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Offshoring of services functions in manufacturing

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Abstract

About 40% of employment in manufacturing is in services functions. This paper develops a measure of narrow outsourcing, matching services functions performed by workers inside manufacturing firms to the same services functions provided by outside suppliers. Narrow outsourcing is entered into labour demand functions where labour is broken down on business functions using OECD data combined with the 2016 releases of the World Input Output Database (WIOD). The impact of narrow offshoring on manufacturing labour demand is small on average but depends strongly on the complexity of the value chain, the policy environment and technology. Manufacturing employment is more services intensive the longer the value chain. In-house IT functions complement and support offshored IT functions, while offshored R&D functions tend to replace in-house R&D. The results are largely driven by ICT mature manufacturing sectors.

Keywords

Outsourcing, offshoring, labour demand, technology, regulation, structural changes

JEL Code: F16

Introduction[1]

Between 25 and 60% of employment in manufacturing is in services functions such as transport, marketing, IT, R&D, management, maintenance, repair, cleaning and training (Miroudot & Cadestin, 2017). Digitization and trade liberalization have significantly brought down transaction costs in services which has opened the opportunity to outsource such supporting services. Following the rise of India as a major exporter of computer services, scholars took interest in offshoring of services, sometimes referred to as trade in tasks (Grossman & Rossi-Hansberg, 2008). Trade in tasks is portrayed as the latest turn in the spiral of ever deepening specialization and fragmentation of production.

According to business surveys in Europe and the Americas, however, firms tend to outsource services functions rather than individual tasks.[2] Furthermore, the surveys reveal that most firms outsource locally. When they buy services from abroad, the source is most often countries in the same region with similar production costs as in their own country. Multinationals are more likely to offshore than local firms and they often offshore from their own subsidiaries. The story of deepening globalization through the slicing of the value chain into ever thinner slivers seems not to tally with the insights from these surveys.

This paper proposes an empirical approach to study the make-or-buy decision embedded in the offshoring literature in a multi-country setting. It exploits new information on employment in services functions within manufacturing firms and the 2016 release of the World Input Output Database (WIOD) to map the services functions produced inside the manufacturing sector and services provided by outside suppliers. I next use this mapping to create a new measure of narrow outsourcing and offshoring, which makes it possible to rigorously analyse the make-or-buy decision for services in the offshoring context in a similar manner as for goods.

The empirical literature on offshoring distinguishes between narrow and broad offshoring. The former includes imported intermediate inputs from the importing industry only, while broad offshoring comprises imports of any intermediate inputs. Broad offshoring captures all imports of intermediate inputs, not only inputs commonly produced in-house, and empirical offshoring studies therefore prefer to analyse narrow offshoring. From this perspective, offshoring of services are excluded. Bearing in mind the importance of services functions inside manufacturing firms, however, narrow offshoring should capture not only the fabrication activities in manufacturing but also the supporting services functions. Consider for example a computer engineer employed in the IT department of a car manufacturer. The market for her skills is IT departments in any sector, including special computer services firms. Similarly, she and her colleagues in the IT department face direct competition from computer services firms that may offer to take over the IT functions of the car manufacturer on a contractual basis rather than car producers abroad.

The main contribution to the literature of this paper is, first, to create a measure of narrow offshoring that matches the services functions inside manufacturing to services provided by outside suppliers. Second, it analyses the relationship between market and product characteristics as well as the policy environment on the one hand and the outcome of the make-or-buy decision on the other. The contribution in this regard is to create sector-specific policy and technology indicators and explore how the location of services functions is conditioned on the policy and technology framework.

[1] Acknowledgements: I am grateful to Sebastian Benz, Holger Breinlich, Bernard Hoekman and Sebastien Miroudot for comments and suggestions on earlier versions of this paper.

[2] The National Organization Survey in the US and similar surveys in Canada and the European Union. See https://ec.europa.eu/eurostat/statistics-explained/index.php/International_sourcing_and_relocation_of_business_functions and http://irle.berkeley.edu/files/2013/The-2010-National-Organizations-Survey.pdf.

The data reveal that the aggregate share of services inputs in manufacturing has not changed much during the period 2000 – 2014. There is however substantial variation across manufacturing sectors and countries. Furthermore, the share offshored and the share produced inside manufacturing have both increased slightly at the expense of local services suppliers.

Tentatively our results suggest that on average offshoring does not have a large impact on in-house employment. However, the average conceals large variations across sectors and functions. Furthermore, the marginal impact of offshoring on internal manufacturing employment strongly depends on the characteristics of the sector and the policy environment. Narrow offshoring affects manufacturing employment mainly in ICT mature sectors. Narrow offshoring tends to replace in-house functions in short and simple value chains, but complements in-house functions in long and complex value chains. The function that is most affected by offshoring is R&D which seems to be completely hived off when offshored. Finally, narrow offshoring complements internal employment when policy barriers to entry and investment are high.

The rest of the study is organized as follows. The data and stylized facts are portrayed in section 2. Section 3 positions the paper in the literature and spells out the analytical framework. Regression results are presented and analysed in section 4, while section 5 concludes.

Data and stylized facts

Data[3]

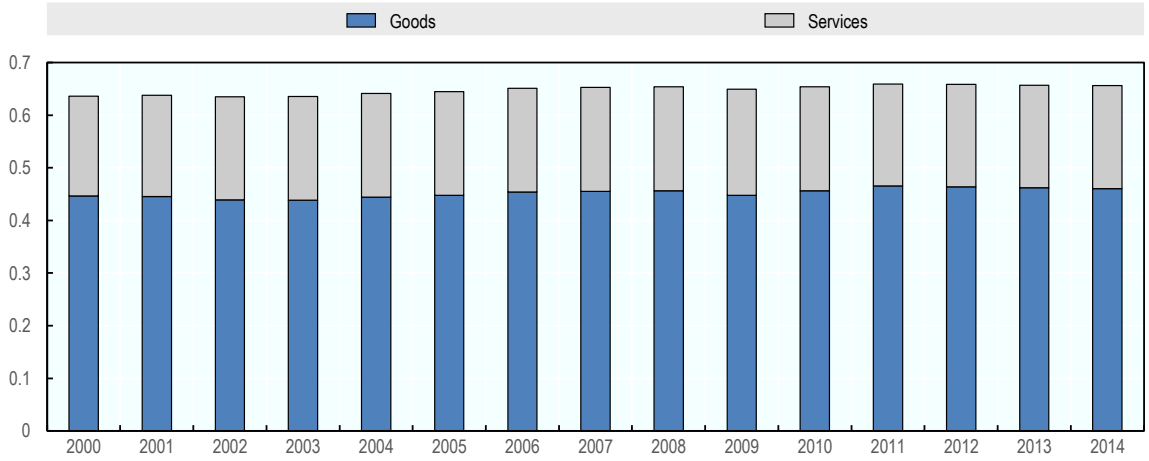
The main sources of data for this study are the 2016 release of the World Input Output Tables (WIOD), the associated Socio Economic Accounts (Timmer, Dietzenbacher, Los, Stehrer, & de Vries, 2015) and OECD estimates of employment by business function (Miroudot & Cadestin, 2017). The WIOD input output tables provide information on intermediate inputs by sector and source for 43 countries plus "rest of the world" from 2000 to 2014. Figure 1 depicts the average share of intermediate inputs in manufacturing for all countries included in the WIOD database by year. The most striking takeaway from this chart is the stability of the share of intermediate inputs, accounting for about two thirds of gross output throughout the period. Bearing in mind the popular debate about the increasing fragmentation of production this may be surprising.[4] The share of intermediate services in gross output has also been stable hovering around 20% and peaking at 21.1% in 2009.

[3] This section draws heavily on (Hildegunn Kyvik Nordås, 2019)

[4] This may be partly, but far from entirely a statistical artefact since input-output coefficients may not be frequently updated in the underlying data.

