Sales and marketing (MAR); Technology and process development (TECH); Administrative and back-office (ADM); General and strategic management (MGT); and Other activities (OTH). *Source*: 2012 Global Value Chain survey.

Appendix table 4. Functional specialization in local areas, 2006

#	Local area	RD	FAB	TR	MAR	TECH	ADM	MGT	OTH
1	Oost-Groningen	5.9	15.4	7.8	12.4	1.4	8.1	11.4	36.8
2	Delfzijl en omgeving	8.8	12.0	4.0	14.4	3.2	12.8	7.2	36.8
3	Overig Groningen	8.4	14.6	3.9	12.3	3.4	9.2	13.4	34.1
4	Noord-Friesland	7.3	19.7	5.6	13.2	1.5	10.7	11.8	29.2
5	Zuidwest-Friesland	7.6	19.9	5.6	15.3	1.3	7.0	9.0	33.9
6	Zuidoost-Friesland	9.2	19.8	7.0	13.4	1.9	8.7	10.4	28.4
7	Noord-Drenthe	7.4	12.1	3.8	12.9	2.3	9.5	14.4	36.4
8	Zuidoost-Drenthe	7.4	17.0	6.3	13.1	2.2	8.1	12.9	32.7
9	Zuidwest-Drenthe	5.5	20.1	6.3	15.5	1.3	8.8	14.5	26.8
10	Noord-Overijssel	8.3	17.9	5.5	12.9	2.3	10.4	11.1	30.9
11	Zuidwest-Overijssel	7.1	16.3	10.5	11.6	1.1	9.0	13.9	29.8
12	Twente	7.4	16.7	5.7	13.9	2.0	8.8	11.1	33.0
13	Veluwe	7.4	15.7	5.1	13.5	3.5	9.6	15.5	29.1
14	Achterhoek	5.5	22.7	6.2	14.1	1.3	8.5	9.7	31.4
15	Arnhem/Nijmegen	8.4	10.5	6.6	14.2	2.6	9.4	13.4	33.9
16	Zuidwest-Gelderland	5.7	21.0	9.2	13.1	1.7	9.2	10.8	28.6
17	Utrecht	9.6	8.7	5.1	13.7	4.9	11.0	15.5	30.6
18	Kop van Noord-Holland	6.2	22.3	6.0	13.1	1.2	9.1	13.8	27.7
19	Alkmaar en omgeving	9.7	14.4	4.8	15.7	2.4	10.0	8.9	33.5
20	IJmond	7.1	15.5	5.0	13.4	1.5	10.7	13.2	32.9
21	Agglomeratie Haarlem	8.8	8.8	2.8	13.9	2.8	10.8	16.9	34.6
22	Zaanstreek	9.5	14.0	6.3	14.6	3.9	11.0	9.2	30.4
23	Groot-Amsterdam	10.8	7.7	4.3	16.2	5.3	10.4	14.6	29.4
24	Het Gooi en Vechtstreek	7.3	10.2	3.2	18.5	4.0	8.8	11.9	35.2
25	Agglomeratie Leiden en Bollenstreek	9.8	12.0	6.3	14.0	1.8	8.7	11.4	34.9
26	Agglomeratie 's-Gravenhage	11.1	6.4	3.4	13.1	4.8	10.9	19.3	29.2
27	Delft en Westland	11.2	21.2	8.2	13.3	2.3	8.8	10.0	23.3
28	Oost-Zuid-Holland	7.0	16.0	6.1	13.0	3.9	10.1	12.8	30.2
29	Groot-Rijnmond	8.9	10.8	5.7	13.5	2.6	11.8	13.9	31.8
30	Zuidoost-Zuid-Holland	8.1	15.7	6.5	14.8	1.9	9.7	10.9	31.6
31	Zeeuwsch-Vlaanderen	5.1	21.6	7.8	11.5	0.7	8.1	16.6	27.7
32	Overig Zeeland	7.0	15.6	6.1	14.2	0.7	10.2	14.4	31.0
33	West-Noord-Brabant	6.7	13.6	8.5	14.7	2.2	8.8	13.1	31.7
34	Midden-Noord-Brabant	7.3	17.2	6.0	13.4	2.0	10.9	13.5	29.0
35	Noordoost-Noord-Brabant	8.5	17.3	6.6	13.2	3.0	9.3	13.1	27.9
36	Zuidoost-Noord-Brabant	8.8	16.0	6.1	13.1	4.0	9.3	14.5	27.0
37	Noord-Limburg	5.5	23.0	7.9	13.4	1.4	8.9	10.6	28.0
38	Midden-Limburg	7.4	16.7	8.5	11.9	1.2	10.8	13.4	29.1
39	Zuid-Limburg	8.5	12.4	5.2	12.5	2.6	10.2	15.5	31.7
40	Flevoland	5.8	14.4	7.2	16.3	1.6	9.6	14.3	29.7

Notes: Employment shares by local area of occupations related to R&D (RD); Fabrication (FAB); Transport, logistics, and distribution (TRA); Sales and marketing (MAR); Technology and process development (TECH); Administrative and back-office (ADM); General and strategic management (MGT); and Other activities (OTH) in 2014. *Source*: authors' calculations using the 2014 Dutch labor force survey.

Appendix Figure 1. Local areas in the Netherlands[16]

[16] Reference sourse: https://en.wikipedia.org/wiki/COROP.