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SERVICES TRADE POLICY, STRUCTURAL CHANGE AND LABOUR MARKET ADJUSTMENTS

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Abstract

This paper studies how services trade policy contributes to shaping the location of economic activities along international production networks and value chains, and the labour market impact of structural changes induced by services policy changes. The paper starts with mapping linkages between goods and services in production combining the WIOD database with a new dataset that breaks down labour input by business functions. The mapping also traces the channels through which services trade policies that target one link or node in complex production networks affect the composition of input demand, including labour inputs by business function. The role of services trade policy in shaping the location of economic activities is next analysed econometrically. A trans-log input demand equation system is constructed from the augmented WIOD database and services trade policy as measured by the PMR is introduced as shift parameters. The relative importance of trade and technology in shaping factor demand and production patterns has been widely discussed in the literature. To shed light on this question, indicators of ICT use are added as shift parameters in their own right as well as interacted with the PMRs to study to what extent the marginal impact of services trade policy differs with the intensity of ICT use; and conversely to what extent the intensity of ICT use is affected by the level of services trade restrictions. Finally, comparative statics using recent policy changes are presented to illustrate the results and support the policy analysis in the concluding section.

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1. Introduction

One of the most striking insights from trade in value added data is the role of services in international trade. While the services share of world gross exports fluctuates around 20-22%, the share is closer to half in value added terms, reflecting a significant contribution of services to the value of traded goods. Furthermore, if services activities within manufacturing firms are taken into account, the share of services in value added exports rises to two thirds (Miroudot and Cadestin, 2017). These shares come closer to the share of services in total output and employment in most developed and emerging economies. Furthermore, with the codification and digitisation of knowledge which form the basis of a number of professions, more services are directly exposed to international competition, for instance through software as a service. Against this backdrop one would expect that services trade policy have a significant impact on labour market dynamics.

The impact of services offshoring on employment has been studied extensively in the literature. The seminal papers by Elehan Helpman and co-authors pioneered the development of a theoretical framework for analysing offshoring, or trade in tasks, which has been extended and brought to the data by a number of authors. Early studies used the term offshoring and analysed input-output data which distinguish between sourcing of inputs from local and foreign markets. Narrow offshoring, which reflects imports of intermediate inputs from the same sector, i.e. the diagonal cells in input-output tables, is associated with international fragmentation of production and caught a lot of interest in the literature. Nevertheless, many studies found that broad offshoring, defined as importing inputs from other sectors, have a stronger impact on local labour demand. An early survey of this literature summarizes the findings as follows: material offshoring has contributed to growing wage inequality between skilled and unskilled labour, but the impact is difficult to distinguish from technical change. Services offshoring has only a small effect on total employment, but has contributed to a shift in employment from unskilled to skilled workers. Importantly, the shifts have mainly taken place within industries (Crinò, 2009).

Bringing the task theory of offshoring to the data requires information of what workers actually do, which is not readily available. Proxies used are distinctions between production and non-production workers or employment by occupation, depending on availability of data. The latter is often combined with estimates of the tradability of occupations, using the O*Net database to identify tradable tasks and then estimate the intensity of tradable tasks for each occupation.[1] Using this approach on US data covering the decade up to 2007, Crinò (2010) found that services offshoring is skills biased, and for a given skill level offshoring has a stronger negative impact on the most tradeable occupations. These findings illustrate the complexity and ambiguity of the problem, which stems from different effects pulling in opposite directions. First, there is a direct displacement effect, replacing locally produced inputs with imported inputs, which obviously contributes to lower labour demand. However, there is also a productivity effect as imported services may be cheaper or better than local inputs – and some may be unavailable locally. Higher productivity improves competitiveness, raise output and contribute to higher labour demand. The net effect depends on the intensity of use of the offshored tasks across sectors (Wright, 2014).

This paper follows a modified task approach to offshoring. The modification is motivated by growing evidence that firms offshore business functions rather than individual tasks or jobs.[2] Information on business functions and their sourcing has been collected through surveys both in the US and in Europe, but is not yet available in a systematic manner across countries, sectors and over time. Miroudot and Cadestin (2017) made a first attempt to fill this gap. They used information from labour force surveys to associate occupations with business functions breaking down employment on core manufacturing activities and services support functions within manufacturing as well as in other sectors.

[1] The O*Net database is sponsored by the US Department of Labor and Training and contains information on work and worker characteristics for 83 occupations https://www.onetcenter.org/database.html

[2] See for instance Lanz et al (2012), Brown et al. (2014), and Miroudot and Cadestin (2017) and references therein.

Using the data from Miroudot and Cadenstin (2017) I construct a new measure of narrow offshoring based on matching of internal employment by business function and offshoring of products that serve the same function in the production process. To illustrate the difference between traditional measures of narrow offshoring, consider car manufacturing. About 60% of employees in this sector are engaged in performing the core function of fabricating cars while 40% are employed in support functions. Narrow offshoring captures the sourcing of parts and components from other car manufacturers and directly affects the 60% of the workforce engaged in the core business function. However, the 40% working in supporting services are directly affected by services offshoring in the same manner as production workers are affected by offshoring of parts and components. Matching internal business functions to imported services of the same category sheds new light on the dynamics of labour market adjustments to offshoring of services.

The paper also contribute to new insights by studying direct and indirect effect of services trade policy changes over time, including different marginal effects depending on the ICT intensity of the sector in question and on the length of the value chain.

[a summary of the results will be added].

The rest of the study is organised as follows: The next section relates the paper to existing literature. Section 3 describes the data and stylized facts. Section four describes the empirical strategy while section five presents the results and section six concludes.

2. Linkages between goods, services and services functions in production and trade

The micro foundation of the offshoring and trade in task literature is the make-or-buy decision from the theory of the firm, which has been embedded in trade models featuring imperfect competition.[3] For instance, Antràs and Helpman (2004) proposed a setting where firms produce differentiated final goods using headquarter services and intermediate inputs. Their model features four possible ways of organising production: i) vertical integration at home; ii) vertical integration with FDI; iii) outsourcing to a local firm; iv) outsourcing to a foreign firm. Each organisational form is associated with fixed organisational costs which are higher with vertical integration and higher when sourcing from abroad. The fixed costs are denoted f_k^l where k = V, O (vertical integration or outsourcing) l = H, F (home or foreign). The fixed costs are ranked as follows: $f_V^F > f_O^F > f_V^H > f_O^H$. Fixed costs include the inevitable costs of setting up production facilities or establish a contract with a supplier. In addition, compliance costs with foreign regulation as well as outright trade and investment barriers add to the fixed costs of engaging in offshoring. To capture the impact of such policy-induced costs I augment previous studies by introducing measures of policy restrictions in the empirical analysis.

The ability to absorb fixed costs is related to the size of the market over which the fixed costs can be dispersed and the productivity of the firm. Tradelis (2002) add another dimension finding evidence that the more complex the product, the more likely it is to be produced in-house. A number of papers have taken these predictions to the data studying the impact of outsourcing and offshoring for productivity in the firm or sector (Amiti and Wei, 2006), and the impact on local employment patterns. The empirical literature on labour market effects of services offshoring has evolved from the early contribution of Liu and Trefler (2008), finding only minor effects of services offshoring to China and India to more recent studies that find that services offshoring may have contributed to a widening skills premium. An interesting recent contribution to this stream of literature finds that services intensive manufacturing industries are less affected by the China shock than manufacturing in general (Bamieh et al., 2017). A possible interpretation is that countries with a rich services supplier base have comparative advantage in services-intensive industries, and that a reduction in trade costs leads to the reallocation of resources towards the sectors of comparative advantage.

