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Linking Services to Manufacturing Exports[†]

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Abstract

In this paper, we analyse the interplay between services and manufacturing. This is done by identifying and quantifying a direct link between manufacturing exports and sales by service providers. For identification of this transmittance mechanism, we create a localised export exposure (LEE) variable, with the help of highly detailed geographic data, that captures the variation in demand for service inputs based on nearby exporters. Since manufacturing firms form industrial clusters while service activities are more evenly dispersed over space, we observe a high spatial variation in service firms' exposure to manufacturing exports. We use this spatial variation in export-driven service demand to assess the interplay between manufacturing and services. Our results show that a 1% increase in the localised export exposure increases the volume of sales of service firms by 0.19% (and plant employment by 0.11%). The results show also that the link is *highly* local and the strongest for service firms within 20 km from the exporters.

JEL classification: F10, F14, F6

Keywords: Spillovers, Services, Manufacturing Exports, Input-output Linkages

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1 Introduction

A profound change in the wake of the globalisation process since the 1990s has been the fragmentation of industrial production. The rise or fall of a firm therefore stretches far beyond its own boundaries into businesses linked to it through buyer-seller networks. This between-firm interdependence has also grown more important across broader sectors such as manufacturing and services through a process dubbed the "servicification" of manufacturing. The main implication of this phenomenon is that services have become an increasingly important part of the manufacturing process and hence also as an embedded part of manufacturing goods. Although the servicification of manufacturing has many dimensions, we focus on the implication of increased external demand for services in manufacturing firms.[1] Lodefalk, (2013, 2014) showed, in the Swedish context, that firms' share of external services (i.e., bought-in services) in total manufacturing output more than doubled from 1975 to 2005 (from around 12 to 25%).[2] A similar story is also found in Lanz and Maurer, (2015), who showed that external services form around 30% of the export value of goods for high-income countries. The servicification of manufacturing may therefore partly explain the overall growing importance of services (World bank, 2016), and this is particularly true for business services (see ECSIP, 2014).[3] Figures for the EU show, for example, that business services grew on average 2.4% per year between 1999 and 2009, while the overall growth of the EU economy was more modest, at around 1.1% (European Union, 2014).

Our aim in this paper is to evaluate how important the emerging linkages between manufacturing and services are, and we assess these linkages by focusing on how service sales are influenced by manufacturing exports. We identify this interplay by relying on three features[4]: First, service firms are much less specialised than manufacturing firms across space. Second, services are less tradable over space and are therefore, to a much larger extent, influenced by local supplier-buyer networks. Third, manufacturing exporters consist of large specialised firms

[1] Baldwin, Forslid, and Ito, (2015) brought up three possible explanations for the servicification of manufacturing: reclassification (internal services moving out of the firm), task-composition-shifts (more services needed to cope with a more complex production process or new attributes in produced goods), and task-relative price shifts (service tasks become relatively more expensive).

[2] This trend is also visible in other countries; see, for example, Crozet and Emmanuel, (2004) and Keller and Yeaple, (2013).

[3] Business services is a broad concept related to a variety of services provided by one firm to another to support its business without producing any tangible commodities. Business services include management consultancy, legal services, auditing, engineering, and marketing.

[4] See section 3.2 for a more detailed discussion regarding our identification strategy.

that are highly integrated in the global market.[5] The implication of these stylised facts is that the effect of an idiosyncratic shock in manufacturing exports on services will be location specific. An evenly distributed service sector with linkages to a spatially specialised manufacturing sector ensures a high variation in export-driven service demand across similar types of service firms located in different parts of the country. We use this variation to identify the strength of the linkages between global manufacturing firms and service providers.

To answer this question, we employ Swedish firm-register data from 2003 and 2011. A unique aspect of this dataset is that we make use of very detailed geographical information about firms' location, which implies that we do not rely on broad administrative borders (e.g., municipalities or commuting areas) that have little to do with the business distance between manufacturing and services. This allows us to use a more flexible approach and enables us to investigate how an export expansion in a fine geographical unit spreads over space, like ripples on water. To capture how service firms are exposed to or affected by changes in manufacturing exports in their proximity, we create a location-specific measure, localised export exposure (LEE). Hence, LEE captures how demand for service inputs in a particular location fluctuates as a result of changes in exporting. As there may be an endogeneity problem between manufacturing exports and local service providers, we make use of global market fluctuations as an instrument for exporting.[6]

The main contribution of this paper is, for the first time to our knowledge, to assess the significance of the interplay between service providers and manufacturing exporters. We therefore expand upon the knowledge of how export fluctuations influence local markets within nations; that is, through ripple effects that contribute to regional performance differences. Our results suggest that the link between manufacturing exports and sales by service firms is substantial and highly local. We find that a 1% increase in the localised export exposure (LEE) increases service sales by 0.19%. We also find that these linkages are highly local and significant only within 20 km of the service providers. Finally, we find a substantial effect on service employment since a similar change in exporting increases the plant employment of service firms by 0.11%.

In addition to the literature on the linkages between services and manufacturing, our paper is related to a growing body of literature on how an idiosyncratic shock on the micro level builds

[5]See, for example, the survey of Bems, Johnson, and Yi, (2013) on the global interdependence of manufacturing firms from 2008-2009.

[6]The instrument builds on work by Hummels, Jørgensen, Munch, and Xiang, (2014) about using global demand variation as an instrument for firm-level exporting. See section 3.2.

up to aggregate fluctuations. One strand of this literature is represented by Gabaix, (2011), who concentrated on the granularity of the economy and showed how "firm-level shocks can explain an important part of aggregate movements". Another strand focuses on how linkages between firms act as a "propagation mechanism" when individual firms are faced with a shock that is transmitted to other parts of the economy, influencing aggregate fluctuations (see Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi, 2012). Our paper is related to both strands, as we focus on how export fluctuations in generally *large* exporters are transmitted or propagated to their service providers.

This paper is also related to the literature focusing on local input output-linkages (or local labour markets), which uses for identification the spatial variation in the exposure to global shocks within an economy. Autor, Dorn, Hanson, and Song, (2014), Autor, Dorn, and Hanson, (2013), Caliendo, Dvorkin, and Parro, (2015), and Hakobyan and McLaren, (2016) all focused on how local labour markets within a single nation react differently to the same trade shock in manufacturing, which varies spatially since the manufacturing sector is highly specialised within a nation. One finding is that local labour markets tend to contain shocks created by trade variations locally. This is because workers' geographical mobility is, at least in the short and medium-long perspective, quite limited, while mobility across sectors is more pronounced. Hence, the structure of the local economy is formed by the location decision of firms, which, together with price changes, influences the demand for local inputs. The results in both Autor, Dorn, and Hanson, (2013) and Hakobyan and McLaren, (2016) suggest, for example, that a negative import competition shock on local manufacturing reduces demand for local services.

To motivate our empirical analysis, we discuss in section 2 a simple theoretical model explaining the mechanism between exporters and service firms, which draws heavily from the work of Fujita and Thisse, (2002, pp. 321–326). We then relate the predictions of this model to the empirical specification used in the paper. Section 3 discusses the data and our identification strategy. Section 4 discusses the results and is followed by the conclusion in section 5.