Figure 1. Average share of intermediate goods and services in gross output

Manufacturing, all countries

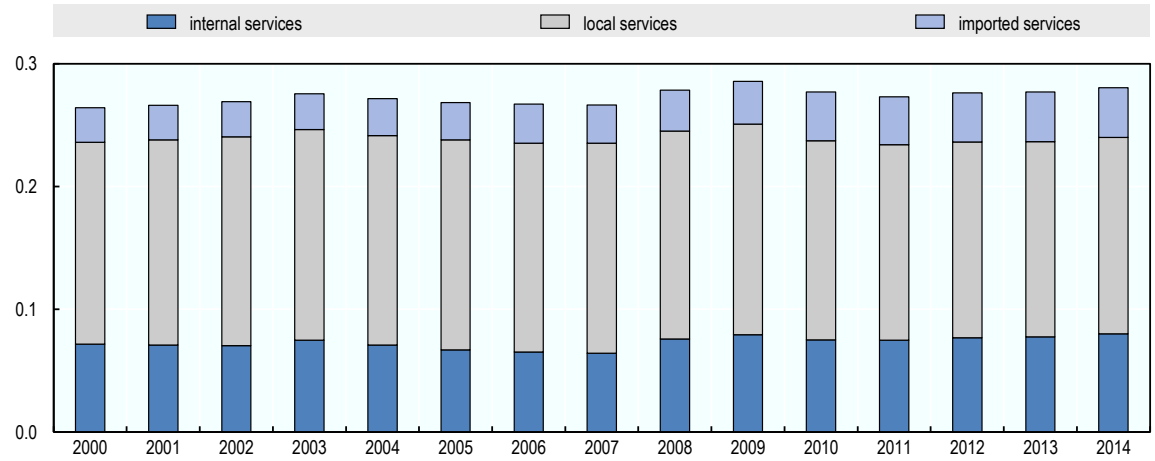


Source: Author's calculations based on WIOD.

Services are also produced inside the manufacturing sector. Figure 2 breaks down intermediate services inputs into locally sourced and imported and adds services produced internally. It shows that externally sourced services from the local market is the most important, followed by internal services production. Services imported directly account for a relatively small share. We also observe that although the overall share of services in gross output has been relatively stable over the past decade and a half, there has been a shift in the composition from locally sourced to internal and imported services. Thus, the import share of intermediate services has increased from 13% to 18% during the period 2000 - 2014.

Figure 2. Services inputs in manufacturing

Internal, local and imported



Source: Author's calculations based on WIOD; Miroudot and Cadestin (2017).

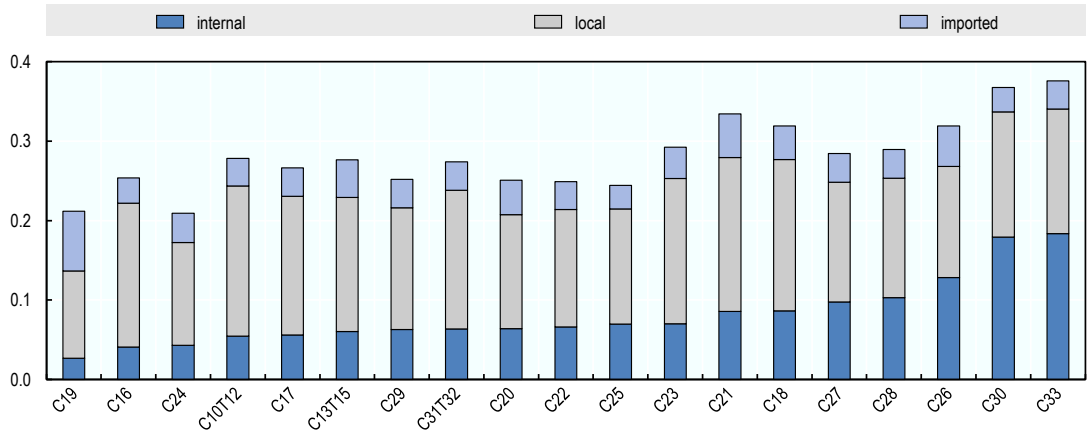
The rather underwhelming dynamics gleaned from the averages conceal large differences across manufacturing sectors and across countries within the same sector. Starting with variation across sectors, Figure 3 shows the average services share of gross output by ISIC rev 4 manufacturing sector in 2014 for all WIOD countries. Sectors are ranked by the share of gross output provided by internal services functions. Unsurprisingly, the sector that uses services the most intensively is repair and installation of manufacturing

equipment (C33), a sector at the borderline between goods and services. Manufacture of other transport equipment (C30) and pharmaceuticals (C21) follow as the second and third most services intensive manufacturing sectors. Pharmaceuticals have the highest share of locally outsourced services, while the highest share of imported services are found in manufacture of coke and petroleum products (C19).[5]

Finally, we highlight differences in services intensity across countries. Such differences can be due to variation in industrial structure across countries, or due to a more services intensive production technology within a sector. Here we are interested in the latter, and choose manufacture of computer, electronic and optical products (C26) to illustrate the point. The sector is characterised by a large number of products ranging from simple cables and switches to the most sophisticated computers and optical instruments. Internationally dispersed value chains in which there are large variations in the positioning of countries also distinguish it. Figure 4 ranks countries by intensity of internal services functions.

Figure 3. Services inputs in manufacturing by sector, 2014

Internal, local and imported

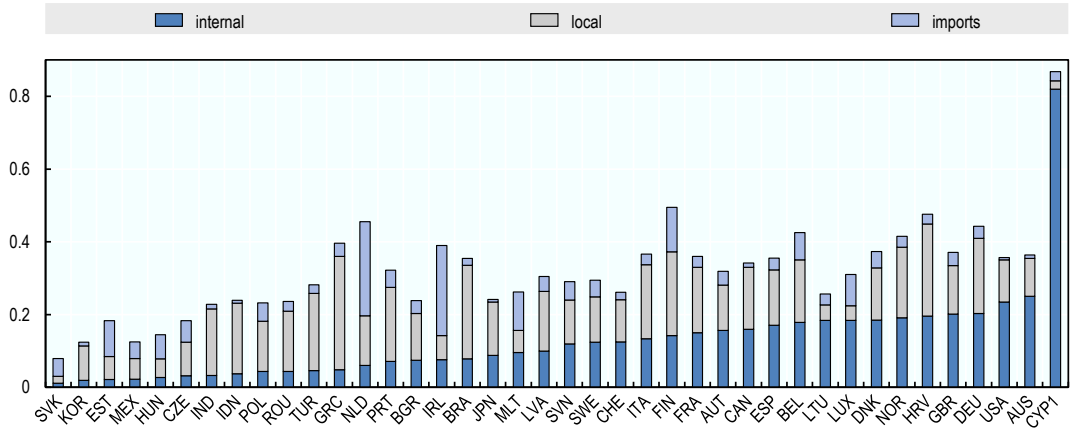


Source: Author's calculations based on WIOD; Miroudot and Cadestin (2017).

[5] We follow the practice in previous work and omit this sector from the econometric analysis in Section 4 due to measurement problems related to sharp fluctuations in oil prices (Foster-McGregor, Poeschl, & Stehrer, Offshoring and the Elasticity of Labour Demand, 2016).

Figure 4. Services inputs in manufacture of computer, electronic and optical products, 2014

Internal, local and imported



Source: Author's calculations based on WIOD; Miroudot and Cadestin (2017).

The figure depicts substantial variation in both services intensities and the sourcing of services. At the one extreme, manufacturers in Cyprus appear to engage mainly in the services stages of the production process while in the Slovak Republic services account for less than 10% of gross output, of which more than half is imported.