[3] There are two strands of literature on the theory of the firm: the transaction theory and the property rights theory.

Studies of services offshoring include Hijzen et al., (2005) who analysed the employment effect of trade in producer services using UK firm level evidence. They found no evidence that offshoring of services is associated with job losses or greater worker turnover. To the contrary, employment increases more in firms that start to import intermediate services than in firms that do not. A likely explanation is that firms that are able to offshore services are more flexible and thus in a better position to benefit from a positive demand shock. Nevertheless, Geshecker and Görg (2013) found that services offshoring in the UK has contributed to a higher skills premium.

Two empirical strategies are frequently found in empirical studies of the labour market impact of offshoring. One derives conditional and unconditional labour demand from firms' cost-minimizing and profit maximization problem respectively. Conditional labour demand is derived from minimising unit costs, keeping output fixed. Offshoring is entered as a shift parameter in the estimations.[4] In this setting, a statistically significant negative effect of offshoring implies that offshoring has a negative impact on unit labour demand – in other words a positive effect on labour productivity. Unconditional labour demand is derived from profit maximization where firms choose both input quantities and the level of output, taking input and output prices as given. Again offshored services enter the labour demand function as a shift parameter for the same reason as for conditional labour demand.

The second approach to analysing the labour market impact of offshoring is to study how it affects the cost shares of different categories of labour inputs (e.g. by skill level or occupation) in the total variable cost function. A commonly used functional form of the cost function is trans-log, which is convenient since cost shares are derived for each variable input by differentiating the cost function with respect to the input price of that particular input.[5] As for labour demand functions, offshoring enters the regression equation as a shift parameter. This setting is better suited for the analysis of longer-term structural changes following changes in trade patterns. As is well known, trade theory predicts that trade affects the composition of production and employment and relative earnings, but not the overall level of employment.

This paper is closely related to two recent studies of labour demand and labour shares in variable costs respectively, both using the 2013 release of the World Input Output Database (WIOD). Foster-McGregor et al (2013) analysed the impact of outsourcing and offshoring on the skill structure of labour demand and found that the share of labour in variable production costs is negatively associated with offshoring and that medium-skilled workers are the most affected. Foster et al. (2016) estimated the impact of offshoring on labour demand elasticities and found no effect at the aggregate level but a small negative impact of services offshoring. I do a similar analysis as these two papers, using the 2016 release of WIOD. This release no longer provides information on employment by skill level. Instead I break employment down into business functions using data from Miroudot and Cadestin (2017). In addition, I introduce policy and technology shift parameters into the regressions and trace their direct, indirect and joint impact on employment patterns by business function.

3. The data and stylized facts

I combine the 2016 release of the World Input Output Tables (WIOD) and the associated Socio Economic Accounts with Miroudot and Cadestin (2017) estimates of employment by business function. 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. The socio-economic accounts contain information on key macro-

[4] Including intermediate services directly in the factor demand equation system would require the break-down of offshored services values into quantity and unit prices, which is rarely possible.
[5] This result is known as Shepard's lemma in the literature.

economic variables reported in local currencies, which I convert to USD using annual average exchange rates from the OECD.stat.[6]

Miroudot and Cadestin (2017) estimated employment by business function for 27 EU countries plus Brazil, Canada, India, Korea, Mexico and the United States.[7] The functions are approximated using information on employment by occupation where between 25% and 60% of employment within manufacturing firms are found to be in service functions including design and engineering, transport, logistics and distribution and finally marketing and after-sales services. I match these functions with intermediate inputs from sectors for which the core output corresponds to the function in question to construct a measure of narrow offshoring.

Table 1. Business functions in value chains

	Business function	Definition	Related sector (WIOD)
1	**Operations**/core business functions	The core/primary business function of the firm.	A01-C33
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

Source: Based on Miroudot and Cadestin (2017)

In the following the business functions will be denoted by the bold text in the first column of Table 1. Narrow outsourcing and offshoring of business functions are defined as follows:

$$OS_{i,lf} = \frac{S_{fl}}{VA_i}; \quad OS_{i,mf} = \frac{S_{fm}}{VA_i} \tag{1}$$

The left-hand side variable denotes outsourcing and offshoring respectively (subscript *l* indicates local sourcing and *m* imports) by sector *i* of function *f* as a share of value added in the sector, where *i* and *f* corresponds to each other as indicated in Table 1.

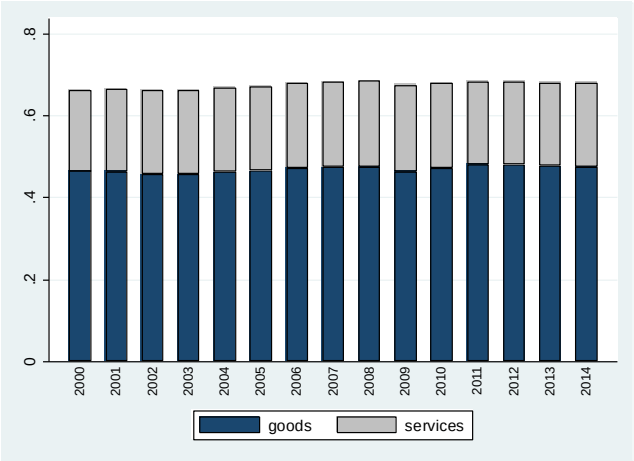
3.1 Mapping the linkages between goods and services in manufacturing

This section maps the linkages between goods and services in manufacturing value chains using the WIOD database combined with Miroudot and Cadestin (2017)'s estimates of internal services production in manufacturing. Figure 1 depicts the unweighted average share of intermediate goods and services in manufacturing gross output across all the countries included in the WIOD database as described in Timmer et al. (2016). 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

[6] Exchange rates for Chinese Taipei are retrieved from the Central Bank of Chinese Taipei. Most of our descriptive work uses ratios, which allows for comparison across countries without conversion to the same currency.
[7] The missing EU country is Croatia.

about the increasing fragmentation of production this may be surprising. Also, the services share in gross output has been stable hovering around 20% and peaking at 21.1% in 2009.

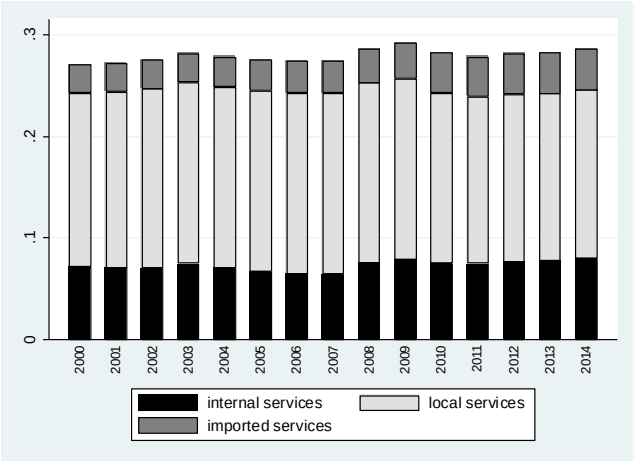
Figure 1. Average share of intermediate goods and services in gross output, manufacturing, all countries



Source: WIOD

As discussed in the previous section, inputs can be made inside manufacturing firms or bought from the market. The make or buy decision rests on firm and sector characteristics, the thickness of the market for external services, and the policy environment in which the firm operates. Thus, the potential for services sourcing is best understood when considering the total contribution of services, both those sourced from outside and those produced inside the sector. Figure 2 breaks down the services share of gross output in Figure 1 into locally sourced and imported services and adds the services functions produced in-house.

