Crossing Industrial Borders: German Manufacturers as Services Exporters

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Abstract

Manufacturing Firms increasingly engage in service trade activities. Micro-level data show that German Manufacturers account for roughly 30% of German cross-border producer service exports. I find that particular construction, engineering and R&D services are exported. The machinery industries, automobile and chemicals producers dominate the overall pattern. The types of services exported vary strongly across industries. Furthermore, export activities are concentrated on few large exporters. Generally, firms export more likely to countries near-by with a large market size. Altogether, I find a strong positive link between goods and services exports. Particular, construction services likely represent complementary services to exported products. Headquarter services appear hardly in the data. Many manufacturing MNEs do not export any services at all.

Keywords: services exports, manufacturing sector, goods trade, multinational firms, industrial interrelationships

JEL classification: D22, F14, F23, L80

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1. Introduction

Services Trade has become a more and more important issue in the economic literature. On the one hand, this is due to its increasing economic importance. In 2007, the share of services in GDP in the OECD had grown to roughly 75%. Furthermore, cross-border trade of services accounted for 20 percent of total trade and amounted to 3.3 trillion $ in 2007 (Francois and Hoekman 2010). This development makes service trade liberalization a potential source of economic welfare gains. Hence, there are several efforts to organize trade liberalization; for instance, in the negotiations on the "General Agreement on Trade in Services" (GATS) (WTO 2011) or the EU-Service-Directive (EU 2006). This process should be guided by profounded academic advice which can be provided only with a deeper understanding of services trade.

On the other hand, empirical research is facilitated through the increasing quality of empirical data in recent years. The time span of available data, the level of disaggregation and completeness of the information is increasing and allows a deeper understanding of existing service trade relationships. This may allow the development of more sophisticated and realistic service trade models in the future.

Particularly, the linkages between the manufacturing and services sectors in economies and the consequences for international trade might be an important issue for future empirical research. For instance, Daniels (2000) emphasizes that there are very dynamic linkages and synergies between service and manufacturing activities in an economy, which are, however, hardly analyzed and understood in the context of international trade. The existing literature is mainly focussing on services as inputs that are important for competitiveness of firms and their access to international markets (e.g., Debaere et al., 2010, Francois and Woerz, 2008, Nordas, 2010 and Wolfmayr, 2008). However, services are not only inputs in the value added chain of products. Increasingly, they are also an output in the manufacturing sector. For instance, the IG Metall (2003) reports that it has become common in the German machinery sector that firms selling the machines or equipment also install it as well as maintain and supervise electronic systems that are necessary to run them. Those complementary services accounted for 20% of the sales of machinery producers in 2002. Gage and Lesher (2005) even summarize that it becomes more and more difficult to categorize firms either as manufacturers or service firms, because complementary service activities become more and more important for manufactured goods.

Kelle and Kleinert (2010) find in a firm level analysis using service trade micro data of the Deutsche Bundesbank that producer services trade activities in Germany are often carried out by manufacturing firms. These accounted for nearly 30% of cross-border trade volumes in their sample for 2005. This result is particularly striking for exports, because the supply of services, by definition, is not the main business line of manufacturers. I find in a comparable set of producer services that

the share of manufacturing firms in total cross-border exports was especially high for R&D services (80.8%), engineering (75.2%)[1] and construction services (71.3%). Total service exports of manufacturers amounted to 28.1 billion euro in 2005.[2] Altogether, the service exports from manufacturing firms increased by roughly 75% between 2001 and 2005 in Germany while cross-border imports increased only by 6%.[3] Goods Exports increased by about 25% in this period. Obviously, service exports became increasingly important for the manufacturing sector.

Compared to other developed countries the manufacturing sector is still relatively important in Germany.[4] The high competitiveness of the industry in the international markets constitutes an important source of economic welfare (e.g., Barba Navaretti et al., 2010). Thus, understanding the role of service exports in the international business of German manufacturers might be helpful to find sources for future growth of welfare. One important part of this process will be to find how and to which extent international activities of firms are affected by service trade barriers, how these could be reduced and which gains and costs a future liberalization process might have. I contribute to this issue in the present paper by describing the pattern of services exports of the manufacturing sector in Germany. In particular, I show which kind of services are exports, which industries are most prevalent and how firm heterogeneity shapes the pattern of exports. Furthermore, I examine the motives that might be driving the observed activities of firms.