2 Theoretical Motivation and Empirical Specification

To capture the interdependence between manufacturing and services, we build on a model by Fujita and Thisse, (2002) that contains vertical linkages. This in turn builds on a framework originally developed by Krugman and Venables, (1995) and Venables, (1996), which suggest that agglomeration (and a core-periphery situation) may evolve through vertical linkages between firms, influencing their choice of location, while consumers are fixed in space.[7] The simplified assumptions of a labour force that is geographically immobile but perfectly mobile across sectors is also used, among others, by Autor, Dorn, and Hanson, (2013) in their theoretical motivation for how workers respond to import competition. Their empirical results also suggest that import competition affects the local labour market in many ways, but not through migration.[8] In the case of Sweden, we found that 83% of all individuals working in both 2001 and 2011 (over three million individuals) worked in the same labour market area, while only 59 and 40% of these individuals stayed in the same sector (using two-digit sector codes) and plant, respectively. These stylised facts of much higher mobility across sectors and plants, compared to spatial mobility, are in line with the model's presumption that the local economic structure is formed by firms' location decision.[9]

The specific model we use to explain the input-output linkages of service providers and manufacturing exporters draws heavily from Fujita and Thisse, (2002, pp. 321–326). We take the point of departure in a stylised model with two regions, three industries (agriculture, manufacturing, and services), and one compound factor of production (labour). Both agriculture and manufacturing are, in this setting, producing homogeneous goods and operate under constant returns to scale. However, these sectors differ when it comes to trade costs since agricultural goods are assumed to be traded without friction, while manufactured goods face an iceberg trade cost. The assumption of homogeneous goods and perfect competition in manufacturing implies that this sector will be located in the lowest-cost region and that we paralyse the possibility of an agglomeration force driven by consumers' love for final good varieties. We also ignore other possible agglomeration forces by assuming identical consumers and firms in both regions. Instead, agglomeration stems from how manufacturing firms use, in a Cobb-Douglas fashion, both labour and services to produce their final goods and how their demand for services, which are costly to import, is characterized by a love for variety (modelled by a CES function). Hence, there is an incentive for manufacturing firms and services to share a location. Manufacturing

[7]See also Combes, Mayer, and Thisse, (2008).

[8]See also Hakobyan and McLaren, (2016)

[9] Puga, (1999) compared models with and without labour mobility, concluding that the relatively lower mobility in the EU compared to the United States may explain the more dispersed economic activity observed in the EU.

firms gain from cheaper inputs since co-location makes them more competitive, as the unit cost of production falls when they avoid trade costs associated with imported services. Service firms, in turn, gain from co-location since their customers are reached without trade costs.[10]

If we assume, as in Fujita and Thisse, (2002), an asymmetric equilibrium where all manufacturing and service firms are located in the home region, the equilibrium will be stable as long as the trade cost of services is large enough so that manufacturing firms have a cost advantage when they are located in the same region as services. A high trade cost in services ensures that manufacturing firms have no incentive to move to the foreign region without local services even though it faces a trade cost to supply consumers in that region. How high trade costs in services must be to support this equilibrium correlates positively with the trade cost of manufacturing goods. In addition, the relative trade cost in services must be high to support the asymmetric equilibrium if consumers' expenditure share on manufacturing is high (i.e., the gravity of foreign consumers on manufacturing firms is large) or if the share of services in manufacturing production costs is small (i.e., the linkage between local service providers and manufacturing firms is weak). A fall in the trade cost of services decreases the advantage of manufacturing firms located in the home region together with services; eventually, manufacturing firms may find it profitable to move to a foreign region and start producing by importing services from the home market. The location of choice for services will, however, still be the home region as long as its share of total manufacturing output is larger than in the foreign region.

In this setting, the link between sales made by services and manufacturing is highlighted by a gravity-type equation when it comes to the total sales of a service firm i located in region j (see Fujita and Thisse, 2002):

$$sales_{j(i)} = p_{j(i)}q_{j(i)} = (\alpha w_j \sigma/(\sigma-1))^{1-\sigma} D_j \tag{1}$$

where $D_j = c_j X_j P_j^{\sigma-1} + c_m X_m \tau_{jm}^{1-\sigma} P_m^{\sigma-1}$ is the total demand of services in j from manufacturing firms located in both j and m, σ is the elasticity of substitution between service varieties, α is the cost share of services in manufacturing, w is the labour cost in j, P is the ideal price index for the CES function, c is the unit cost of producing manufacturing goods, τ is the trade cost

[10] The similarity with the more common link between consumers and final goods producers in a Dixit-Stiglitz model is discussed in Combes, Mayer, and Thisse, (2008). In this context, however, manufacturing firms act as consumers, and the total cost of production corresponds to consumer income, while the different varieties of business services take the role of final goods varieties.

of services (equal to 1 if $j = m$), and X is the quantity of manufacturing goods produced for the different markets ($X_j = x_{jj} + x_{jm}, X_m = x_{mm} + x_{mj}$). The sales volume of service firms is therefore influenced by the production of goods (for both the local and the foreign market) as well as other factors, such as the cost of producing goods (c_j) and the general price level of services in both regions ($P_{j/m}$). Hence, if we use equation 1 to assess the importance of the interplay between manufacturing and services, then, without relying on a structural model, we face several endogeneity issues.

To overcome these issues, our identification strategy (as discussed in more detail below) focuses on the variation of local demand caused by exogenous export fluctuations in the manufacturing sector. Equation 1 highlights the relationship between manufacturing exports and local service sales, from which we can derive the following elasticity of sales made by service firms with respect to manufacturing exports ($x_{jm,j\neq m}$):

$$\frac{\partial sales_{j(i)}}{\partial x_{jm}} \frac{x_{jm}}{sales_{j(i)}} = c_j P_j^{\sigma-1} x_{jm} \tau_{jm}^{1-\sigma} / D_j, \tag{2}$$

which underlines two important expectations that will be investigated in the empirical section.

The first expectation is that the responsiveness of sales made by service firms to exporting will depend on the export intensity in manufacturing. In an extreme case where the service firm only supplies the manufacturing firms located in the same region, we expect a 1% increase in manufacturing exports, leading to a $x_{jm}/(x_{jj} + x_{jm})$ % increase in service sales. Hence, our prior for the empirical analysis is that we expect the elasticity of sales made by services, with respect to manufacturing exports, to be approximately equal to the export intensity of the manufacturing sector (0.14 in our dataset; see Appendix A, table A1). The second expectation is that the export variation of manufacturing exporters located farther away will be deflated by the trade cost of services. Hence, we expect export shocks to be mainly transmitted to service providers locally, while export fluctuations in manufacturing firms located at a distance have no impact.

2.1 The Empirical Specification

Using the expectations from the forgoing model on vertical linkages, we proceed to empirically assess the relationship between sales made by service firms and manufacturing exports by using the following reduced-form specification:

$$ln(sales_{j(i)t}) = \beta ln(D_{jt}) + f_i + \zeta_{tsl} + \epsilon_{it}. \quad (3)$$

This specification captures the ideas presented in the previous section with the dependent variable, $ln(sales_{j(i)t})$, the log of sales made by service firm i located in region j at time t, while D_{jt} is firm i's exposure to exports.[11] Sales made by service firms are, however, also influenced by other factors, such as general equilibrium effects (e.g., price changes in goods, services, or factors) and local effects (e.g., changes in demand). Therefore, to mitigate identification problems caused by unobserved factors, we include firm fixed effects (f_i) plus a stringent year-sector-labour market area fixed effects (ζ_{tsl} using three-digit sector codes).[12]

Hence, we identify the link between manufacturing exports and sales made by service firms by zooming in on within-firm variation over time while we control for year-specific fixed effects within each labour market and sector. We expect that the year-specific effects within each labour market are of utter importance to identify the export transmission since these will capture any local effect on service sales originating from changes in prices (goods or factors), the economic structure (e.g., industry composition or unemployment), and the size of the local economy.

3 Data and Empirical Strategy

3.1 Data

To investigate empirically the relationship between manufacturing and service firms, we use firm-register data from Statistics Sweden covering all Swedish firms from 2003-2011. We focus, however, on two sets of firms. The first set consists of all exporters and their export flows at the firm-product-destination level. This set includes 37,825 exporters with, on average, 50 employees, which is used to generate the variation in exporting. Firms in the manufacturing sector account for the lion's share of the export value in the dataset (around 83%). See Appendix A for descriptive statistics about the set of exporters (table A1).

The second set of firms and the one of primary interests of this study, consists of all private

[11] See section 3.3 for a more detailed discussion and definition of the localised export exposure, D_{jt}.
[12] The results are also robust to inclusion of less stringent fixed effects such as separate year-sector (θ_{ts},) and year-labour market area fixed effects.

services firms (around 332,000 firms) and includes all types of services (e.g., printing, accommodations, transportation, computer programming, R&D, and building services). Although all types of services may be important inputs to the manufacturing sector, we start our analysis by focusing on business services, and thereafter, we investigate whether the interplay between manufacturing and services differs between different types of services using a broader definition. The reason for this is that business services are highly integrated in manufacturing and are an important part of the servicification process. To define business services we use as a baseline the EU definition (from 2008). The four largest two-digit sectors within business services in the data are management and consulting, architecture and engineering, computer programming and related, and legal and accounting services. See Table 1 for information about the sectors included (two-digit level) and summary statistics, both for the baseline sample of business service firms and the alternative broad definition of service firms. Note that, in both cases, multi-plant service firms are excluded since we only have information about sales at the firm level, which implies that we have no way of identifying the location of sales changes in firms with two or more locations. In addition, our baseline sample uses only firms with at least one employee. Firms with zero employees are excluded since these tend to be 'hobby' or micro-firms with very small and erratic sales volumes.