Figure 2. Average services inputs in manufacturing; internal, sourced locally and imported, all countries

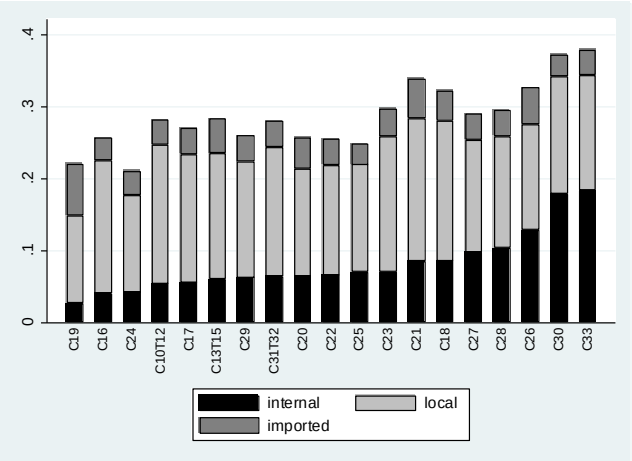


Source: WIOD and Miroudot and Cadestin (2017)

Figure 2 shows that externally sourced services from the local market is the most important, followed by internal services production. Imported services 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 slight shift in the composition from locally sourced to internal and imported services. Thus, in the aggregate, the make-or-buy decision appears to have tilted a bit towards make, while the outsourcing-offshoring decision has shifted slightly towards offshoring. The theory reviewed in the previous section predicts that this would happen when firms become more productive, make more complex products and when services trade barriers come down. The global average may conceal large differences both across sectors and countries. Figure 3 depicts the composition of services inputs by manufacturing sector in 2014.

Figure 3. Average services inputs in manufacturing; internal, sourced locally and imported, by sector, 2014, all countries



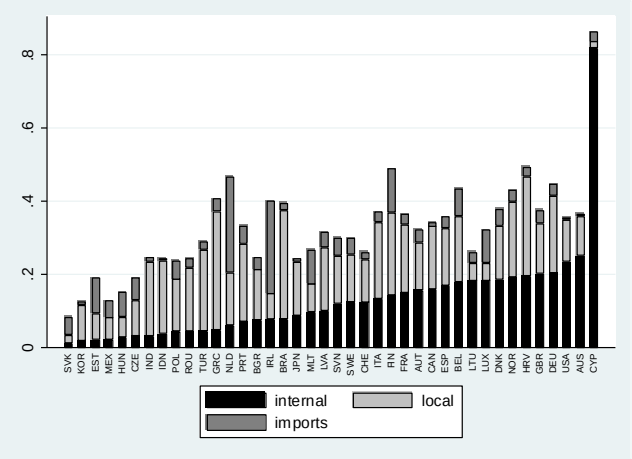
Source: WIOD and Miroudot and Cadestin (2017). Sectors are two-digit ISIC Rev 4.

Unsurprisingly, the sector that uses services the most intensively is repair and installation of manufacturing equipment (C33), a sector at the borderline between manufacturing and services. Manufacture of other transport equipment (C30) and pharmaceuticals (C21) follow as the second and third most services intensive manufacturing sectors on average. 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).[8] Lastly the largest share of internal services production is found in repair and installation and in the manufacture of other transport equipment.

We finally highlight differences in services intensity across countries. To control for differences in industrial structure, I compare services intensities across countries within the same sector. Figure 4 depicts services inputs by country for manufacture of computer, electronic and optical products (C26) in 2014. This sector is characterised by internationally dispersed value chains with large variations in how countries are positioned in the value chain (Gereffi et al., 2006).

[8] This sector is excluded from the analysis in Foster-McGregor et al (2013) and Foster et al (2016), due to volatility of input and output prices.

Figure 4. Services inputs in manufacturing; internal, sourced locally and imported, 2014
Manufacture of computers, electronic and optical products (C26)



Source: WIOD and Miroudot and Cadestin (2017)

The observed variation probably reflects different product categories within the sector as well as differences regarding the position in value chains. In Cyprus manufacturers 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.

3.2 Services and performance in manufacturing

Deepening division of labour is a source of economic growth (e.g. Grossman and Helpman, 1991). Manufacturers' external sourcing of services is one manifestation of deepening division of labour and one would expect it to contribute to productivity growth. Amiti and Wei (2006) found evidence for this in US manufacturing. To explore a possible productivity effect in a cross-country setting with recent data, I calculated total factor productivity growth from WIOD data as follows: $\Delta lnTFP = \Delta lnGO - a\Delta lnVA - (1-a)\Delta lnII$ where GO is gross output, VA represents value added, a the value added share in gross output, and II denotes intermediate inputs. Growth in total factor productivity was next regressed on growth in total services inputs and the length of the value chain. The former reflects the breadth of specialization and the latter the depth of specialization. I also broke down total intermediate services on locally sourced and imported.[9] The results are reported in Table 2.

[9] The length of a value chain is defined as the number of production stages as explained in De Backer and Miroudot (2013).

Table 2. Growth in total factor productivity in manufacturing and sourcing of intermediate services, 5 year differences

	(1)	(2)
Δ ln intermediate services	0.008*	
	(0.005)	
Δ ln length of value chain	0.014**	0.012**
	(0.006)	(0.006)
Dummy, year 2008	0.001**	0.001**
	(0.001)	(0.001)
Δ ln local intermediate services		0.005
		(0.003)
Δ ln imported intermediate services		0.003*
		(0.002)
R2	0.104	0.107
N	11177	11177

Note: regressions are OLS with country and sector fixed effects. Robust standard errors are in parentheses and ** and *signify statistical significance at a 5% and 10% level respectively.

As expected, total factor productivity is positively associated with services inputs, although the statistical and economic significance is relatively weak. When broken down on local and imported, the impact of imported services can be more precisely estimated. The largest impact, however, comes from the length of the value chain, which relates to how many production stages there are and thus directly reflects productivity growth through deepening specialisation. It should be noticed that TFP growth has been pretty flat over the period considered with an average annual growth rate of 0.0004 for manufacturing. This may have to do with the financial crisis that disrupted production and caused significant slack in the economy. To explore the possible effect of the financial crisis I introduced a dummy that split the sample into pre and post crisis, taking the value of unity for 2008 and later years, and zero for earlier years. In fact, it turns out that productivity growth has been slightly higher in the post-crisis years.

Export performance in manufacturing is related to offshoring of services in two ways. First, as previous studies have shown and the results reported in Table 2 support, services offshoring may improve productivity in manufacturing, making manufactures more competitive. Second, services sourced from the destination country, such as transport, distribution, marketing, technical testing and legal services to mention but a few, directly support the exporting activity. I explored this using a simple OLS regression controlling for country and sector fixed effects. The results are reported in Table 3 where the first column shows the regression on levels of exports while the second displays the results of a difference regression with the same variables. We observe that all the services are simultaneously statistically significant with transport (G) and finance (K) having the strongest association with the level of exports, while distribution (H) is most strongly associated with changes in exports.