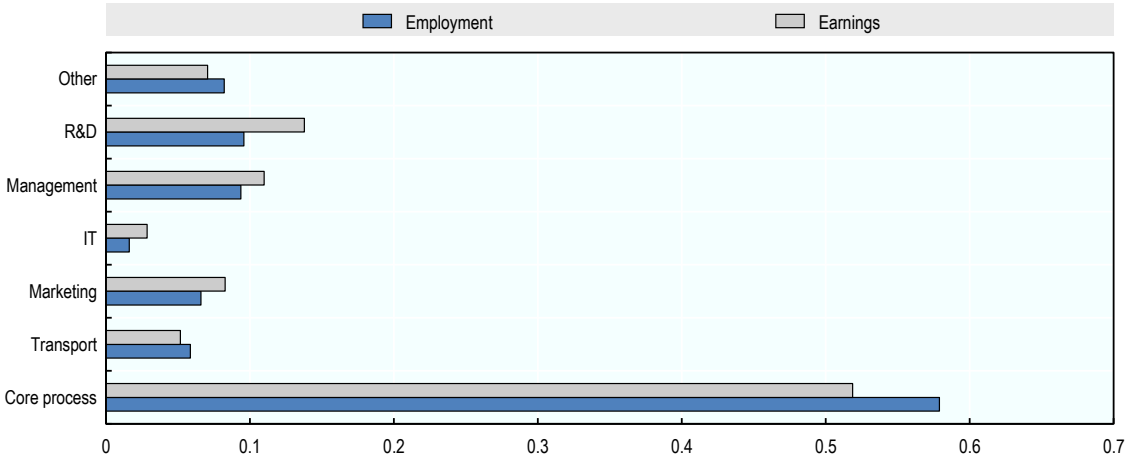
To summarise the stylised facts, services functions account for about 30% of manufacturing gross output and about 40% of employment in manufacturing. These aggregates have not changed much over time, but a slight shift from local outsourcing towards both imports and internal provision has been observed. Most importantly, there is substantial variation in both the services intensity and the sourcing of services across manufacturing industries and across countries within the same industry. In the following we will exploit this variation to explain what determines whether services are made or bought in the manufacturing sector.

Matching internal services functions to services sectors

Figure 5 exhibits the composition of employment by business function in manufacturing in 2014. On average almost 60% of employment and about half of wage earnings ensue in fabrication of products at the shop floor. Conversely, more than 40% of employment and half of the wage earnings go to services workers in the manufacturing sector. R&D, which also includes engineering and other technical services, figures most prominently, followed by management and marketing.

Figure 5. Employment and earnings in manufacturing by business function, 2014

Unweighted average shares of total employment and earnings in manufacturing, 31 countries



Source: Author's calculations based on WIOD; Miroudot and Cadestin (2017).

The next step is to match these services functions to sectors classified under International Standards Industrial Classification (ISIC) rev 4, which is used in the WIOD database. The matching is reported in Table 1 and reflects the description of the function in the business surveys, and the sector in the ISIC manual.[6] The matching forms the basis for our measure of narrow offshoring, which is defined as the purchase from foreign suppliers of intermediate services that correspond to the in-house functions defined in Table 1 and illustrated in Figure 6. Bold italics highlight the label to be used for each function in the rest of the paper.

Table 1. Matching business functions to sectors

	Business function	Definition	Related sector (WIOD)
1	***Operations***/core business functions	The core/primary business function of the firm.	Materials
2	***Transport***, logistics and distribution support functions	A support function related to procurement, transportation, warehousing and the delivery of goods and services to customers.	H49-H53
3	***Marketing***, sales, after sales services	A support function related to market analysis, advertising, selling, retail management and customer services.	G45-47, M73
4	***IT*** services and software support	Activities related to data processing, software development and the provision of ICT services	J62-63
5	***Management***, administration and back-office support functions	Activities associated with the administration of the firm, including legal, finance, accounting and human resource management.	K64-66, M69-70
6	***R&D***, engineering and related technical services and R&D support functions	Activities related to experimental development, research, design, engineering and related technical consultancy, technical testing, analysis and certification.	M71-72
7	***Other*** business functions	Maintenance, repair, security, education and training.	N

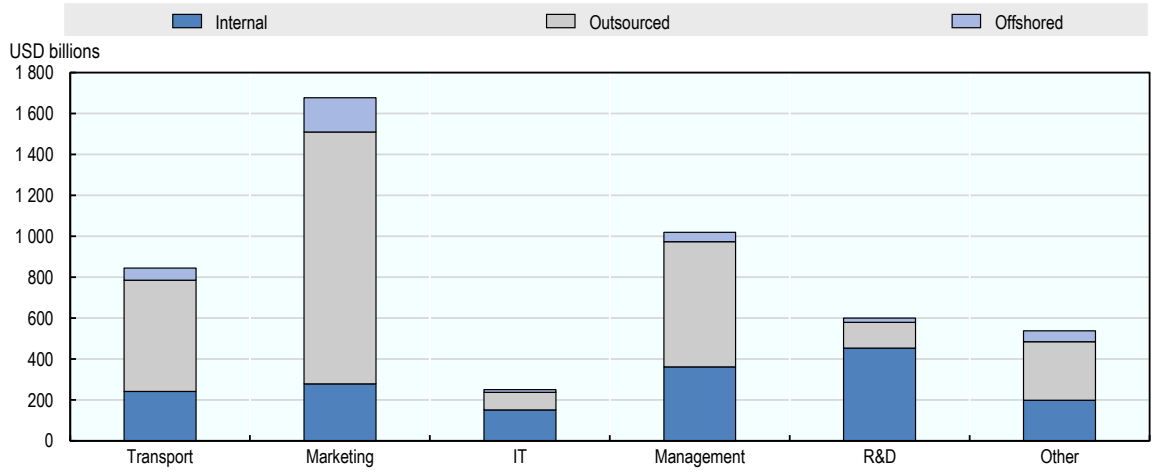
Note: The definition of the seven business functions corresponds to those used in Eurostat and NOS surveys and applied by (Miroudot & Cadestin, 2017) in their estimate of services functions performed inside manufacturing firms. The matching to ISIC Rev 4 sectors at the WIOD level of aggregation is the author's.

[6] Ideally, one could explore sensitivity to the matching in the econometric analysis to follow. However, at the level of aggregation used in the WIOD table, there are no border sectors that could sensibly be matched with a different function.

The input from each service business function by source, i.e. internal, outsourced locally or offshored is depicted in Figure 6. It adds up earnings by internal employees and payments to local and foreign suppliers for each function for total manufacturing in all countries covered. Consistent with Figure 2 which reports totals for all service business functions, local outsourcing is also clearly the most important source of services functions for each function. There are, however, interesting differences across functions. Marketing and transport appear to be the functions most likely to be sourced from outside, and thus furthest from the manufacturing core activity, while R&D is the function most often provided in-house. The IT function is surprisingly small and largely provided in-house.[7] In the aggregate, offshoring does not feature prominently for any of the services business functions, although as discussed in Section 2, offshoring is important in some sectors and some countries.

Figure 6. Business functions by source

Total manufacturing 2014



Source: Autor's estimates based on WIOD (2016) and Miroudot and Cadestin (Services In Global Value Chains: From Inputs to Value-Creating Activities, 2017).

The control variables

The relative cost of providing business functions in-house or sourcing them from outside suppliers depends on characteristics of the sector as well as the policy environment in which it operates. Sector characteristics included in the empirical analysis are the length of the value chain, the product market regulation index (PMR) from the OECD and ICT maturity.

The length of the value chain is defined as the number of production stages from raw material to final output. It has been calculated from the WIOD database using a methodology developed by De Becker and Miroudot (2013) in a similar manner as calculating backward linkages.