A key feature of our data is that we have very detailed information about the location of firms. That is, we know in which SAMS area (Small Areas for Market Statistics) each firm is located, and these SAMS areas divide Sweden's 290 municipalities (or 105 labour-market areas) into over 9,000 small spatial areas. Around 67% of the SAMS areas have an area of less than 10 km^2, while 89% have less than 100 km^2. The smallest areas are less than 0.1 km^2 and the largest over 12,000 km^2. The difference in the mean size of 50 km^2 and the median size of 2.2 km^2 is explained by some large remote and sparsely populated areas along the north-western border. We also make use of broader administrative regions to control for trends specific to local labour market areas (LMA), while the fine geographical detail of the SAMS areas ensures high variability within each LMA (see Table A2 in Appendix A). Figure A1 in Appendix A shows, for each SAMS area, the number of business services firms (left) and the number of firms when using the broad definition of services (right).[13]

[13]The figure also provides an overview of the size and detail of the SAMS areas used. Note that the SAMS areas may appear larger than they actually are since we do not observe a border between areas that are in the same group in terms of the number of firms in each area.

Table 1: Summary statistics for service firms using the broad definition of services and the baseline definition/sample of business service firms only (sales in Swedish kr.).

	Broad definition			Baseline definition		
	Sales	Empl.	# firms	Sales	Empl.	# firms
Support to agriculture	833715	0.4	4732			
Support to forestry	1547313	1.7	1164			
Printing and related services	4183627	3.0	3007			
Remedation waste management	3216363	1.9	144			
Maintenance parts vehicles	4037258	1.7	14243			
Transport removal services	4142685	3.0	16726			
Warehousing	41916892	13.3	3059			
Postal, courier activities	15368335	20.2	559			
Accommodation	5877950	5.4	4536			
Food and beverage	2626179	2.8	32611			
Publishing activities	7322160	3.6	6608	16017480	9.2	1146
TV, film, sound recording	2047550	0.7	10388			
Computer progr., consultancy	5279831	2.7	34589	14432259	7.8	11598
Information services	5076898	3.0	2212	14871952	9.4	602
Legal and accounting	1236958	1.0	25395	2678400	2.6	10185
Management consulting	1560055	1.0	51575	3603077	2.7	18287
Architecture, engineering	2227327	1.6	36792	4902137	4.0	14470
Scientific R&D	4899064	2.6	2955			
Advertising, research	3571264	1.6	16066	8901211	4.2	5874
Other professional activ.	1063236	0.6	31292			
Rental and leasing activ.	5649233	2.0	5660			
Temp. employment activ.	8799786	15.7	3642	13591073	24.7	2398
Security and investigation	6892961	10.2	1597			
Building services, landscape	2957623	4.4	16917			
Office, business support	4906470	10.9	5533			
# firms, broad definition	332002					
# firms, baseline definition				64560		

The broad definition of services includes all service firms, even those that report no employment. Baseline definition includes business service firms that report positive employment.

3.2 Empirical Strategy

An important part of our empirical strategy is that distribution across space is very different within the manufacturing and service sectors. One way to illustrate this is to make use of the Krugman-specialisation index (see Krugman, 1991), which measures how similar the distributions of economic activity across industries are between regions, using the distribution of Sweden in general as a benchmark. A value close to zero implies that a region's distribution of economic activity (often measured with the help of the workforce) is similar to the benchmark, while a value approaching two implies that the industrial composition has nothing in common with the benchmark.[14] We calculate the Krugman-specialisation index for Swedish municipalities using the distribution of the workforce across industries (four-digit SNI codes) within two sectors separately: manufacturing and business services. We find that almost 80% of the labour force in manufacturing in an average municipality has to change industries within the manufacturing sector to get in line with the average Swedish distribution. If we focus instead on the business service sector, we find that it is much more evenly distributed. Only about 45% of the workforce in the average municipality has to switch to another industry within the services sector to be in line with the average distribution of services in Sweden. In other words, the heterogeneity of regions in Sweden is high when it comes to the distribution of manufacturing firms, while services are much less specialised regionally. Figure 1 clearly shows that the distribution of services is less concentrated (i.e., biased towards the left side of the figure) than the distribution of manufacturing firms.

The diffusion of services suggests that the local economy demands a broad set of service inputs in proximity, while manufacturing outputs could more easily be supplied at an arm's length. We find support for this in a survey by Gullstrand, (2016) of small and medium-sized Swedish manufacturing firms asked about the location of the major source[15] for different inputs. One result that is particularly striking is that more than 80% of the firms answered that their major source of business support (e.g., legal advice, accounting, and technical support) was from the local region (see Figure 2). If we compare this with intermediate goods, then our results show that only around 30% of the firms indicated that the local market was their major source. This

[14] A value of 1 implies that at least 50% of the economic activity has to switch industries to have the same distribution as the benchmark region.

[15] A source is defined as major when 50% or more of an input originates from that source.

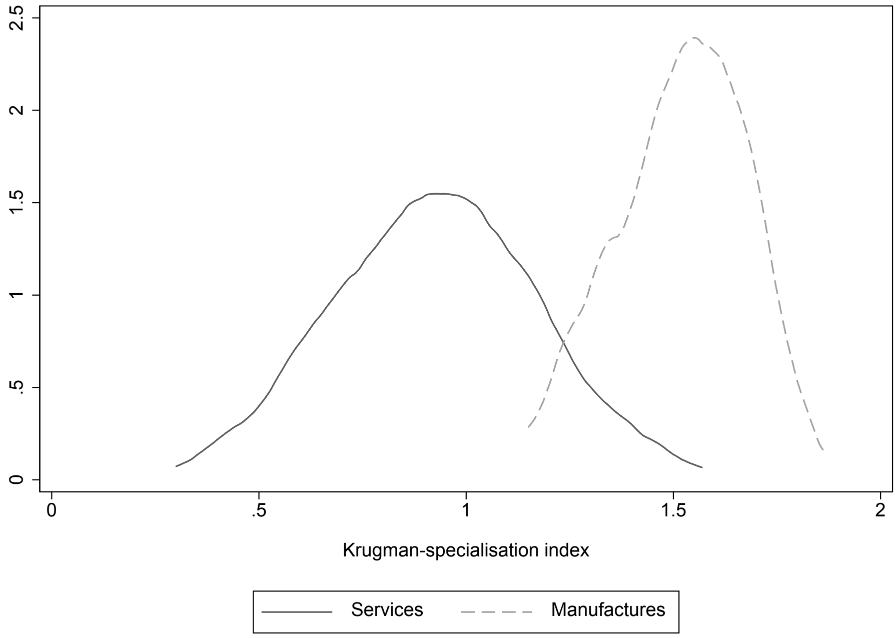

Figure 1: Krugman Specialization index (2011). A higher value of the index means that a larger fraction of the labour force needs to change sectors to be in line with the average municipality in Sweden (i.e., more specialised).