Table 3. Services offshoring and export performance in manufacturing

	Level	One year difference
G, Wholesale and retail trade	0.273***	0.166***
	(0.008)	(0.018)
H, Transport and storage	0.129***	0.207***
	(0.009)	(0.018)
J, Information and communication	0.068***	0.116***
	(0.009)	(0.016)
K, Finance and insurance activities	0.244***	0.138***
	(0.011)	(0.013)
M, Professional, scientific and technical activities	0.046***	0.046***
	(0.007)	(0.007)
N, Administrative and support activities	0.058***	0.050***
	(0.006)	(0.009)
R^2	0.981	0.756
N	12280	11459

Note: OLS regression with country, sector and year fixed effects. The left hand side variable is the log of exports and the right hand side variable the log of imported intermediate services in the sector indicated. The second column reports the one year differences of the same variables as in the first column. ***, **, and * signify statistical significance at a 1%, 5% and 10% level respectively.

I finally observe that the outsourcing/offshoring decision does not appear to be a question of either or. Rather, the two are positively correlated with the strongest correlation observed for sector M (professional, scientific and technical service) with a correlation coefficient of 0.644, significant at a 0.1% level.

4. Empirical strategy

To explore the labour market impact of services outsourcing and offshoring, I use standard trade and labour market analysis tools following Hijzen et al. (2005), Foster et al. (2013) and Mc-Gregor et al. (2016). My approach differs from theirs by breaking down labour into in-house business functions, rather than skill levels. As discussed in the introduction, companies outsource business functions, not individual jobs or tasks, so I believe this approach is better aligned with the actual decisions facing businesses. The conditional labour demand for function *f* in sector *i*, country *c* at time *t* can be written as follows:

$$lnl_{fict} = \alpha_0 + \sum_f \alpha_j lnw_{fict} + \beta_k lnk_{ict} + \beta_y lny_{ict} + \sum_l \gamma_l lnz_{ilct} \quad (2a)$$

$$lnl_{fict} = \alpha_0 + \sum_f \alpha_j lnw_{fct} + \beta_k lnk_{ict} + \beta_y lny_{ict} + \sum_l \gamma_l lnz_{ilct} \quad (2b)$$

Conditional labour demand reflects unit labour demand which is a measure of labour productivity. The second term contains the unit prices of all variable inputs, which are the seven business functions and material inputs. Equation (2a) allows price differentiation across sectors, while (2b) applies the law of one price. The next two terms represent capital and output respectively. The last term represents a set of demand shifters. Among these are local and foreign sourced intermediate services, the length of the value chain, technology indicators and policy variables.

Average wages for the seven functions have been calculated using two alternative methods. The first allows heterogeneity across sectors. Thus, wages for the same function may vary across sectors within the same country and same year. It is calculated by dividing wage expenditure on each business function on the number of hours worked in that business function. The second methodology applies the law of one

price assumption and thus that functions are uniform across sectors and obtain the same unit price whatever the use. The uniform wage rates for each function are calculated by optimizing an equation system where wages are unknown but the employment by function and overall wage cost for each sector are known. The statistical annex provides summary statistics on the variables used in the regressions.

Turning to policy variables I start with the OECD product market regulation (PMR) indices, which are available for most of the countries included in the WIOD database for the period covered. Policy and technology variables are assigned a weight in the regressions corresponding to coefficients in the inverse Leontief matrix for the US in the year 2000. For instance, the PMR for the infrastructure services sectors (transport, telecommunications and electricity) is multiplied with the sum of the coefficient for transport, electricity and telecommunications in the inverse Leontief matrix for the US. We use weights that reflect the direct and indirect importance of the input in each sector and we apply the weights from the US inverse Leontief matrix in the first year of the analysis to mitigate possible endogeneity problems.

Following Foster-McGregor et al. (2016) we estimate the labour demand functions in five-year differences to reduce the sensitivity to measurement error. The regression equation then becomes:

$$\Delta lnl_{fict} = \alpha_0 + \sum_f \alpha_j \Delta lnw_{fict} + \beta_k \Delta lnk_{ict} + \beta_y \Delta lny_{ict} + \sum_l \gamma_l \Delta lnz_{ilct} + \varepsilon_{fict} \quad (3a)$$

$$\Delta lnl_{fict} = \alpha_0 + \sum_f \alpha_j \Delta lnw_{fct} + \beta_k \Delta lnk_{ict} + \beta_y \Delta lny_{ict} + \sum_l \gamma_l \Delta lnz_{ilct} + \varepsilon_{fict} \quad (3b)$$

Differentiating the cost function, making the standard assumption that it takes a trans-log form, with respect to input prices yields the shares of each input in total costs. The regression function derived from this process, where business functions and intermediate inputs constitute the variable costs, reads as follows:

$$\Delta s_{fict} = \alpha_0 + \sum_f \varphi_j \Delta lnw_{fict} + \delta_k \Delta lnk_{ict} + \delta_y \Delta lny_{ict} + \sum_l \vartheta_l \Delta lnz_{ilct} + \varepsilon_{fict} \quad (4a)$$

$$\Delta s_{fict} = \alpha_0 + \sum_f \varphi_j \Delta lnw_{fct} + \delta_k \Delta lnk_{ict} + \delta_y \Delta lny_{ict} + \sum_l \vartheta_l \Delta lnz_{ilct} + \varepsilon_{fict} \quad (4b)$$

The dependent variable is now the cost share in total variable costs of business function *f* in industry *i* country *c* at time *t*. Since the shares must add up to unity, one variable input, material intermediate inputs is left out of the equation system. The independent variables are the same as in the conditional and unconditional factor demand functions.

5. Results

5.1 Labour demand by business function

It would be natural to start the analysis replicating Foster et al. (2016) and Foster-McGregor et al. (2013) who estimated factor demand by skills category using the 2013 release of WIOD. Unfortunately, the 2016 release does not provide a break-down of employment by skill-level, so that is not possible. The only option to compare with other studies is to estimate labour demand for aggregate employment. Following the approach for the two previous studies, I exclude manufacture of coke and petroleum products (C19) and public services (sectors O to U). The results are reported in Table 4. The first two columns exhibit regressions using one year differences and the last two columns show five year differences.

Table 4. Conditional and unconditional total labour demand and services outsourcing and offshoring

	One year differences		Five year differences	
	conditional	unconditional	conditional	unconditional
Δ ln wage	-0.587***	-0.501***	-0.586***	-0.534***
	(0.005)	(0.005)	(0.005)	(0.006)
Δ ln Price intermediates	0.054***	0.079***	-0.008	0.034***
	(0.015)	(0.009)	(0.020)	(0.011)
Δ ln Capital	0.094***	0.279***	0.188***	0.476***
	(0.008)	(0.009)	(0.012)	(0.012)
Δ ln Gross output	0.483***		0.393***	
	(0.005)		(0.007)	
Δ ln output price index	-0.125***		-0.092***	
	(0.017)		(0.022)	
Δ ln services outsourcing	-0.210***	-0.119***	-0.189***	-0.074***
	(0.012)	(0.013)	(0.015)	(0.015)
Δ ln services offshoring	-0.597***	-0.495***	-0.544***	-0.561***
	(0.017)	(0.019)	(0.020)	(0.022)
R^2	0.466	0.322	0.443	0.349
N	30101	30101	21490	21490

Note: Robust standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively. The one year difference regression includes country, sector and year fixed effects.