Comparable policy indicators that covers the WIOD countries for the period 2000 to 2014 are not readily available. One of the few is the OECD Product Market Regulation (PMR) indicators. They are available for infrastructure-related services (electricity, gas, transport, post and telecommunications) for the entire period for most of the countries included in the WIOD database. The PMR takes values between zero and six with higher scores reflecting more burdensome regulation. They cover information on entry barriers, public

[7] IT is a relatively new function, and IT departments may not be common in some industries. The number of observations is therefore fewer for these functions as reported in the descriptive statistics in annex Table A1.

ownership, vertical integration and market structure (Koske, Wanner, Bitetti, & Barbiero, 2015). A drawback for the purpose of this study is that the PMR varies across countries and over time, but not across manufacturing sectors, which makes it hard to identify its impact. Another problem is that the PMR combines information on policies and outcomes and may pose endogeneity problems when used in regressions.[8]

We solve the first problem by creating sector-specific policy indices exploiting sector variation in the intensity of use of infrastructure services within and across countries. We first calculate the weight of infrastructure services in each manufacturing sector in a benchmark country and year (United States for 2000) based on the WIOD input-output tables and then multiply the sector-specific weights with the country-year specific PMR index to obtain a country-year-sector specific policy measure. The second problem is mitigated by using the entry regulation sub-indicator, which does not contain outcome measures (see the annex for details).

ICT-maturity indicators are from the OECD (Calvino, Criscuolo, Marcolin, & Squicciarini, 2018) and characterize sectors by their investment in tangible ICT, software and the share of on-line sale in total sale. The indicators are available at the ISIC rev4 2-digit level and can be matched directly with the WIOD sectors. ICT maturity does, however not vary over time or across countries. See descriptive statistics in annex table A1.

The analytical framework

Previous studies relating offshoring to changes in overall employment found no or limited effects (Hijzen, Pisu, Upward, & Wright, 2011; Liu & Trefler, 2008). Nevertheless, there is evidence of quite significant effects on the skills composition of employment and relative wages (Geishecker & Görgy, 2013; Hijzen, Görg, & Hine, 2005).[9] Little is known about the impact of offshoring on the functional composition of employment, but there is some evidence that offshoring of material inputs from the US to China is associated with a net decline in low-skilled production workers, which has been more than offset with a net increase in employment of non-production workers (Wright, 2014).

Analysis of micro data is suitable for gaining insights on job creation and job separation across firms within sectors and sometimes even within firms, distinguishing between firm and worker characteristics. It is, however, difficult to study trade and regulatory policy drivers of labour market outcomes in country-specific microanalysis, since firms and workers within a country face the same policy environment. Furthermore, it is well known from the classical work of Hecksher, Ohlin, Vanek and others that trade leads to changes in relative prices, which drive a reallocation of resources to their most efficient use. These changes affect all firms and workers in the economy, not only those directly engaged in trade. Therefore, cross-country analysis may be more suitable for policy analysis and studies on the overall impact of trade.

The WIOD and the TiVA databases have been instrumental for cross-country analysis of trade and jobs at the industry level. They confirm that overall employment is mostly determined by factors other than trade and trade policy. There is evidence that services offshoring has contributed to making hiring and firing more sensitive to changes in wages and other market conditions (Foster-McGregor, Stehrer, & de Vries, 2013; Hijzen & Swaim, 2010), and thus may have had an impact on job security.[10] Finally, cross-country analyses support the finding that offshoring may have contributed to polarisation of earnings where the medium skilled workers have seen their share of the total wage bill decline to the benefit of high-skilled workers and, to a less extent to low-skilled workers (Foster-McGregor, Poeschl, & Stehrer, 2016).

[8] The outcome measures included in the PMR for network services are the number of firms operating in the market and the market share of new entrants.

[9] These studies analyse UK micro data.

[10] Technically speaking the studies find that offshoring is associated with higher labour demand elasticities.

Theoretical framework

The fundamental question that determines the relationship between local outsourcing, offshoring and internal provision of business functions is firms' make-or-buy decision. This question has been central to the field of economics since its inception with the work of Adam Smith in the 18th century. The classical work looked at the question from a growth and development perspective. Growing industries create space for deeper specialisation allowing firms to hive off non-core activities to outside suppliers. In the process, firms become more productive and new sectors emerge from taking up the hived-off functions. Thus, what is non-core activities for one firm becomes the core of another as the size of the market expands and sustains deeper specialisation (Stigler, 1951).[11]

The transaction cost approach to the study of organizations considers transactions as the basic unit of analysis and transaction costs as a key determinant of the boundary of the firm (Williamson, 1981). An early empirical analysis of the make or buy decision in automobile manufacturing hypothesized that firms are more likely to make inputs when demand for the final output is uncertain; when there is uncertainty related to technology, including design of the component in question; when the manufacturer has a cost advantage in producing the input; or when there is little competition in the upstream supplier market. In addition, the experience of both the buyer and the seller matters (Walker & Weber, 1984).

The cost of governing outside suppliers also depends on the characteristics of the product and the production process. Complex processes begets complex contracts that may be difficult to draw up and monitor, raising the relative transaction cost of outsourcing (Tadelis, 2002; Bashir & Thomson, 1999; Novak & Eppinger, 2001). The cost of outsourcing includes not only the contractual payments to the outside suppliers and the cost of governing the contract, but also the cost of re-integrating the outsourced process into production.

The concept of modularity is useful for understanding the relative costs of make versus buy from a business perspective. Modularity is defined as the portioning of a process or a product into independent and self-contained modules. Modular processes are more likely to be outsourced than non-modular processes, and business functions that can be fine-sliced into individual tasks are associated with lower cost of reintegration into the production process of the outsourcing firm (Elia, Massini, & Narula, 2017).[12]

The literature on offshoring embeds the make-or-buy decision into a trade model with intermediate inputs that can be made in-house, sourced from local suppliers or sourced from abroad (Antràs & Helpman, 2004). There are four possible outcomes of the make-or-buy decision: i) make at home; ii) make in a subsidiary established abroad; iii) buy from a local supplier; iv) buy from a foreign supplier. Each outcome is associated with a set of fixed and variable costs and the decision minimises the total production and transaction costs. Setting up a subsidiary abroad is the highest fixed cost alternative, but the higher cost of establishment may be compensated by lower cost of operations. The cost of governing production is lower when performed inside the firm, but lack of scale may still favour outside suppliers. In addition, compliance costs with foreign regulation as well as outright trade and investment barriers add to the costs of engaging in offshoring.

The underlying analytical framework for the empirical analysis in this paper is a standard model of outsourcing with differentiated products, monopolistic competition and heterogeneous firms inspired by (Melitz, 2003) and (Antràs & Helpman, 2004). Firms differ along the productivity dimension, and firms of higher productivity can absorb higher fixed costs of sourcing from outside suppliers be they local or foreign. We make the standard assumption that the fixed cost of offshoring is higher than the fixed cost of outsourcing to local suppliers, which in turn is higher than making the input in-house. Variable governance and transaction costs would typically follow the same pattern, while the cost of the input would often be highest

[11] In contrast, declining industries tend to integrate vertically as for instance observed by Michael Porter in his path-breaking work on competitiveness (Porter, 1979).

[12] The authors argue that firms should focus on making business functions more modular to reap the benefit from offshoring to third parties.

when produced in-house and cheapest when offshored. Firms will offshore if their productivity level is such that revenue net of variable costs covers the fixed cost of offshoring.

Standard offshoring models assume that firms are heterogeneous along the productivity dimension and that firms' productivity follows a Pareto distribution. This is justified empirically and has the convenient property that all possible outcomes of the make-or-buy decision can be observed in the same country, same industry at the same time. Changes in the relative fixed and variable cost of offshoring will affect the productivity threshold of the different outcomes, and thus the number of firms that produce in-house, outsource locally or offshore. The offshoring response to changes in trade costs can therefore be analysed using data at the sector level, for instance the WIOD database.