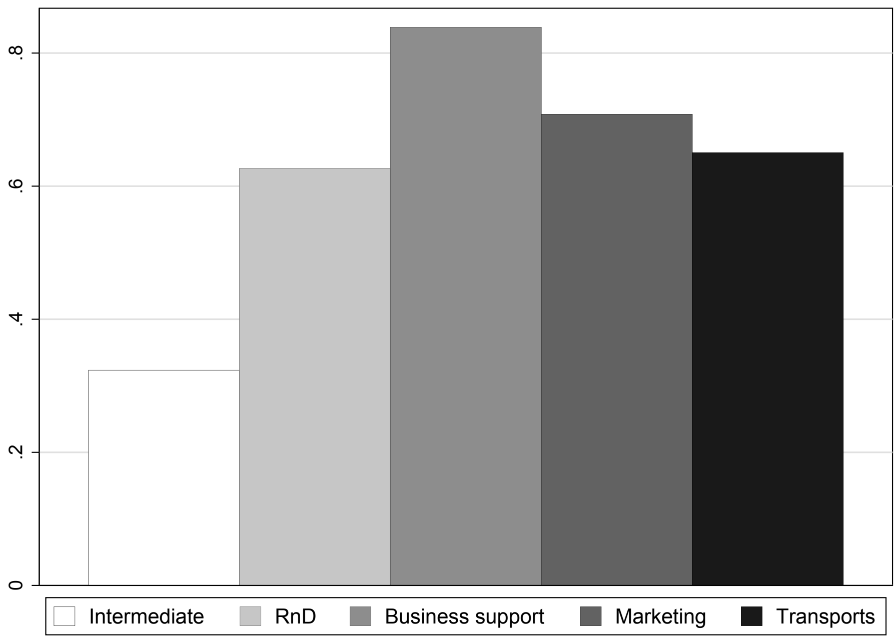

Figure 2: Survey results showing the major regional links of manufacturing firms (2014). The figure shows the percentage of firms indicating that their local region was the major source region for that specific type of input. A major source is defined as constituting more than 50% of that input category. See Gullstrand, (2016) for more information.

finding matches the results in Gervais and Jensen, (2015), which found that services in general, but not for all, are less tradable than manufacturing (see also Jensen, 2011). Hence, services are harder to trade over a distance, which may be especially important for non-standardised services that require a high degree of knowledge and direct communication. A body of literature has also found that local business linkages matter for (complex) inputs in a globalised world.[16] One specific example of this local nature is found in Bennett, Bratton, and Robson, (2000), who showed that firms hire business advisors in over 60% and 80% of cases within 10 and 25 kilometres of their location, respectively.

Services are not only less tradable but Lodefalk, (2013) also shows that services are a highly integrated but external part of manufacturing production. If one breaks down manufacturing firms' expenditure on services into internal and external services, then external services account for 75% of total service costs from 2001-2006.[17] Additionally, using Swedish input-output tables, he found that 83% of service inputs are sourced from domestic suppliers.[18] The servicification of manufacturing and the significance of short distances to service input suppliers suggests that we should find important local input-output linkages between manufacturing and services. We also found tentative evidence for this by calculating coagglomeration indexes between sectors.[19] The results show that the average pairwise coagglomeration between industries in services and in manufacturing was the most pronounced one; it was even stronger than between industries within manufacturing and much stronger than between industries in manufacturing and other types of economic activity (e.g., mining, agriculture, wholesale and retail, or public services).

For our identification, we make use of the foregoing discussion indicating that the manufacturing sector is spatially specialised and that there are important *local* input-output linkages between manufacturing and service firms. An idiosyncratic industry-specific shock on manufacturing exports will therefore be transmitted to local service firms and affect their volume of sales.

[16] See Bernard, Moxnes, and Saito, (2015), Hillberry and Hummels, (2008), Hummels and Schaur, (2013), Iammarino and McCann, (2013), Keller and Yeaple, (2013), and Wrona, (2015) See also Ellison, Glaeser, and Kerr, (2010), who find that, of the three Marshall theories of agglomeration, input-output linkages are found to be particularly important. See also Meliciani and Savona, (2015) and Dinteren, (1987) for an early descriptive analysis of the role of business services in the local economy.

[17] He finds that expenditure on services in general increased while the share of external services was stable, suggesting that external and internal services grew in tandem.

[18] We replicate the aggregate figure of Lodefalk, (2013) and found additionally large differences across sectors. If we focus on business services, then the domestic share of external service inputs increases to 89%, while it falls to 73% for other services.

[19] We used the Ellison, Glaeser, and Kerr, (2010) metric to measure coagglomeration (EG-index), and we used the two-digit level of the Swedish Industry Classification system.

As service firms are much more evenly distributed over space, we will observe large variations within the service sector because of varying exposure to the same shock.

3.3 Localised Export Exposure

To identify the link between manufacturing and service firms, we *localise* manufacturing exports; this helps to capture the fact that manufacturing demand for service inputs is influenced by their distance from the service firm. In other words, we make use of the highly detailed SAMS areas (see discussion in section 3.1) and construct a variable called localised export exposure (LEE) by spatially weighing manufacturing exports so that they become location specific.[20] The localised export exposure (D_{jt}) is constructed by first calculating the total manufacturing export of each SAMS area m, $X_{mt} = \sum_i X_{i(m)t}$.[21] Then, to account for the impact of distance on the demand for services in a SAMS area j, we use a spatial weight so that SAMS-level exports (X_{mt}) are deflated by distance between the pair of SAMS areas j and m. Hence, the localised export exposure to services (specific for each SAMS area), D_{jt}[22], equalling the distance-weighted sum of all SAMS-level exports:

$$D_{jt} = \sum_m \frac{X_{mt}}{d_{jm}} \tag{4}$$

where d_{jm} is the distance (in km) between the centroids of SAMS areas j and m. Note that the distance within a SAMS area, d_{jj}, is estimated to be the circle-radius of the SAMS area to account for their varying size. The specialisation pattern of manufacturing and product-specific idiosyncratic shocks on the world market imply that the demand for services varies considerably across SAMS areas. The heterogeneity of the localised export exposure (D_{jt}) is visible in the top row of Figure 3, which shows the annual percentage change of D_{jt} for each SAMS area from 2004-2011.

[20] The use of the SAMS areas is a great strength of the analysis, as even very short distances have been found to have a large deterring effect on business relationships. See, for example, Hillberry and Hummels, (2008), who stressed the advantage of highly detailed geographic data, as distance is found to have a pronounced effect on a firm's trade even over very short distances within a municipality or other administrative areas.

[21] Some exporters have multiple plants, and to take that into consideration, we distribute the exporting of each firm to plants based on relative employment before aggregating the export value to the SAMS level. Hence, if a firm has two plants and the headquarters has eight of ten employees, then 80% of the firm-level export value will be allocated to the SAMS area of the headquarters and the rest, 20%, to the SAMS area of the other plant. Note that the results are robust to putting the entire weight on the location of the headquarters.

[22] An alternative formulation of this shock is as follows: $WD_t = [D_{jt}]$. Here, W is a spatial weight matrix with the dimension JxJ (J is the number of SAMS areas in Sweden), and D_t is a $J \times 1$ matrix with SAMS-specific exports for year t.