The results are largely in line with the outcome of other studies. Both offshoring and outsourcing reduce unit labour demand, as depicted in the conditional demand regressions, improving labour productivity. The marginal effect of offshoring is more than twice as large as that of outsourcing. Turning to unconditioned labour demand, offshoring also reduces labour demand in absolute terms and again the marginal impact is stronger for offshoring.

Having ascertained that the last version of the WIOD database has similar properties as earlier versions as far as the relationship between employment and outsourcing is concerned, I now turn to labour demand by business function and the impact of outsourcing and offshoring. For this purpose I use seemingly unrelated regressions (SUR), taking into account that the error terms of the demand functions may be related. An important caveat is that the price index for intermediate inputs may capture some of the effects of services outsourcing and offshoring since the price index is only available for total intermediate inputs. The estimated effects could therefore be biased downwards. The conditional demand functions are depicted in Table 5.

Table 5. Regression results, conditional labour demand by function, 5-year differences, broad services outsourcing and offshoring

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ ln wage1	-0.325***	0.240***	-0.074***	-0.038	-0.143***	-0.177***	0.119***
	(0.017)	(0.027)	(0.026)	(0.029)	(0.021)	(0.029)	(0.026)
Δ ln wage2	-0.008	-0.310***	0.014	-0.033**	-0.030**	-0.031*	0.054***
	(0.010)	(0.016)	(0.015)	(0.017)	(0.012)	(0.017)	(0.016)
Δ ln wage3	-0.047***	-0.070***	-0.185***	0.004	-0.035***	0.058***	-0.043***
	(0.009)	(0.014)	(0.013)	(0.015)	(0.011)	(0.015)	(0.014)
Δ ln wage4	-0.049***	0.014	-0.032***	-0.354***	-0.030***	-0.035***	0.003
	(0.007)	(0.011)	(0.011)	(0.012)	(0.009)	(0.012)	(0.011)
Δ ln wage5	-0.034***	-0.049**	-0.059***	-0.039*	-0.327***	-0.237***	-0.036*
	(0.013)	(0.020)	(0.019)	(0.021)	(0.015)	(0.022)	(0.020)
Δ ln wage6	-0.028***	-0.001	-0.030***	-0.049***	-0.024***	-0.157***	0.017*
	(0.006)	(0.010)	(0.010)	(0.011)	(0.008)	(0.011)	(0.010)
Δ ln wage7	-0.026***	0.012	-0.004	0.006	-0.046***	-0.060***	-0.284***
	(0.009)	(0.014)	(0.013)	(0.015)	(0.011)	(0.015)	(0.014)
Δ ln Price intermediate inputs	0.098	-0.023	0.057	-0.043	0.170**	0.177	-0.061
	(0.069)	(0.108)	(0.106)	(0.116)	(0.084)	(0.119)	(0.107)
Δ ln capital	0.307***	0.226***	0.709***	0.114*	0.167***	0.093	-0.005
	(0.038)	(0.059)	(0.058)	(0.064)	(0.046)	(0.065)	(0.059)
Δ ln gross output	0.262***	0.178***	0.058	0.326***	0.165***	0.149***	0.101**
	(0.026)	(0.040)	(0.039)	(0.043)	(0.031)	(0.044)	(0.040)
Δ ln price final output	-0.356***	-0.183	-0.331***	-0.255**	-0.214**	-0.203	-0.143
	(0.076)	(0.119)	(0.116)	(0.127)	(0.092)	(0.130)	(0.118)
Δ ln local services inputs	-0.316***	-0.259***	-0.07	-0.124	-0.321***	-0.392***	-0.051
	(0.049)	(0.077)	(0.075)	(0.082)	(0.060)	(0.085)	(0.076)
Δ ln imported services inputs	0.04	-0.146	-0.098	-0.005	0.207**	0.419***	-0.173
	(0.086)	(0.134)	(0.131)	(0.144)	(0.104)	(0.148)	(0.133)
R^2	0.094	0.06	0.051	0.106	0.093	0.063	0.053
N	8766	8766	8766	8766	8766	8766	8766

Note: Five year difference SUR regressions. Robust standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively.

We first observe that more than half of the observations are dropped when employment is disaggregated into business functions. This is first and foremost because of the limited country coverage of information on employment by business function, but also missing information to calculate earnings by business function in some sectors even in the countries that are covered.[10] The regression results thus represent a sub-sample of those reported in Table 4. Reassuringly, the own price elasticities are always negative and statistically significant at a 1% level. Similarly, we notice that most cross-price elasticities are negative too suggesting that employment by business function reflects division of labour within sectors and firms and a production process where functions are complementary. There are two exemptions to this. Demand for Transport functions as well as Other business functions tends to go up when the wage rate for the core

[10] Further work is under way to fill the gaps for the countries for which information on employment by business function.

Operating functions go up. Thus, higher wages in the core Operating functions appear to shift employment away from core Operations, Marketing and IT functions towards Transport and Other business functions. Another interesting observation is that demand for each business function increases less than proportional to real output, suggesting that the share of the omitted variable, material inputs, grows with increasing output. Unsurprisingly the core Operations business function is complementary to all supporting business functions, although insignificantly so for Transport (function 2).

Turning to services outsourcing and offshoring, we observe that in this sample and when analysing labour demand by business function, domestic outsourcing appears to have the largest impact, shifting down unit demand for core Operating functions (1), Transport (2), Management (5) and R&D (6). Offshoring, on the other hand appears to be associated with an upward shift in in-house unit demand for Management and R&D functions, suggesting that local in-house provision of these business functions may be substitutes to locally sourced and complementary to offshored services. Interestingly, local outsourcing and offshoring may thus be qualitatively different and serve different purposes.[11] For unconditional labour demand the results are virtually the same as for the conditional demand regressions, suggesting that scale effects are not important for the composition of labour demand by function. In the interest of space I do not report these results.

The overall relationship between in-house, outsourced and offshored business functions may conceal differences across the services being outsourced or offshored. To explore this, we now turn to narrow outsourcing and offshoring, relating demand for in-house functions to the corresponding services sector reported in Table 1 above. The results are presented in Table 6 where the column heading indicates the business function.

[11] To what extent this is related to the export intensity of the sector will be explored in the final version of this paper.

Table 6. Regression results, conditional labour demand by function, 5-year differences, narrow outsourcing and offshoring

	1	2	3	4	5	6	7
Δ Ln wage1	-0.326***	0.238***	-0.073**	-0.039	-0.144***	-0.181***	0.119***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Δ Ln wage2	-0.008	-0.309***	0.014	-0.033	-0.029*	-0.031	0.054***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Δ Ln wage3	-0.046***	-0.068***	-0.186***	0.005	-0.032**	0.060***	-0.044**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Δ Ln wage4	-0.047***	0.014	-0.031**	-0.354***	-0.030***	-0.036**	0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ Ln wage5	-0.028*	-0.045*	-0.058**	-0.039	-0.325***	-0.240***	-0.035
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Δ Ln wage6	-0.028***	-0.001	-0.030**	-0.049***	-0.024**	-0.158***	0.017
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ Ln wage7	-0.025**	0.012	-0.004	0.006	-0.045***	-0.061***	-0.284***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Δ Ln price intermediate inputs	0.073	-0.061	0.066	-0.078	0.106	0.096	-0.064
	(0.07)	(0.11)	(0.10)	(0.11)	(0.08)	(0.12)	(0.11)
Δ Ln capital	0.302***	0.271***	0.701***	0.134*	0.193***	0.101	0.008
	(0.04)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)
Δ Ln gross output	0.255***	0.142***	0.059	0.310***	0.136***	0.159***	0.089*
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)
Δ Ln final output price	-0.312***	-0.114	-0.353**	-0.2	-0.123	-0.085	-0.127
	(0.07)	(0.12)	(0.11)	(0.12)	(0.09)	(0.13)	(0.11)
Δ Ln services outsourcing	-0.372***	-0.925***	-0.338*	-0.381	-0.290*	-1.386***	-0.584*
	(0.06)	(0.23)	(0.15)	(0.53)	(0.12)	(0.36)	(0.24)
Δ Ln services offshoring	-0.186***	0.298	-0.47	-1.352	-0.296	1.463*	0.121
	(0.06)	(0.23)	(0.31)	(2.50)	(0.38)	(0.72)	(0.44)
R^2	0.095	0.0595	0.0517	0.1057	0.0907	0.0628	0.053
N	8766	8766	8766	8766	8766	8766	8766