Empirical strategy

Demand for workers performing each business function (V) is derived from minimising costs subject to the production technology and is a function of input prices and output. Following the literature, outsourcing and offshoring enter the equation as shift parameters, which means that for a given level of input prices and output, outsourcing and offshoring may shift labour demand up or down, but do not affect the elasticity of labour demand to factor prices. Demand for workers performing function *f* in sector *i*, country *c* at time *t* can be written as follows:

$$lnV_{fict} = \alpha_0 + \sum_f \alpha_j lnw_{fict} + \delta_{fict} Out_{fict} + \theta_{fict} Off_{fict} + \beta_k lnk_{ict} + \sum_l \gamma_l lnz_{lict}$$

The first term is a constant while the second term contains the average wage rate of workers performing each of the seven business functions presented in Table 1. The next two terms represent narrow local outsourcing and offshoring respectively. They are function, sector, country and time specific and as noted enter as shift parameters. The fifth term denotes capital while the last term represents a set of control variables that also serve as labour demand shifters. These are the length of the value chain, ICT maturity and the PMR. The length of the value chain is included to capture the complexity of production, which should tilt the make-or-buy decision towards make. The ICT revolution has instigated the standardization, digitization and sometimes automation of a number of services tasks, making them more offshorable. ICT maturity is introduced to capture this effect, and we expect that it would contribute to more offshoring. Finally, the policy environment affects the relative cost of making or buying. The PMR indices for infrastructure-related services reflect burdensome regulation that make services markets less competitive and we expect them to favour in-house production. Labour demand functions are estimated in five-year differences to reduce the sensitivity to measurement error as follows:

$$\Delta lnl_{fict} = \alpha_0 + \sum_f \alpha_j \Delta lnw_{fict} + \delta_{fict} \Delta Out_{fict} + \theta_{fict} \Delta Off_{fict} + \beta_k \Delta lnk_{ict} + \sum_l \gamma_l \Delta lnz_{lict} + \varepsilon_{fict}$$

As noted, outsourcing, offshoring, and the controls included in the second to last term in the regression equation are entered as shift parameters additively. However, it may well be the case that the elasticity of labour demand to offshoring depends on the policy and technology environment. For instance, industries that use ICT intensively may be more sensitive to offshoring than less ICT intensive industries. To capture this possibility, I also run a set of regressions where narrow offshoring is interacted with the control shifters. These regressions are estimated in levels with country, year and industry fixed effects to control for unobserved country, sector or time-specific factors that could influence labour demand.[13]

[13] This is necessary since interaction terms are not compatible with difference equations.

Results

I start with estimating unconditional aggregate labour demand introducing services outsourcing and offshoring as shift parameters. This very basic regression is to confirm that the WIOD 2016 version exhibits the predicted relationship between employment and the core variables in the labour demand function. The result is reported in Annex Table A3. As expected, labour demand is downward sloping in wages, investment generates employment, local outsourcing of services supports employment in manufacturing, while offshoring of services does not have a statistically significant impact on overall manufacturing employment. I next break employment down to the seven functions presented in Table 1 and run the same regressions for each function, using seemingly unrelated regressions (SUR) where all variables are in five-year differences. Table 2 reports the results.

The own and cross price elasticity of labour demand by function reveals complementarities and substitutability among business functions. First, and reassuringly, all own price elasticities are negative and all are statistically significant, except for the management function. The core operations function is complementary to management and R&D (negative cross price elasticity) and substitute to transport (positive cross price elasticity). These results are intuitively appealing as the number of managers and supervisors tend to follow the number of shop-floor workers. It also makes sense that higher wages for shop-floor workers is associated with more R&D, which in turn is likely to be associated with higher productivity when targeting process innovation or higher output prices when targeting product innovation. Finally, one could envisage that higher wages for core operators may raise demand for transport workers. This occurs if e.g. machine operators initially do some internal transport. A wage rise could then trigger the transfer of internal transport to a specialized transport division. Presumably internal transport workers are less skilled and earn lower wages than machine operators.

Table 2. Labour demand by business function and broad offshoring, manufacturing

	F1	F2	F3	F4	F5	F6	F7
Δ ln wage 1	-0.170***	0.182***	0.085	0.02	-0.196***	-0.203***	-0.032
	(0.031)	(0.048)	(0.059)	(0.057)	(0.049)	(0.054)	(0.051)
Δ ln wage 2	0.03	-0.355***	-0.090**	0.011	0.04	0.061	0.085**
	(0.022)	(0.035)	(0.042)	(0.041)	(0.035)	(0.038)	(0.037)
Δ ln wage 3	0.023**	-0.008	-0.193***	0.061***	0.112***	0.079***	-0.006
	(0.011)	(0.017)	(0.020)	(0.020)	(0.017)	(0.019)	(0.018)
Δ ln wage 4	0.006	0.001	-0.029	-0.331***	-0.031*	0	0.002
	(0.012)	(0.018)	(0.022)	(0.021)	(0.018)	(0.020)	(0.019)
Δ ln wage 5	-0.099***	-0.037	0.082**	0.087***	-0.01	0.062**	-0.073**
	(0.018)	(0.028)	(0.034)	(0.033)	(0.028)	(0.031)	(0.030)
Δ ln wage 6	-0.053***	-0.068***	-0.060***	-0.040**	-0.140***	-0.377***	0.071***
	(0.010)	(0.016)	(0.020)	(0.019)	(0.016)	(0.018)	(0.017)
Δ ln wage 7	0.085***	0.103***	-0.080**	0.021	0.050*	-0.008	-0.225***
	(0.018)	(0.029)	(0.035)	(0.034)	(0.029)	(0.032)	(0.030)
Δ ln price intermediates	-0.027	-0.055	-0.218***	0.056	-0.015	-0.06	0.274***
	(0.022)	(0.035)	(0.042)	(0.041)	(0.035)	(0.039)	(0.037)
Δ ln capital	0.168***	0.100***	0.051***	0.080***	0.126***	0.139***	0.114***
	(0.007)	(0.011)	(0.014)	(0.013)	(0.011)	(0.012)	(0.012)
Δ ln outsourcing	0.090***	0.072***	-0.037	0.041	0.144***	0.280***	0.129***
	(0.017)	(0.027)	(0.033)	(0.032)	(0.027)	(0.030)	(0.029)
Δ ln offshoring	0.025*	-0.022	0.009	-0.042	0.055**	-0.186***	-0.056**
	(0.014)	(0.022)	(0.026)	(0.026)	(0.022)	(0.024)	(0.023)
R^2	0.176	0.072	0.08	0.085	0.081	0.192	0.086
N	3386	3386	3386	3386	3386	3386	3386

Note: Five-year difference regressions. Robust standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively. Dependent variable is labour demand by function measured in total hours worked and wages are hourly wages by function. Column headings correspond to the function as numbered in table 1.

Marketing substitutes for administration and R&D. The latter may suggest that firms have two ways of product differentiation – product development or targeting certain market segments through marketing. R&D complements all other business functions except "other".

We note that, as in the aggregate, outsourcing to local suppliers goes hand in hand with higher labour demand for most functions. The exceptions are marketing and IT for which there is no statistically significant effect. Offshoring on the other hand has a smaller marginal effect on in-house demand than outsourcing and is associated with slightly higher employment in the management function, and less employment in the R&D function. Thus, we note that outsourcing and offshoring of R&D and "other" have opposite effects on in-house labour demand. This is further discussed below.

Turning to narrow offshoring, labour demand in each of the seven business functions is regressed on matched local and foreign sourced services as indicated in Table 1. The results are reported in Table 3. The impact of narrow offshoring and offshoring is strikingly different from broad outsourcing and offshoring. Fewer functions are affected, but the marginal impact of those concerned is larger.