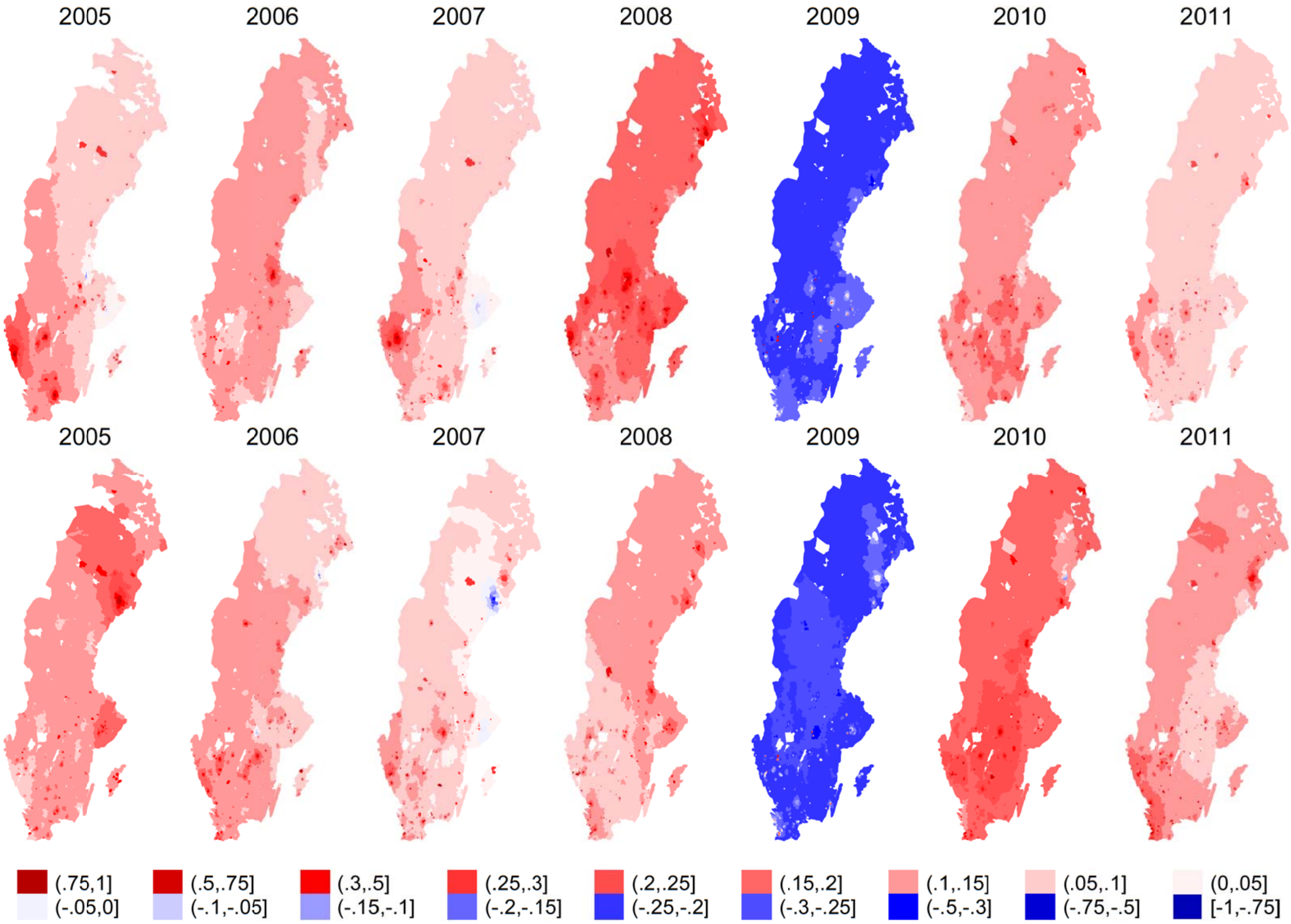

Figure 3: Yearly percentage growth in the SAMS level localised export exposure, D_{jt} (top row) and the instrument for localised export exposure, $D^{\star}_{jt}$ (bottom row), between 2005 and 2011. The yearly percentage growth is calculated as follows: $\triangle D_{jt} = ln(D_{jt}) - ln(D_{jt-1})$ and $\triangle D^{\star}_{jt} = ln(D^{\star}_{jt}) - ln(D^{\star}_{jt-1})$.

3.4 Instrumenting for the Localised Export Exposure

A potential concern of using actual export flows of nearby manufacturing firms as a source of variation is that input-output linkages between manufacturing and service firms imply that the characteristics of the service sector in the proximity of manufacturing firms may influence their export performance. A potential endogeneity problem therefore arises. Evangelista, Lucchese, and Meliciani, (2015) found, for example, using European input-output data, that business services "exert a positive impact on the international competitiveness of manufacturing industries". To address this concern of simultaneity, we build our identification strategy on an instrument for the localized export exposure in equation 4.

To construct the instrument, we first create a firm-specific instrument, using a similar methodology as Hummels, Jørgensen, Munch, and Xiang, (2014), which we aggregate to the SAMS level. To create the firm-level instrument, we begin by calculating pre-sample shares (s_{ick}) of the export flow of product k to destination c in the total exports of firm i.[23] The next step is to use data from the UN Comtrade database on bilateral trade flows at the HS six-digit product-destination level to create product-destination-level demand shocks (I_{ckt}) by using the total imports (except from Sweden) of each country at the product level. The time-varying firm-specific instrument is then calculated by multiplying the firm-product-destination specific shares by the product-destination country-specific import demand (I_{ckt}) and then aggregating over all products and destinations. The firm-specific instrument therefore equals

$$I_{it} = \sum_{kc} s_{ick} \times I_{ckt}. \tag{5}$$

The next step is to aggregate the firm-specific instrument[24], I_{it}, at the SAMS level:

$$X^{\star}_{mt} = \sum_{i} I_{it} \tag{6}$$

Similarly to equation 4, we finally create a time-varying instrument for each SAMS area j by

[23] This is either 2003 or the first year a firm exists in the dataset.

[24] A similar adjustment as above for multi-plant exporters is performed (when calculating the D_{jt}). As some firms have multiple plants, we take that into consideration by distributing the firm-level instrument, I_{it}, to the SAMS areas of the plants based on the relative employment in each plant.

weighing shocks by the inverse distance between SAMS areas:

$$D^{\star}_{jt} = \sum_{m} \frac{X^{\star}_{mt}}{d_{jm}}. \tag{7}$$

This variable, $D^{\star}_{jt}$, is thereafter used as an instrument for the localised export exposure, D_{jt} in equation 4.[25] Hence, we capture the export of Swedish firms in each SAMS area driven by fluctuations in the import demand from other sources than Sweden on the destination markets. The link between service firms and Swedish exports is therefore disconnected, especially since Swedish exports of core products (defined as major export products at the five-digit level) forms on average not more than around 1.5 % of world trade. Figure 3 compares the yearly percentage change for the localised export exposure (top row) and the instrument of the localised export exposure (bottom row). From a simple eyeballing of the figures, we can see a very similar pattern over the period. Importantly for our identification, we see that there is large variation across space and time in the exposure measure. The growth of the localised export exposure was, for example, very high in the western part of Sweden in 2007, while the north-eastern part was more stagnated. In 2008, one could see a reversed pattern, with high growth in the north-eastern part of Sweden. One could even identify differences in the downturn and some regional pockets of positive changes during the big freeze in 2009 after the financial crisis. This detailed and heterogeneous pattern of localised export exposures across Sweden is the central component in our identification strategy. If there is an important channel or a feedback effect from manufacturing firms to nearby service firms, then we would expect a positive change in the localised export exposure to increase sales of service firms. Table A2 in Appendix A shows summary statistics for both the localised export exposure, D_{jt}, and the localised export exposure instrument, $D^{\star}_{jt}$.

4 The Effect of Manufacturing Exports on Services

The objective of this paper is to analyse the linkages between manufacturing and service firms. For our empirical identification, we use an instrumental variable approach, where we instrument

[25] For robustness, we consider using the inverse distance squared as an alternative distance weight. The alternative instrument is defined as follows: $D^{sq.\star}_{jt} = \sum_{m} X^{\star}_{mt} \times \frac{1}{(d_{jm})^2}$. The new LEE, $D^{sq.}_{jt}$, is adjusted in the same manner.

for the exposure of service firms to changes in exporting. If we consider the validity of the instrument, the first stage regression shows a strong positive correlation between the localised export exposure and our localised export exposure instrument; see Table 2. The first stage F-statistic is above 500 in our estimates.

Table 2: Baseline sample: Main results using both IV and OLS specification. Dependent variable is domestic sales(log) for firms supplying business services (except for the first stage)

	IV	IV - First stage	OLS
	Sales	D_{jt}	Sales
Localized Export Exposure	0.191^a		0.112^a
	(0.0185)		(0.0138)
LEE Instrument, ($D^{\star}_{jt}$)		0.560^a	
		(0.0233)	
Nr. obs.	236244	236244	236244
R^2	0.82	0.98	0.82
Within R^2	0.0003	0.5696	0.0007
First stage F stat.	577.8		
# clusters	103	103	103
Firm-FE	Yes	Yes	Yes
LMA-Sector-year FE	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standards errors are clustered on labour market areas (LMA) level.

The main result on how business service firms' sales respond to changes in manufacturing exporting are shown in Table 2. From the theoretical motivation discussed in section 2, our theoretical prior regarding the responsiveness of service firms' sales to exporting was an elasticity on par with the export intensity of the manufacturing sector. In other words, if we use the export intensity of the manufacturing sector in Sweden as a benchmark, then a 1% increase in manufacturing exports should increase service sales by around 0.14%. If we consider the results from our IV regressions in Table 2, we find that a 1% increase in exporting (localised export exposure) increases sales made by services by around 0.19%. Hence, our results suggest that an idiosyncratic shock on the world market will have a significant impact not only on those exporters facing this shock but also on services (and other parts of the economy) through input-output linkages.