Note: The five year difference regressions are run using seemingly unrelated regressions (SUR). Standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively. The column headings represent the business function number and associated sector as reported in Table 1.

A similar pattern is observed for narrow outsourcing and offshoring. Outsourcing has the largest and broadest impact, shifting unit labour demand down where significant, while offshoring of services appear to have only a minor impact on in-house business functions. Similar to the finding for broad offshoring, narrow offshoring has a positive, although not very precisely estimated impact on internal employment in R&D functions. Imports of material inputs in contrast reduce unit labour demand for the core Operation function.

The most interesting story emerging from these results relates to IT (4) and R&D (6). Against the backdrop of being at the core of the services offshoring debate in the late 1990s and early 2000s, the non-result for offshoring of IT services is interesting. We notice that IT functions are the least related to other functions with mainly insignificant cross-price elasticities, except for R&D functions which are complementary to IT

functions. At the same time ICT functions are the most strongly related to total output. This reflects that IT and software have become ubiquitous and an integrated part of production in any sector. As we shall see below, IT is more affected by offshoring in the manufacturing sector. R&D, in contrast, is related to most other functions and demand for this function is the only one with a positive, large but weak association to narrow offshoring. As for broad outsourcing and offshoring, the unconditional demand regressions produced very similar results as the conditional ones and in the interest of space we do not report them here.

5.2 Trans-log factor demand by function

A complementary approach to labour market impact of offshoring and outsourcing is to study a trans-log factor demand function where the left hand side variable is expressed in shares. We focus on the impact of narrow offshoring for the structure of employment in the manufacturing sector. As usual in such analysis, the dependant variable is the cost shares in variable cost of each input, in this case employment by business function and intermediate inputs. The omitted regression equation is for the share of local intermediate goods and services.[12] Table 7 reports the results of the base line regression using the same controls as in the labour demand regressions above and where the demand shifter is imported inputs corresponding to the business function as indicated in Table 1.

[12] As noted above we do not have price indices for intermediate inputs for local and intermediate inputs separately, so it is assumed that the price index is similar for local and imported inputs, which may introduce a bias.

Table 7. Trans-log factor demand, labour functions, narrow outsourcing and offshoring, 5 year differences

	1	2	3	4	5	6	7
Δ lnwage1	0.075***	0.001	-0.011***	0.001	-0.031***	-0.007*	0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ lnwage2	-0.001	0.012***	-0.001	-0.004***	0	-0.001	0.002**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ lnwage3	-0.003*	0	0.012***	-0.004***	0.002*	0	-0.003***
	(0.00)	0.00	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ lnwage4	0	-0.001*	-0.002**	0.009***	-0.001	-0.001	-0.001**
	(0.00)	0.00	(0.00)	0.00	(0.00)	(0.00)	0.00
Δ lnwage5	-0.005*	-0.004***	-0.001	-0.004***	0.029***	-0.006***	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ lnwage6	0	-0.001	-0.002**	-0.007***	-0.002*	0.014***	-0.002**
	(0.00)	0.00	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ lnwage7	-0.002	-0.001**	0	-0.003***	0	-0.004***	0.011***
	(0.00)	0.00	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ ln price intermediate inputs	0.003	0.008	-0.030**	-0.008	-0.001	0.015	-0.016*
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ ln capital	0.021***	0.003	0.020***	0.005*	0.008*	0.001	0.001
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ ln gross output	-0.053***	-0.008***	-0.010***	0.003	-0.019***	-0.012***	-0.008***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ ln price final output	0.006	-0.008	0.021	0.004	-0.01	-0.017	0.008
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ ln narrow offshoring	-0.006	-0.022	0.013	0.104	-0.937***	-0.076	-0.039*
	(0.01)	(0.03)	(0.02)	(0.12)	(0.05)	(0.06)	(0.02)
R^2	0.15	0.121	0.089	0.217	0.215	0.099	0.148
N	2862	2862	2862	2862	2862	2862	2862

Note: The regressions are run using seemingly unrelated regressions (SUR) for shares in variable costs by the business functions indicated by the column heading for manufacturing. The omitted variable input is locally sourced inputs. Standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively.

We first notice that the share of each business function in total variable costs is not very sensitive to movements in factor prices or offshoring, supporting the finding from the previous section that business functions complement each other in the production process. Nevertheless services offshoring is associated with a modest shift in variable cost shares from the Management function to local sourcing of intermediate inputs.[13] The overall impact of narrow offshoring on the structure of employment in manufacturing seems to be limited. In the following I explore if this tentative conclusion is robust to the introduction of additional controls that could be important and to what extent the marginal impact of offshoring is conditional on such controls.

[13] Since shares add up to unity and none of the other business functions are significantly related to offshoring, the change must be absorbed by the omitted input.

As discussed above, the length of the value chain is associated with higher productivity while more complex products are more likely to be produced in-house.[14] To explore the relationship between the length of the value chain and structural changes in employment by business function we introduce the log of the length of the value chain as a shift parameter in the regressions. The result is reported in Table 8. Adding length did not change the parameters on the core variables in the regression, but it strengthened the significance of offshoring. In the interest of space, Table 8 only reports the coefficients of the variables of interest.

Table 8. Trans-log factor demand, labour functions, narrow outsourcing and offshoring, 5 year differences, additional shift variables

	1	2	3	4	5	6	7
Adding length of value chain							
Δ ln length	-0.235***	-0.026***	-0.019	-0.028***	0.009	-0.086***	-0.023***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ ln offshoring	0.078***	0.001	0.016	0.303*	-0.980***	0.033	-0.036*
	-0.008	-0.025	-0.021	-0.128	-0.049	-0.06	-0.015
R^2	0.175	0.126	0.090	0.221	0.213	0.117	0.152
N	2862	2862	2862	2862	2862	2862	2862
Adding technology (internet use)							
Δ ln length	-0.225***	-0.024***	-0.022*	-0.026***	0.015	-0.091***	-0.020**
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ ln internet use	0.008*	-0.004*	0.003	-0.011***	0.005	0.011***	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ ln offshoring	0.071***	0.003	0.017	0.335*	-0.971***	0.041	-0.031*
	(0.01)	(0.03)	(0.02)	(0.13)	(0.05)	(0.06)	(0.02)
R^2	0.175	0.126	0.090	0.221	0.213	0.117	0.152
N	2625	2625	2625	2625	2625	2625	2625
Add PMR for infrastructure services							
Δ ln length	-0.225***	-0.024***	-0.033**	-0.042***	0.027*	-0.093***	-0.017*
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Δ ln internet use	0.010*	-0.002	0.003	-0.007***	0.004	0.012***	0
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Δ PMR	0.131***	0.012	0.02	-0.098***	0.052*	0.048	0.026
	(0.04)	(0.01)	(0.03)	(0.02)	(0.03)	(0.03)	(0.02)
Δ ln offshoring	0.062***	0	-0.012	0.620**	-1.138***	-0.04	-0.029
	(0.01)	(0.03)	(0.03)	(0.20)	(0.05)	(0.07)	(0.02)
R^2	0.174	0.094	0.091	0.186	0.214	0.096	0.142
N	2,073	2,073	2,073	2,073	2,073	2,073	2,073

Note: The regressions are run using seemingly unrelated regressions (SUR) for shares in variable costs by the business functions indicated by the column heading for manufacturing. The omitted variable input is locally sourced inputs. Standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively.