Table 3. Labour demand by business function, narrow offshoring, manufacturing

	F1	F2	F3	F4	F5	F6	F7
Δ ln wage 1	-0.168***	0.187***	0.086	0.023	-0.180***	-0.206***	-0.025
	-0.031	-0.049	-0.059	-0.057	-0.049	-0.054	-0.051
Δ ln wage 2	0.03	-0.350***	-0.085*	0.018	0.042	0.089*	0.096**
	-0.022	-0.035	-0.042	-0.041	-0.035	-0.039	-0.036
Δ ln wage 3	0.028**	-0.001	-0.188***	0.070***	0.118***	0.110***	0.008
	-0.011	-0.017	-0.02	-0.02	-0.017	-0.019	-0.018
Δ ln wage 4	0.01	0.002	-0.028	-0.333***	-0.023	-0.007	0.002
	-0.012	-0.018	-0.022	-0.021	-0.018	-0.02	-0.019
Δ ln wage 5	-0.103***	-0.041	0.080*	0.082*	-0.018	0.072*	-0.081**
	-0.018	-0.028	-0.034	-0.033	-0.028	-0.032	-0.03
Δ ln wage 6	-0.052***	-0.069***	-0.061**	-0.041*	-0.141***	-0.383***	0.070***
	-0.01	-0.016	-0.02	-0.019	-0.016	-0.018	-0.017
Δ ln wage 7	0.093***	0.106***	-0.080*	0.018	0.065*	-0.022	-0.224***
	-0.018	-0.029	-0.035	-0.034	-0.029	-0.032	-0.03
Δ ln price intermediates	-0.016	-0.042	-0.211***	0.063	-0.001	-0.012	0.304***
	-0.022	-0.035	-0.042	-0.041	-0.035	-0.039	-0.037
Δ ln capital	0.162***	0.094***	0.048***	0.089***	0.096***	0.137***	0.110***
	-0.007	-0.011	-0.013	-0.013	-0.011	-0.012	-0.011
Δ ln outsourcing	0.002	-0.087	-0.346**	0.77	-0.146	2.000***	0.4
	-0.035	-0.221	-0.129	-1.225	-0.276	-0.317	-0.416
Δ ln offshoring	0.218***	-0.066	0.155	5.565	-0.023	-2.438*	0.428*
	-0.036	-0.502	-0.313	-2.91	-0.752	-0.963	-0.2
R^2	0.1754	0.0697	0.0804	0.0853	0.0684	0.1743	0.082
N	3386	3386	3386	3386	3386	3386	3386

Note: Five-year difference regressions. Robust standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively. Dependent variable is labour demand by function measured in total hours worked and wages are hourly wages by function.

Only marketing and R&D are significantly related to outsourcing while offshoring is significantly associated with core processing, R&D and other business functions. Interestingly, the marginal impact is quite strong for R&D with opposite sign for outsourcing and offshoring. Recall, however that R&D is mainly done in-house (see Figure 6), so that a small change in absolute numbers will translate into a large percentage change. Remarkably, while outsourced R&D increases labour demand in in-house R&D, offshored R&D has the opposite effect with a similar but less precisely estimated parameter in absolute value. A possible story behind these results is that R&D, particularly the research part of it, requires a minimum efficient scale and highly specialized skills. Only large and innovative companies can recover the cost of research. Smaller and less innovative companies resort to licensing technology, which tends to be an arms-length transaction. The development part of R&D in contrast often involves in-house teams supported by external services providers working close to the operation activities. Frequent face-to-face interaction is needed in this kind of activity, which is therefore more likely to be sourced locally. Furthermore, such collaboration requires substantial in-house capacity to make full use of external support (Bengtsson & Dabhilkar, 2009; Muller & Zenker, 2001)

The analytical framework explaining the make-or-buy decision emphasizes the nature of the product and production process as important determinants. As noted, complex production processes and products beget complex contractual relationships. Complex contractual relationships in turn may require more in-house effort to monitor and enforce the contracts. We use the length of the value chain as an indicator of complexity and analyse to what extent it makes a difference as far as the in-house employment response to outsourcing and offshoring is concerned. Thus, do offshored services function require more in-house support and

monitoring in long value chains? Or conversely, are business functions more likely to be completely hived off in long value chains? We explore this question by entering the length of the value chain together with an interaction term with offshoring in the labour demand system.

A potential problem is that outsourcing, and offshoring may result in longer value chains, which could constitute an endogeneity problem. The length of the value chain and offshoring are indeed correlated for core operations, but not for services (see annex table A2). If the length of the value chain is partly determined by offshoring, the estimate of the marginal effect of offshoring conditioned on the length of the value chain would be upward biased. The marginal impact of offshoring on in-house labour demand by function at different lengths of the value chains are reported in Table 4, while the full regression results are presented in Annex table A4.

Table 4. Marginal effect of offshoring on labour demand by business function

Conditioned on length of value chain

Length of value chain	F2	F3	F4	F5	F6	F7
Mean less 0.5 standard deviations	-3.83	-2.48	17.95	-6.48	-6.32	0
Mean	-2.41	-1.47	12.28	-3.90	-7.88	0
Mean plus 0.5 standard deviations	-1.00	-0.45	6.62	-1.32	-9.44	0
Mean plus one standard deviation	0.42	0.56	0.95	1.26	-11.01	0

Note: The table reports the marginal effect of offshoring on internal employment in each services business function inside manufacturing for coefficients significantly different from zero.

Bearing in mind the caveat that the estimates could be upward biased, we first notice that the marginal impact on labour demand in manufacturing is statistically significant for all business functions except "other". There are also fundamental differences among the five remaining business functions. Transport, marketing and management depict a similar pattern, while the IT and the R&D functions display different and distinct features. Starting with transport, marketing and administration, the result indicates that when value chains are short and simple, offshoring is associated with a large reduction in in-house employment in the same function. Within our analytical framework of heterogeneous firms, the result suggests that the firms that offshore these business functions completely hive them off, possibly retaining an internal interface with foreign suppliers. With increasing complexity, however, the marginal impact of offshoring on in-house employment in the same function turns positive, supporting the prediction that complex processes require more in-house support. In addition, the finding is consistent with dynamic offshoring and automation models where tasks and functions are standardized, digitized and offshored or automated while in-house workers move on to new functions that cannot easily be offshored or automated.[14]

IT follows a different pattern. As shown in figures 5 and 6, IT is by far the smallest services function in manufacturing and there are fewer observations on this function than the other six. There may therefore be more noise in the data for this function than the others. With this caveat in mind, it appears that narrow offshoring of IT functions is strongly complementary to in-house employment when supply chains are short and simple. With lengthening value chains, the positive effect on in-house employment declines sharply. Like for the business functions discussed above, this finding is also consistent with a dynamic offshoring model where mature tasks and functions are automated and offshored while new tasks and functions are performed in-house. For IT functions the job creation effect is stronger than the destruction effect in short value chains, while the balance shifts towards the job destruction effect as the value chain becomes longer and more complex.

Finally, offshoring of R&D services replaces internal R&D functions with a higher marginal effect the more complex the value chain. As discussed above, R&D may not be modular. It is therefore less likely to be

[14] See for instance (Acemoglu & Restrepo, 2018) for a recent model focusing on automation.

offshored, but when it is, the entire function may be offshored. This may particularly refer to research where external sourcing are often in the form of arms-length licensing.

Another important factor characterizing the product and production process is technology, particularly ICT. Most studies find that ICT is skills-biased, pushing up demand and relative wages for skilled workers. This paper explores a different aspect, namely if ICT affects the sensitivity of labour demand to offshoring. For this I use the OECD ICT maturity index. It is sector-specific but unfortunately does not vary across countries and over time. The best I can do to study the different marginal effects conditioned on ICT maturity is to divide manufacturing into different ICT maturity categories and run the labour demand regressions separately for each category. I sort manufacturing industries into three categories; high, medium and low-ICT maturity and run the same SUR regressions as reported in Table 3 for each category. High ICT maturity is defined as sectors with an ICT maturity index above the mean plus one standard deviation, low ICT maturity refers to a score below the mean less one standard deviation, while medium ICT maturity represent the scores between high and low ICT maturity.[15] Table 5 reports the results. In the interest of space, I report the coefficients on narrow offshoring only.

Table 5. Marginal labour demand effect of narrow offshoring by ICT intensity

ICT maturity	F1	F2	F3	F4	F5	F6	F7
High	0.282***	-1.307	-0.126	-7.471	2.620	-11.956***	-3.343**
Medium	0.235***	-0.264	0.035	6.255*	0.353	-1.397	0.424*
Low	-0.106	0.115	-0.932	3.785	-0.427	3.892	-0.336

Note: The table reports the coefficients on the log of offshoring when the labour demand regressions by function are estimated for each ICT maturity category separately, using five-year difference regressions. ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively. The dependent variable is labour demand by function measured in total hours worked and wages are hourly wages by function. The number of observations are 832, 2132 and 422 for High, Medium and Low respectively.