The lower OLS result of 0.11 in Table 2 seems reasonable since the instrument tilts the localised export exposure towards regions with large exporters as long as these firms respond more readily to the demand variation on export markets. If we consider the major exporters in

Sweden, then around 8-10% of all exporters forms around 80-90% of the total export volume (similar figures are also found in, e.g., France Mayer and Ottaviano, 2008) and their export intensity (i.e., export as a share of firm sales) is on average 0.58, while the other 90% of the firms has an average export intensity around 0.16. Hence, our localised export exposure is tilted towards service firms that are more influenced by the mechanism we focus on since they are located in the neighbourhood of major exporters not only highly connected to the world market through a high number of markets and products but also highly dependent on the world market since a major part of their total turnover consists of exports.

4.1 Are Linkages Local?

A natural extension of the results presented above is to investigate the reach of this transmission mechanism. Since our data include highly detailed information about firm location, we can explore whether there is a distance decay in how a fluctuation in manufacturing exports is transmitted to the local economy. We split the localised export exposure faced by service firms into several smaller shocks depending on their distance away from the firm. We use the following distance ranges: 0-20km, 20-100 km, 100-200 km, 200-300 km, 300-400 km, and 400 km+. This allows us to investigate whether shocks closer to the service firm are more significant in comparison to those farther away, as we expect because of significant trade costs in services.

We run a regression similar to before, except now, we include an instrument for multiple measures of export exposures based on distance.[26] The same fixed effects are included as in the baseline. The result is presented in a coefficient plot in Figure 4, and more detailed results can be found in Table B1 in Appendix B. The figure shows the coefficient for each interval (included in a single regression) and the 95% confidence intervals. A clear distance decay is present, and the results suggest that the links are highly local. The link between service firms and manufacturing exporters is driven by changes in the exporting of firms located within 20 kilometres of the service firm. Thereafter, the relationship disappears.[27]

As an alternative to the distance bands, we use a steeper distance decay for the baseline

[26] Effectively, we create localised export exposure and localised export exposure instruments for each interval. For the first interval, it becomes $D_{jt,0-20km}$ and $D^{\star}_{jt,0-20km}$ etc. In a single regression, we use the $D^{\star}_{jt}$'s as an instrument for each D_{jt} separately.

[27] The result is robust to using a either a steeper decay function within each distance band (see Table B1 or no distance decay adjustment within each band. In the latter, we do not use a distance decay *within* each interval but only aggregate exports within, for example, the 20 to 100 km range for each SAMS area. See the no-decay column in Table B1.

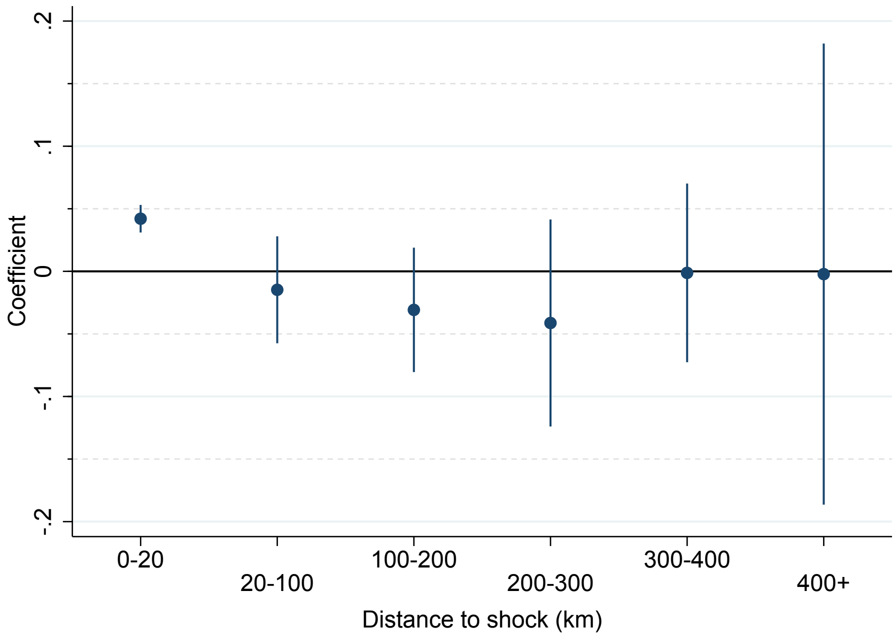

Figure 4: Coefficient plot: IV regression results when log firm service sales are regressed on the localised export exposure for each distance range (six separate exposures in a single regression). More detailed information on this regression can be found in Table B1 column 1 in Appendix B.

specification. Instead of using spatial decay according to inverse distance, as in equations 4 and 7, we use the inverse distance squared (ID sq., see section 3.4). The inverse distance squared specification implies that the decay function becomes steeper; therefore, exports in proximity have a relatively higher weight. It is therefore reasonable that the results using the steeper decay function and the 0-20 km distance bands are of similar magnitude. See Table B2 in Appendix B. Note that, by using the distance bands and a steeper decay function, we may not capture the entire variation in demand stemming from exports, as a shock to a large nearby exporters is quickly deflated with this alternative decay function. A steeper decay function may therefore overemphasize the very close neighbours, especially in non-urban locations.

4.2 Robustness

For the baseline specification, we perform a number of robustness checks. First, we include micro-business service firms that report zero employment (excluded in the baseline) and find a lower elasticity than before (0.154 compared to 0.19 baseline; see Table 3). This change is not surprising, as micro-firms without employment may be dormant firms, or they may consist of entrepreneurs with multiple employments. Alternatively, we alter the definition of services to embrace a much broader scope and include both business services and other types of services.[28] The results for this broad definition show a highly significant but slightly smaller elasticity than for business services. This is also expected since these other types of services firms may have a broader customer base outside manufacturing compared to business services. See Table 3.

Table 3: Alternative definitions of services and inclusion of micro-firms (IV results except col. 4). Note that micro firms reporting zero labour are included in columns 1 and 2 (unlike the baseline sample). Dependent variable is domestic sales (log).

	Micro-firms included		Micro-firms excluded		
	BS		Broad Def.		Interaction
	Sales	Sales	Sales	Sales(OLS)	Sales
LEE	0.154^a	0.177^a	0.138^a	0.103^a	0.151^a
	(0.0147)	(0.0266)	(0.0150)	(0.0163)	(0.0516)
$LEE \times BS$					0.0400
					(0.0456)
Nr. obs.	628036	476855	1237579	476855	476855
R^2	0.81	0.85	0.85	0.85	0.85
Within R^2	0.0001	0.0003	0.0000	0.0006	0.0003
First stage F stat.	706.7	412.0	582.8	n.a.	119.4
# clusters	105	105	105	105	105
Firm-FE	Yes	Yes	Yes	Yes	Yes
LMA-Sector-year FE	Yes	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standards errors are clustered on labour market area (LMA) level. BS refers to business services and broad def. to the broader definition of services. The interaction, $LEE \times BS$ interacts LEE and a dummy equalling 1 if the firm is providing business services.

To test for differences between business service firms and other service firms, we used the total sample consisting of service firms with positive employment and then interacted the localised export exposure instrument with an indicator for business services. The result did not, however, support any significant differences between businesses and other services; see Table 3. A possible explanation may be, as discussed by Gervais and Jensen, (2015), that there is a considerable variation within service sectors when it comes to their tradability over space.

One concern with the baseline specification may be that services firms set up a contract with manufacturing firms where they specify a bulk purchase of services during the year. If this is the case, then the responsiveness may be lagged, as fluctuations in exports may not influence the sales of services until the year after. To control for this, we introduced a lag structure, which

[28]For more information on the sectors included in the broad definition, see Table 1. Firms that report zero employment are also included.

is presented in Table B2 in Appendix B. The results suggest that there is both an immediate and a lagged effect; using only lagged shocks suggests that the relationship becomes slightly weaker, although it is still highly significant. We also test whether there are some unobserved trends that may be contributing to the results. We replace the fixed effects with sector and LMA trends; the results are unchanged (see Table B2 in Appendix B).