[14] It is, however, not necessarily the case that longer value chains indicate more complex products even if they do represent more fragmented production processes.

A longer supply chain is associated with a smaller share of most internal business functions, with the exception of Marketing and Management which are unaffected. By implication, local intermediate inputs account for a larger cost share and wages a smaller cost share the longer the supply chain. This could be associated with higher productivity as reported in Table 2. The finding does, however, not support the prediction that more complex products tend to be produced in-house, to the extent that the length of the supply chain reflects complexity. Introducing the length of the supply chain changes the sign on of narrow offshoring of the core Operations function. Thus, it appears that when the number of production stages is taken into account, offshoring complements local Operations.

The second panel introduces the log of internet use per 100 inhabitants as a technology indicator. The variable is made country and sector specific by weighting with the sum of the coefficients in the inverse Leontief matrix for the US in 2000 for the most internet-intensive inputs.[15] It appears that variation in internet use do not have a large impact on structural changes in the composition of business functions in manufacturing, although more internet use is associated with a modest shift from in-house IT functions to in-house R&D functions. If confirmed through robustness checks this is an interesting observation suggesting that offshoring of IT functions is associated with a movement up the technology ladder towards more in-house R&D.

Services trade related policy variables that cover the sample of countries over the period covered by the WIOD 2016 release are not numerous. The most comprehensive is the OECD Product Market Regulation indices for the network sectors (electricity, transport and telecommunications) which are available annually for most of the countries. The third panel in Table 8 reports the coefficients on the PMR. It indicates that burdensome regulations in the infrastructure sectors are associated with a shift from IT functions to the core Operations functions. Interestingly, it also appears that after controlling for regulation, offshoring of IT services become positive and significant. Thus, regulation of network industries may explain to what extent local industries are able to complement internal IT functions with offshored IT services.

The changes in the parameters on offshoring with the inclusion of new shift variables suggest that the impact of offshoring on the structure of employment may depend on the nature of the supply chain, the policy environment and technology.[16] Interaction terms shed light on such possible joint effects. Interaction terms are, however, not compatible with difference regressions, but can be applied to cost share regressions using their level rather than their rate of change. To control for unobserved sector, country and time effects that could affect the results we add country, sector and time dummies. The core regression equation including all controls is reported in annex table A2. The results are qualitatively similar to the regressions run on the rate of change of the shares of each business function in the cost function. As for the difference regressions, the parameters on the core variables are robust to inclusion of additional shift parameters, so we focus on the variables of interest and the interaction terms in the following.

The results are depicted in Table 9, where marginal effects are reported only when statistically significant. I also report the marginal effects at mean, the mean minus half a standard deviation and the mean plus half a standard variation of the variable of interest included in the interaction term.

[15] These are ISIC 4 sectors G46, G47, J59-60, J61, J62-63 and M73. The OECD will shortly release indicators of ICT-intensity by sector, which captures sectoral differences in ICT-technology use more directly and will be used in the final version of this paper.

[16] Some observations are also dropped with the inclusion of new variables which could also explain the change in the value of coefficients.

Table 9. Structure of employment by business function, interaction term and marginal effects

Business function	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Ln Length	-0.306***	-0.032***	-0.065***	-0.033***	-0.070***	-0.132***	-0.049***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Ln offshoring	0.338***	-0.304***	0.08	1.596***	-0.838***	1.125***	-0.097**
	(0.02)	(0.07)	(0.05)	(0.37)	(0.18)	(0.22)	(0.04)
Ln length * ln offshoring	-0.191***	0.337***	-0.029	-1.285***	0.839***	-1.384***	0.078*
	(0.02)	(0.07)	(0.05)	(0.37)	(0.17)	(0.25)	(0.04)
Marginal effect of offshoring conditional on length							
Mean- 0.5 std. dev	0.185	-0.033		0.564	-0.164	0.014	-0.034
Mean	0.168	-0.004		0.450	-0.090	-0.109	-0.027
Mean + 0.5 std. dev	0.151	0.026		0.336	-0.015	-0.232	-0.021

Business function	**1**	**2**	**3**	**4**	**5**	**6**	**7**
PMR infrastructure	-0.035*	-0.003	0.009	-0.007*	-0.006	-0.001	-0.022***
	(0.02)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Ln offshoring	0.141***	-0.028	0.099***	0.054	0.04	0.257***	-0.01
	(0.01)	(0.02)	(0.01)	(0.12)	(0.04)	(0.06)	(0.01)
PMR*ln offshoring	-0.080***	0.284***	-0.215***	0.979*	-0.106	-1.429***	-0.08
	(0.02)	(0.08)	(0.05)	(0.39)	(0.15)	(0.22)	(0.05)
Marginal effect of offshoring conditional on PMR							
Mean - 0.5 std. dev	-0.045	0.035	-0.026	0.113		-0.175	-0.022
Mean	-0.050	0.053	-0.040	0.176		-0.267	-0.022
Mean + 0.5 std. dev	-0.055	0.072	-0.054	0.240		-0.360	-0.022

Business function	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Ln Length	-0.307***	-0.052***	-0.085***	-0.034***	-0.092***	-0.111***	-0.063***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
PMR infrastructure	0.023	-0.114***	-0.091***	0.005	-0.139***	0.130***	-0.098***
	(0.05)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Ln Length* PMR	-0.104*	0.123***	0.102***	-0.011	0.143***	-0.149***	0.081***
	(0.05)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
Marginal effect of PMR conditional on length							
Mean - 0.5 std. dev	-0.083	-0.015	-0.009		-0.024	0.010	-0.033
Mean	-0.093	-0.004	0.000		-0.012	-0.003	-0.026
Mean + 0.5 std. dev	-0.102	0.007	0.009		0.001	-0.016	-0.019

Note: The regressions are run using seemingly unrelated regressions (SUR). The omitted variable input is material inputs. Standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively.

Starting with the first panel, offshoring appears to have a different impact on the structure of employment by business function depending on the length of the value chain. Offshoring of material intermediates is associated with a higher employment share in core Operations functions, but the marginal effect declines with the length of the value chain. Offshoring of ICT services quite strongly raises the cost share of IT

functions internally, but also here the marginal effect peters out with the length of the supply chain. Interestingly, offshoring of technical business services raised the cost share of internal R&D for short supply chains, but raises the internal cost share for R&D functions in long value chains.