We recall that narrow offshoring is significantly related to labour demand only for operations, R&D and "other" in the pooled regressions for all manufacturing sectors. When splitting the sample into three categories, the same functions are significantly affected by offshoring, but it appears that the results are largely driven by the high ICT maturity sectors. In this category, R&D offshoring has a particularly large and negative impact on labour demand for the in-house R&D function. There is also a relatively large impact on "other" in the high ICT maturity category. We also note that there is a large but not very precisely estimated impact of offshoring of IT functions in medium ICT mature sectors, while offshored core operations strengthen in-house operations in both high and medium ICT mature sectors. Finally, offshoring has no significant impact on labour demand in any function in low-ICT maturity sectors.

Turning to the relative cost of the different outcomes of the make-or-buy decision, trade and investment restrictions as well as burdensome domestic regulation are important determinants of such costs. Unfortunately, information on fixed and variable costs related to the four outcomes of the make or buy decision is not available. As discussed in the data section, the probably only relevant policy indicator that covers the sectors, countries and years corresponding to the WIOD data is the OECD PMR indicators which capture the regulatory burden facing key services inputs to manufacturing.

In the same manner as for the length of the value chain, the PMR and an interaction term between the PMR and offshoring are introduced in the regressions to explore whether the marginal effect of offshoring on internal provision of services functions varies with the level of regulation. The marginal effects are reported in Table 6 and the full regression in Annex table A.6.

[15] Low ICT maturity sectors are basic metal (C24) and fabricated metal (C25). High-ICT maturity sectors are food, beverages and tobacco (C10 to C12), machinery (C28), motor vehicles (C29) and other transport equipment (C30). Medium ICT maturity captures the rest.

Table 6. Marginal effect of offshoring on labour demand by business function

Conditioned on regulatory burden (PMR)

	F1	F2	F3	F5
Mean less 0.5 standard deviation	0.50	0.13	0.96	2.51
Mean	0.75	7.53	-1.10	2.51
Mean plus 0.5 standard deviations	0.99	14.92	-3.16	2.51

Note: the table reports the marginal effect of offshoring on internal employment in each business function for coefficients significantly different from zero as reported in annex table A4.

Product market regulation is significantly associated with offshoring and employment in core operations, transport, marketing and administration. Starting with the core operations function, offshoring complements in-house employment, which is consistent with the results reported in Table 3. Furthermore, the marginal impact is stronger the more burdensome is regulation. A similar pattern is observed in the transport function. Since transport is location-specific, offshoring of the transport function must be related to exports of final output and imports of intermediate inputs.[16] More research is needed on the interface between own account transport and transport sourced from external providers in an international trade context to explain this result.

Offshoring of marketing support internal employment when the regulatory burden is low but replaces in-house marketing functions when the regulatory burden is high. One can only speculate what might explain this finding. A possibility is that modern marketing is highly information-intensive, subject to substantial scale economies and relies heavily on efficient logistics, distribution and telecommunications inputs. With a high regulatory burden falling on these inputs, they are likely to be expensive and only large and highly productive manufacturers have sufficient scale to benefit from doing marketing themselves. Furthermore, the interface between offshored and in-house marketing may become more distinct and marketing more arms-length with weaker infrastructure services.[17]

Finally, in-house administration complements offshored administration when product market regulation is considered, although the marginal effect is independent on the level of regulation.

Concluding remarks

This study has analysed the employment impact of offshoring and outsourcing services functions from manufacturing, matching the services functions performed inside manufacturing to services sourced from outside. Previous studies have defined narrow offshoring as imports of materials from the same sector, ignoring the fact that services workers inside manufacturing are also exposed to offshoring of the activities they perform. Given that on average about 40% of employment in manufacturing is in services functions with a slightly increasing trend over time, shedding light on the relationship between services workers and service offshoring in manufacturing is important.

Like previous studies I find that offshoring has a relatively small impact on overall labour demand in manufacturing. However, the average conceals large differences across functions. The function most sensitive to offshoring is clearly R&D where offshoring replaces in-house employment irrespective of the characteristics of the sector or policy environment. It is, however, worth noticing that offshoring account for a very small share of expenditure on R&D, and the relatively large marginal effects are from a small base. The IT function is also highly sensitive to narrow offshoring, but in this case offshoring complements and strengthens in-house employment.

[16] Offshoring of transport services are indeed correlated with exports of final output (0.50) and imports of intermediate goods, with significant correlation coefficients of 0.5 and 0.6 respectively.

[17] Previous work shows that a higher regulatory burden is associated with weaker performance in the regulated sector (H.K. Nordås & Rouzet, 2017).

As predicted by trade and industrial organization theory, the labour demand response to offshoring depends on sector characteristics as well as the policy environment in which manufacturing operates. Complexity as captured by the length of the value chain is the most important factor shaping labour demand dynamics in manufacturing. Apart from R&D, in-house employment is less sensitive to offshoring the longer the value chain. Furthermore, narrow offshoring is associated with lower in-house employment in short value chains, but as the value chain lengthens, the effect turns positive and narrow offshoring strengthens in-house employment in long value chains. It appears, however, that the employment effect of services offshoring is largely confined to high ICT maturity sectors.

To conclude, the employment impact of narrow offshoring of services functions in manufacturing is small on average but with substantial differences across business functions and when conditioned on technology, market structure and regulation. Previous studies of labour market implications of offshoring have emphasized that the relevant measure of offshoring is narrow offshoring, and most have limited the analysis to manufacturing. However, as services functions gain prominence, the employment effect of narrow offshoring cannot be fully understood if services are ignored. This paper has contributed to filling this gap, but better information and much more research is needed to understand the policy dimension of this.

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Annex

Table A1. Descriptive statistics

Panel A controls

Variable	Observations	Mean	Standard dev.	Min	Max
Length	36960	2.084	0.519	1	9.493
PMR infrastructure	23925	0.254	0.374	0	2.303
Internet use	34485	0.723	1.378	0	6.733
ICT intensity	27721	0.138	0.052	0.039	0.277

Panel B. Business functions

Employment, Thousands					
	Observations	Mean	Std. dev	Min	Max
Operations	10 530	109.6	377.3	0	10 195.8
Transport	10 530	9.7	27.2	0	433.4
Marketing	10 530	7.6	23.4	0	659.4
IT	10 530	1.6	6.2	0	156.0
Management	10 530	16.9	53.7	0	1 560.5
R&D	10 530	7.9	20.9	0	320.1
Other	10 530	10.1	26.3	0	607.3
Average hourly wages, USD					
Operations	8 366	18.5	18.2	0.0	537.0
Transport	7 848	16.5	14.4	0.1	381.3
Marketing	7 603	31.1	31.6	0	748.7
IT	6 219	52.3	211.4	0	10 806.4
Management	8 104	25.5	21.5	0.02	387.0
R&D	7 794	41.0	262.4	0	19 048.7
Other	7 993	17.5	19.3	0	669.4

Note: The descriptive statistics refer to manufacturing employment all years 2000-2014. Extreme values on hourly wages are due to poor information on earnings and are dropped in the regressions.

Table A2. Correlation coefficients

	Ln length	Ln Off F1	Ln Off F2	Ln Off F3	Ln Off F4	Ln Off F5	Ln Off F6
lnLength	1						
lnOff_F1	0.6319	1					
lnOff_F2	0.2191	0.2985	1				
lnOff_F3	0.3503	0.6158	0.4468	1			
lnOff_F4	0.0631	0.0466	0.1447	0.357	1		
lnOff_F5	0.1211	0.0656	0.1734	0.2809	0.3497	1	
lnOff_F6	0.0749	0.0654	0.0837	0.241	0.3546	0.259	1
lnOff_F7	0.101	0.1144	0.2636	0.341	0.4978	0.4547	0.3903

Table A3. Baseline regression, aggregate unconditional labour demand

	Labour demand
Δ ln wage	-0.183***
	(0.019)
Δ ln capital	0.113***
	(0.007)
Δ ln price intermediate inputs	0.067***
	(0.019)
Δ ln outsourcing	0.066***
	(0.020)
Δ ln offshoring	-0.022
	(0.014)
R^2	0.119
N	7377

Note: Five-year difference regression. Robust standard errors are reported in parentheses and *** represent statistical significance at a 1% level.