A final robustness test is to investigate whether export fluctuations develop into more lasting effects and influence employment within service firms. In our dataset, we have information about plant-level employment, and we can therefore investigate how employment at the plant level is affected by changes in local export exposure. Hence, we re-estimate equation 3 after we have replaced the dependent variable, ln(firm sales), with average plant employment, ln(employment). The major and expected difference is that the magnitude of the elasticity drops. We now find that a 1% increase in exporting (LEE) leads to a 0.11% increase in employment of a nearby business service firm.[29] Hence, not only is there a spillover to firm sales but there are also labour market effects on services providers. See Table B3 in Appendix B. The relative inertia when it comes to employment suggests a tight link between manufacturing demand for services and the local profitability of and wages in service firms since a positive shock in manufacturing drives up labour productivity.

5 Conclusion

The last few decades have been characterised by a growing interdependence between services and manufacturing through fragmentation and servicification', leading to a growing use of external services in manufacturing firms.

We set out to assess and quantify the importance of this linkage with the help of a spatial variation in service demand driven by manufacturing exports. For identification, we rely on three features of the Swedish economy. First, manufacturing firms form industrial clusters, while services are spatially dispersed. Second, there are important input-output linkages between manufacturing and services. Third, service firms tend to supply locally. Hence, an idiosyncratic shock on the world market will therefore become area specific, and similar service firms located

[29] As a robustness check, we analyse the employment effects at the firm level and find a weaker effect (elasticity of 0.06). This is expected, as some of the variation in exposure to exporting may be missed for service firms that have geographically spread plants.

in different areas will be exposed differently to such an export fluctuation (the localised export exposure, LEE).

Our results show that a 1% increase in the localised export exposure translates into increased sales made by service providers by 0.19%. Interestingly, we find that this effect is extremely local, as the main effect of exports on a service provider is their exposure within 20 km of its location. Notably, exporting has a significant impact on employment — it was found that a 1% increase in exporting increases local employment by 0.11%.

These results suggest a sizeable transmission mechanism from manufacturing to services and that a shock in manufacturing may penetrate deeply into the local economy and create fluctuations in aggregate. The results show that even non-global and mostly regional firms may be sensitive to global fluctuations through their nearby exporters. The local economy is therefore particularly vulnerable to idiosyncratic shocks on the world market because of both granularity (Gabaix, 2011) and networks (Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi, 2012). That is, the shock enters through a handful of large, specialised global manufacturing firms, and thereafter, it spreads to services.

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Appendices

A Descriptive Statistics

Table A1: Summary statistics for the exporting firms.

	Mean	St. dev.	Min	Max	Obs.
Log Firm Sales	16.6	2.0	6.49	25.5	165296
Firm Labour	51.3	367.1	0	21842	165296
Log Total Exports	12.7	3.2	0	25.0	165296
Exports/Sales	0.14	0.2	1.3e-10	1	165296
# firms	37825				
# SAMS areas	6419				
Man. sect. share	0.830				

Note that a small number of observations are dropped for the descriptive statistics as firm sales are reported to be higher than firm exports. These observations only impact the descriptive statistics on export intensity. If we assume that all sales of these firms are exported (export intensity of 1) then the export intensity of all firms changes to 0.15. Man. sect. share shows that 83% of the value of exports are from firms in the manufacturing sector, 17% from firms in other sectors.

Table A2: Summary statistics for the Localized Export Exposure (LEE), $ln(D_{jt})$, the baseline LEE instrument, $ln(D^{\star}_{jt})$, the alternative LEE $ln(D^{sq.\star}_{jt})$. and the alternative instrument $ln(D^{sq.\star}_{jt})$.

	Mean	St. dev.	Min	Max	Obs.
$ln(D_{jt})$	22.2	0.70	20.0	25.1	69122
$ln(D^{\star}_{jt})$	24.7	0.80	22.4	27.6	69122
$ln(D^{sq.}_{jt})$	18.9	2.00	13.2	26.6	69122
$ln(D^{sq.\star}_{jt})$	21.5	2.18	15.5	30.4	69122
# SAMS areas	8939				

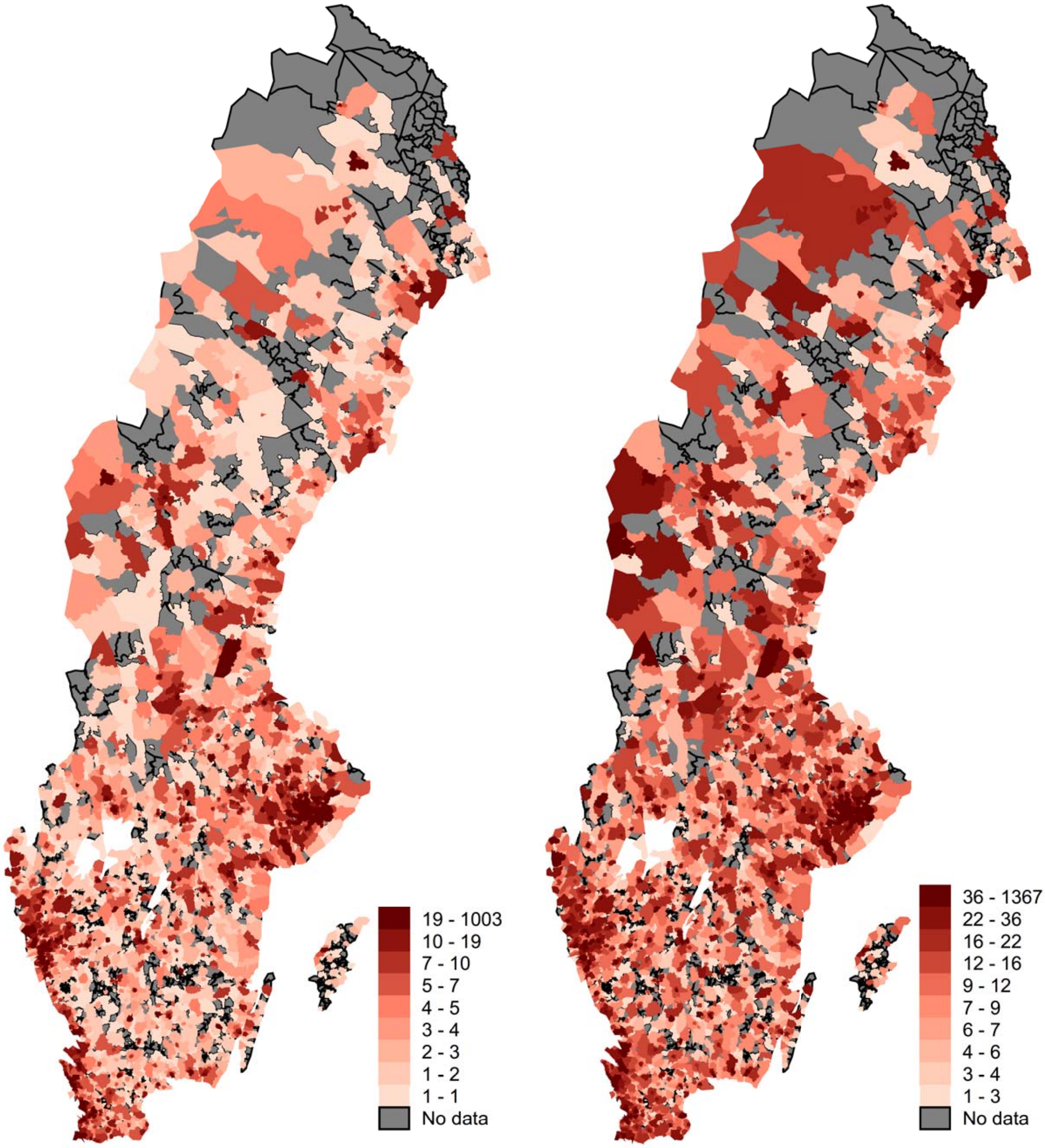

Figure A1: The number of business service firms (baseline definition, left side) and the number of service firms (broad definition on the right side, excluding firms reporting zero employment) located in each SAMS area.

B Results Appendix

Table B1: Baseline sample: IV and OLS results using different distance bands. Dependent variable is domestic sales (log) for firms supplying business services.