The impact of narrow offshoring on the structure of employment also varies with the level of burdensome regulation in infrastructure services. As depicted in the second panel Internal IT functions appear to complement outsourced ICT services, the more so the higher the regulatory barriers. Offshored technical business services in contrast appear to substitute for internal R&D functions, and the marginal effect is higher the more burdensome the regulation.

Finally I explore how the length of the value chain and regulation interacts in driving structural changes in manufacturing employment. The global value chain literature has highlighted the multiplicative effect of trade restrictions when goods and services cross international borders several times. From this insight one might expect that regulation has a larger effect the longer the supply chain. The third panel in Table 9 offer some support for this. Although it indicates that product market regulation on its own is not so important, whatever the length of the value chain, it does find that offshoring of material inputs reduces the cost share of the core Operations function – and the more so the longer the supply chain.

The final version of the paper will:

- Add more policy variables the STRI – which shortens the panel considerably calling for additional identification strategies.
- Add new indicators of technology – OECD forthcoming ICT intensity indicators
- Add refined and expanded information on employment and wages by business function. And add robustness checks for wages following the law of one price.
- Trace out a coherent story line from the various findings

Concluding remarks

[to be added]

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[to be completed]

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ANNEX

Tabel A1: Summary statistics

Total sample						Manufacturing				
Variable	Observations	Mean	Std. dev	Min	Max	Observations	Mean	Std. dev	Min	Max
Business functions share of total employment										
1	33,568	0.408	0.268	0	1	10,800	0.571	0.197	0	1
2	33,567	0.084	0.140	0	1	10,800	0.059	0.054	0	1
3	33,566	0.087	0.130	0	1	10,800	0.049	0.059	0	1
4	33,566	0.027	0.080	0	0.934	10,800	0.015	0.025	0	0.292
5	33,567	0.158	0.147	0	1	10,800	0.100	0.073	0	1
6	33,567	0.076	0.107	0	1	10,800	0.082	0.085	0	1
7	33,566	0.134	0.175	0	1	10,800	0.090	0.117	0	1
Business functions share of total earnings										
1	27,422	0.379	0.245	0	1	8,694	0.510	0.201	0	1
2	27,423	0.079	0.122	0	1	8,695	0.060	0.056	0	1
3	27,420	0.091	0.111	0	1	8,693	0.068	0.071	0	1
4	27,418	0.043	0.093	0	1	8,691	0.030	0.051	0	0.664
5	27,421	0.182	0.145	0	1	8,693	0.128	0.085	0	1
6	27,370	0.112	0.124	0	1	8,676	0.126	0.104	0	1
7	27,422	0.111	0.144	0	1	8,693	0.077	0.077	0	1
Narrow outsourcing, by business function (local sourcing/value added)										
1	34,899	0.364	1.016	0	92.499	11,640	0.690	0.561	0.000	4.469
2	34,899	0.105	0.744	0	93.346	11,640	0.083	0.070	0.000	0.806
3	34,899	0.144	0.454	0	50.658	11,640	0.221	0.167	0.000	4.502
4	34,899	0.015	0.072	0	7.532	11,640	0.009	0.010	0	0.159
5	34,899	0.145	5.265	0	599.428	11,640	0.068	0.048	0.000	0.728

	6	34,899	0.017	0.045	0	1.986	11,640	0.015	0.027	0	0.422
	7	34,899	0.043	0.104	0	8.879	11,640	0.032	0.032	0	0.345
Narrow offshoring, by business function (imports/value added)											
	1	34,899	0.324	0.739	0	76.79	11,640	0.600	0.484	0.019	7.403
	2	34,899	0.029	0.151	0	9.25	11,640	0.017	0.021	0.000	0.324
	3	34,899	0.025	0.067	0	5.06	11,640	0.036	0.043	0.001	0.646
	4	34,899	0.004	0.021	0	2.90	11,640	0.002	0.004	0.000	0.117
	5	34,899	0.022	0.187	0	11.32	11,640	0.012	0.018	0.000	0.254
	6	34,899	0.005	0.024	0	2.13	11,640	0.004	0.011	0.000	0.232
	7	34,899	0.014	0.247	0	42.47	11,640	0.009	0.042	0.000	1.423
Length of value chain		36,960	2.084	0.519	1	9.493	11,880	2.473	0.374	1	3.887
Capital stock		36,120	59036.8	460522.4	0	20100000	11,610	20301.85	57856.15	-1158.5	1156983
Gross output		36,960	44265.4	145718.6	0	3438163	11,880	37727.34	106499.8	0	1811694
Internet use per 100 inh.		4,190	28.348	27.159	0	98.32					
PMR infrastructure services		505	2.640	0.860	0.789	5.31					
PMR telecommunications		505	1.408	0.920	0.265	5.15					

Table A2. Base regression, costs share levels, manufacturing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln wage1	0.049***	0.001	-0.003	-0.003**	-0.021***	-0.019***	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Ln wage2	-0.006**	0.008***	0.001	0.003***	0	0	0.003***
	(0.00)	(0.00)	(0.00)	0.00	(0.00)	(0.00)	(0.00)
Ln wage3	-0.001	-0.003***	0.005***	-0.005***	-0.003***	0.004***	-0.001
	(0.00)	0.00	(0.00)	0.00	(0.00)	(0.00)	(0.00)
Ln wage4	-0.009***	0	-0.002**	0.010***	-0.005***	0	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Ln wage5	0.008**	-0.003***	0	-0.004***	0.031***	-0.005**	-0.005***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Ln wage6	-0.015***	0	0.003***	0	-0.002	0.016***	0.001
	(0.00)	0.00	(0.00)	0.00	(0.00)	(0.00)	(0.00)
Ln wage7	-0.014***	0.001**	-0.001	0	0.001	0.003*	0.009***
	(0.00)	0.00	(0.00)	0.00	(0.00)	(0.00)	(0.00)
Ln price intermediate inputs	0.022	0.002	-0.001	0.002	0.004	0.003	0.018***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Ln Capital	-0.003*	-0.002***	-0.001	0.002***	0	0.006***	0
	(0.00)	0.00	(0.00)	0.00	(0.00)	(0.00)	(0.00)
Ln Gross output	-0.022***	-0.001***	-0.004***	-0.002***	-0.007***	-0.005***	-0.005***
	(0.00)	0.00	0.00	0.00	(0.00)	(0.00)	(0.00)
Ln final output price	-0.034**	-0.001	-0.008*	-0.004	-0.010*	-0.016*	-0.004
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Ln Length	-0.323***	-0.028***	-0.065***	-0.036***	-0.064***	-0.140***	-0.047***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Ln Internet use	0.012***	0.001	-0.001	-0.001	0	-0.006***	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PMR infrastructure	-0.073***	-0.001	0.003	-0.006	-0.007	-0.008	-0.023***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Ln narrow offshoring	0.119***	0.022*	0.048***	0.344***	0.016	-0.086***	-0.024***
	(0.01)	(0.01)	(0.01)	(0.05)	(0.03)	(0.03)	(0.01)
R^2	0.797	0.613	0.650	0.758	0.686	0.751	0.696
N	4797	4797	4797	4797	4797	4797	4797

Note: The regressions are run using seemingly unrelated regressions (SUR). The omitted variable input is local intermediate inputs. Standard errors are reported in parentheses and ***, ** and * represent statistical significance at 1%, 5% and 10% level respectively. Country, year and sector fixed effects are included.