Table A4. Unconditional labour demand, offshoring and length of value chain

	F1	F2	F3	F4	F5	F6	F7
Ln wage 1	-0.732***	0.036	0.048	-0.053	-0.262***	-0.091	-0.019
	(0.040)	(0.045)	(0.048)	(0.047)	(0.040)	(0.048)	(0.051)
Ln wage 2	-0.123***	-0.596***	-0.151***	-0.132***	-0.140***	-0.168***	-0.205***
	(0.030)	(0.033)	(0.036)	(0.034)	(0.030)	(0.036)	(0.037)
Ln wage 3	0.007	0.065***	-0.293***	0.051*	0.050**	0.074***	0.047*
	(0.018)	(0.020)	(0.021)	(0.020)	(0.018)	(0.021)	(0.022)
Ln wage 4	0.078***	0.056**	0.008	-0.221***	-0.014	-0.025	0.018
	(0.017)	(0.019)	(0.021)	(0.020)	(0.017)	(0.021)	(0.021)
Ln wage 5	-0.182***	-0.026	-0.025	0.075*	-0.195***	0.054	-0.131***
	(0.029)	(0.032)	(0.034)	(0.033)	(0.029)	(0.034)	(0.036)
Ln wage 6	0.082***	-0.018	0.050**	0.034	-0.071***	-0.399***	0.086***
	(0.016)	(0.018)	(0.019)	(0.018)	(0.016)	(0.019)	(0.020)
Ln wage 7	0.142***	0.062*	-0.002	0.101***	0.119***	0.163***	-0.331***
	(0.025)	(0.029)	(0.031)	(0.029)	(0.025)	(0.031)	(0.032)
Ln price intermediates	-0.055	-0.01	-0.187***	-0.044	0.018	-0.004	0.307***
	(0.032)	(0.036)	(0.039)	(0.037)	(0.032)	(0.039)	(0.041)
Ln capital	0.466***	0.313***	0.265***	0.256***	0.355***	0.392***	0.345***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.009)
Ln outsourcing	0.171***	-0.749***	0.183*	-2.271**	0.367*	1.236***	0.682*
	(0.030)	(0.127)	(0.073)	(0.779)	(0.160)	(0.246)	(0.280)
Ln offshoring	0.453***	-9.565***	-6.597***	40.886**	-16.940***	8.003	-0.843
	(0.029)	(2.293)	(1.374)	(14.804)	(3.070)	(4.129)	(0.894)
Ln Length		0.329***	-0.578***	0.314***	-0.092	0.178*	0.171
		(0.086)	(0.099)	(0.090)	(0.074)	(0.088)	(0.092)
Ln offshoring*ln length		10.223***	7.333***	-40.899**	18.642***	-11.272*	1.138
		(2.303)	(1.317)	(14.943)	(2.914)	(4.730)	(0.931)
R^2	0.941	0.9083	0.8816	0.7596	0.9222	0.8603	0.8787
N	5887	5887	5887	5887	5887	5887	5887

Note: Seemingly unrelated regressions for each business function, using country, year and sector fixed effects. Standard errors in parentheses and ***, ** and * signify statistical significance at a 1%, 5% and 10% level respectively.

Table A5. Weights of the PMR for infrastructure services

Industry	PMR infrastructure
C10T12	0.134
C13T15	0.034
C16	0.028
C17	0.070
C18	0.051
C19	0.460
C20	0.103
C21	0.041
C22	0.071
C23	0.038
C24	0.091
C25	0.166
C26	0.136
C27	0.041
C28	0.084
C29	0.114
C30	0.073
C31T32	0.026
C33	0.007

The PMR for infrastructure services covers transport, electricity, post and telecommunications. The weights to obtain sector-specific PMRs for each WIOD manufacturing sector is derived from the sum of the coefficient for transport, electricity, gas, post and telecommunications in the inverse Leontief matrix for the United States in the year 2000. These weights reflect the direct and indirect importance of infrastructure services in each sector. The weights from the US inverse Leontief matrix in the first year of the analysis is used to mitigate possible endogeneity problems.

Table A6. Unconditional labour demand by business function, narrow offshoring and PMR

	F1	F2	F3	F4	F5	F6	F7
Ln wage 1	-0.772***	-0.121*	-0.057	-0.013	-0.512***	0.062	-0.109
	(0.047)	(0.057)	(0.063)	(0.057)	(0.049)	(0.059)	(0.066)
Ln wage 2	0.114**	-0.357***	0.050	-0.099*	-0.052	-0.163***	-0.145**
	(0.037)	(0.044)	(0.049)	(0.045)	(0.038)	(0.046)	(0.051)
Ln wage 3	0.023	0.035	-0.328***	0.020	0.017	0.071**	0.035
	(0.019)	(0.023)	(0.026)	(0.023)	(0.020)	(0.024)	(0.027)
Ln wage 4	-0.078***	0.031	-0.041	-0.258***	-0.097***	-0.102***	0.033
	(0.022)	(0.027)	(0.029)	(0.027)	(0.023)	(0.027)	(0.031)
Ln wage 5	-0.052	0.030	0.012	0.066	0.080*	0.086*	-0.144**
	(0.033)	(0.039)	(0.043)	(0.039)	(0.033)	(0.040)	(0.045)
Ln wage 6	0.123***	0.006	0.101***	0.101***	-0.009	-0.407***	0.084**
	(0.022)	(0.026)	(0.029)	(0.026)	(0.023)	(0.027)	(0.030)
Ln wage 7	-0.025	0.010	-0.075	0.036	0.094**	0.092*	-0.278***
	(0.030)	(0.037)	(0.040)	(0.037)	(0.031)	(0.038)	(0.042)
Ln price intermediates	-0.085*	0.011	-0.153***	-0.016	-0.017	-0.054	0.334***
	(0.034)	(0.041)	(0.045)	(0.041)	(0.035)	(0.042)	(0.048)
Ln capital	0.435***	0.300***	0.269***	0.235***	0.335***	0.374***	0.332***
	(0.007)	(0.008)	(0.009)	(0.008)	(0.007)	(0.008)	(0.010)
Ln Outsourcing	0.129***	-0.329*	0.258**	-1.426	0.035	1.162***	0.828**
	(0.031)	(0.145)	(0.084)	(0.909)	(0.178)	(0.240)	(0.300)
Ln offshoring	0.413***	-2.505***	1.693***	5.174	2.511**	0.708	-0.111
	(0.046)	(0.684)	(0.454)	(5.699)	(0.817)	(1.092)	(0.299)
PMR_infrastructure	-3.307***	-2.365***	-2.106***	-1.691***	-1.355***	-1.816***	-3.002***
	(0.365)	(0.387)	(0.433)	(0.384)	(0.329)	(0.391)	(0.438)
Ln offshoring*PMR_infrastructure	1.311***	39.496***	-11.009**	-17.224	3.582	-19.767	6.167
	(0.379)	(8.085)	(4.201)	(46.106)	(7.469)	(11.390)	(4.034)
Ln Length		0.488***	-0.371***	0.243**	0.216**	0.100	0.036
		(0.091)	(0.106)	(0.091)	(0.076)	(0.090)	(0.106)
R^2	0.942	0.900	0.868	0.760	0.920	0.867	0.869
N	4698	4698	4698	4698	4698	4698	4698

Note: SUR regressions with country, sector and year fixed effects. Robust standard errors are reported in parentheses and ***, ** and* represent statistical significance at 1%, 5% and 10% levels respectively. Dependent variable is unconditional labour demand by business function.

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