	IV			OLS
	ID	ID sq.	No-decay	ID
LEE, 0-20 km	0.0420^a	0.0398^a	0.0337^a	0.0296^a
	(0.00555)	(0.00391)	(0.00523)	(0.00396)
LEE, 20-100 km	-0.0148	-0.0142	-0.0107	-0.00103
	(0.0215)	(0.0151)	(0.0289)	(0.0102)
LEE, 100-200 km	-0.0308	-0.0299	-0.0407	-0.0358^b
	(0.0251)	(0.0239)	(0.0320)	(0.0169)
LEE, 200-300 km	-0.0413	-0.0408	-0.0367	-0.0442
	(0.0417)	(0.0398)	(0.0452)	(0.0590)
LEE, 300-400 km	-0.00125	-0.00749	-0.0193	0.0175
	(0.0360)	(0.0327)	(0.0394)	(0.0563)
LEE, 400 km +	-0.00221	-0.0157	-0.0462	0.0488
	(0.0929)	(0.0731)	(0.106)	(0.0936)
Nr. obs.	235611	235611	235611	235611
R^2	0.82	0.82	0.82	0.82
Within R^2	0.0008	0.0013	0.0005	0.0009
First stage F stat.	5.8	7.3	5.5	n.a.
# clusters	102	102	102	102
Firm-FE	Yes	Yes	Yes	Yes
LMA-Sector-year FE	Yes	Yes	Yes	Yes

^{c} $p < .10$, ^{b} $p < .05$, ^{a} $p < .01$. Standards errors are clustered on labour market areas (LMA) level. ID,: inverse distance, as in original specification. ID sq.: equals $1/(d_{jm})^2$. No-decay means that no decay is used within a distance band is applied.

Table B2: Robustness checks for baseline sample: IV results using lagged effects, alternative instruments and trends. Dependent variable is domestic sales(log) except column 4 which is the first stage for column 3.

	Lags		ID sq.		Trend
	Sales	Sales	Sales	$D_{jt}^{sq.}$	Sales
LEE	0.124[a]		0.0661[a]		0.191[a]
	(0.0159)		(0.00482)		(0.0185)
LEE 1-lag	0.128[a]	0.179[a]			
	(0.0218)	(0.0252)			
Alt. instrument, ($D_{jt}^{sq.\star}$)				0.628[a]	
				(0.0180)	
Nr. obs.	208631	208631	236244	236244	236244
R^2	0.83	0.83	0.82	0.97	0.82
Within R^2	0.0004	0.0003	0.0014	0.5533	0.0003
First stage F stat.	269.6	569.2	1216.2		577.5
# clusters	103	103	103	103	103
Firm-FE	Yes	Yes	Yes	Yes	Yes
LMA-Sector-year FE	Yes	Yes	Yes	Yes	Yes
Sector time-trend	No	No	No	No	Yes
LMA time-trend	No	No	No	No	Yes

[c] $p < .10$, [b] $p < .05$, [a] $p < .01$. Standards errors are clustered on labour market area (LMA) level. ID sq.: inverse distance squared, equals $1/(d_{gm})^2$.

Table B3: IV results for impact on plant employment for both business service(BS) and service firms according to the broad definition(broad) of services. Dependent variable is plant employment(logs+1).

	Business Services (BS)			Broad
	Empl.	Empl.	Empl.	Empl.
Localized Export Exposure(LEE)	0.114[a]	0.0684[a]		0.0976[a]
	(0.00695)	(0.00546)		(0.00620)
LEE lag		0.0799[a]	0.102[a]	
		(0.00834)	(0.00952)	
Nr. obs.	293021	264341	264341	638626
R^2	0.93	0.94	0.94	0.93
Within R^2	-0.0005	-0.0006	-0.0004	-0.0004
First stage F stat.	194.9	100.4	382.3	137.2
# clusters	105	103	103	105
Firm-FE	Yes	Yes	Yes	Yes
LMA-year-sector FE	Yes	Yes	Yes	Yes

[c] $p < .10$, [b] $p < .05$, [a] $p < .01$. Standards errors are clustered on labour market area (LMA) level.

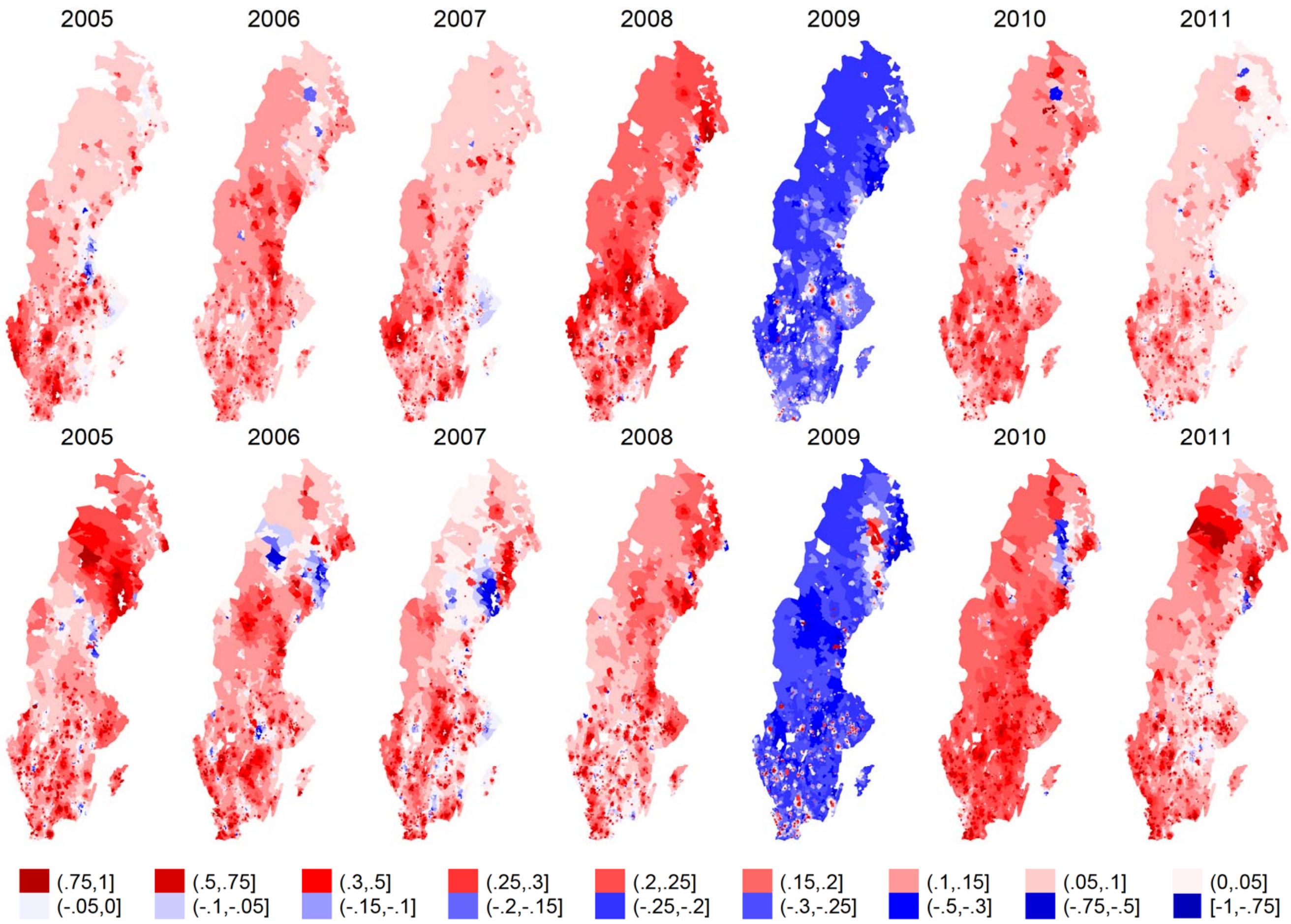

Figure B1: Comparison of the LEE and the LEE instrument using the alternative distance weighting. Yearly percentage growth in the SAMS-level LEE squared, $D_{jt}^{sq.}$ (top row), and the instrument for localised export exposure squared, $D_{jt}^{sq.\star}$ (bottom row), between 2005 and 2011. The yearly percentage growth is calculated as follows: $\triangle D_{jt}^{sq} = ln(D_{jt}^{sq}) - ln(D_{jt-1}^{sq})$ and $\triangle D_{jt}^{sq\star} = ln(D_{jt}^{sq\star}) - ln(D_{jt-1}^{sq\star})$.