In the literature, the motives for manufacturers to export services are not very intensively investigated. The above shown example of the machinery sector in Germany shows that services might be exported as complements to exported products. Combining the supply of goods with services is known in the literature as the bundling of goods and services (e.g., Horn and Shy, 1996). It is assumed that firms bundle goods with complementary services to enhance the perceived value of the product they are selling or can differentiate their products from competitors. In the context of international trade, bundling implies that selling goods abroad - either through goods exports or goods produced abroad in foreign affiliates - might be also associated with selling services abroad. The empirical evidence on whether and to which amount these service exports are relevant for export activities of manufacturers is very scarce. For instance, Lennon (2009) shows with sector level trade

[1] This service group contains engineering, architectural, maintenance and technical support services. I denote these as "engineering services" for convenience in the following.

[2] Table 9 in the Appendix provides a complete list of all services regarded. Accounting for these services, the total volume of service exports by firms from all industries amounted to about 100 billion euro.

[3] The strong increase of exports was in particular driven by engineering services, which were more than 3 times larger in 2005 than in 2001.

[4] The share of the service sector in total value added has been below the OECD average in Germany in 2008 (OECD 2011).

data that there is a complementary relationship between goods and services trade between countries. Among other reasons, a complementary relationship of goods and services at the product level could be a partial micro level explanation of this phenomenon.

A second motive for manufacturers to provide services in foreign countries might be the support of foreign affiliates. Those services are often denoted as headquarter services in the literature. They play an important role in the well-known knowledge-capital model, for instance in Markusen (2002). In this model, multinational enterprises (MNEs) decide where to locate headquarter and production units. Knowledge-capital serves as a public good internal to the firm and is transferred to foreign affiliates. Examples for this knowledge-capital are patents or trademarks sustained by R&D. Furthermore, firms may transfer organizational capabilities to their affiliates to coordinate and plan activities in different markets or support production and distribution. These activities may show up as trade in management or advertising services (e.g., Davies, 2005 and Godart et al., 2009).

The two different motives for exporting services described above can be distinguished by the driving force of the export decision. In the first case of complementary or bundled services, services are closely linked to exported goods.[5] In the second case of headquarter services, service exports are related to a firm's foreign affiliate and serve as an input in the production and distribution process. A third scenario that one might consider is that a diversified supplier of both goods and manufacturers provides services abroad. This idea is closely related to the multi-product firm literature.[6] In this case, service exports are likely rather independent of other business lines of the firm, which is in contrast to the other motives mentioned. These different considerable scenarios show that it is, ex ante, not entirely clear how to explain the observable pattern of service exports.

In the present paper, I use these three possible scenarios to have a basic idea of the driving forces behind the service export behaviour of firms that I find in the data. In particular, I focus on analyzing the role of foreign affiliates of firms and goods exports as determinants of service exports of manufacturers. I implement this analysis with a firm level service trade dataset for German firms from the Deutsche Bundesbank for 2005, which contains service trade transactions from the Balance of Payments Statistics (BoPS). I combine this data with information about manufacturing and distribution foreign affiliates of firms from the Micro Database Direct Investment (MIDI) and industry level goods trade data from Eurostat (2005).[7]

[5]Generally, the concept of complementary services applies also to sales of goods through foreign affiliates, but I neglect this scenario to facilitate the analysis.

[6]For instance, Bernard et al. (2009) and Mayer et al. (2011) develop theoretical frameworks which explain the operation of multi-product or -service firms in international markets.

[7]I exclude foreign affiliate sales of services, which represent mode three exports in the GATS and were generally available in the MIDI dataset. On the one side, this is to facilitate the analysis

In the descriptive part of the paper, I find that R&D, construction, and engineering services are most important types of services exportes. These service exports are conducted by few high-tech industries; most important are the machinery sectors, automobile and chemicals producers. The kind of services exported varies strongly across the different industries. For instance, construction services exports are mainly carried out by the machinery sector. This suggests that different modes of foreign supply are most prevalent in the different industries, which in turn is important for service trade liberalization efforts (e.g., Francois and Hoekman 2010). Generally, headquarter services seem to play a rather minor role in explaining service export activities. For instance, many manufacturing MNEs do not export any producer services at all. Beyond the large industry impacts on trade pattern, I find pronounced firm level heterogeneity. As often stated in the trade literature, few large traders strongly dominate the overall exports.

To round up the descriptive analysis, I use estimation methods to identify determinants of the service export activities of firms. I estimate the service export participation decision of firms at the firm-country level and the intensive margin of service sales at the firm-service-country level. Generally, firms export more likely to countries close-by and with a large market size. Furthermore, I find evidence for a positive link between services exports of firms and industry-level goods exports, which is particular pronounced for construction services. These likely represent complementary services, in particular to exported machinery. Data processing service exports are found to be often exported to support both production and distribution affiliates of firms.

The rest of the paper is organized as follows: Section 2 presents some details about the dataset used and its construction. Section 3 provides descriptive statistics about the types of services exported, the different manufacturing industries conducting them and characteristics of exporting firms. Section 4 analyzes important determinants of service exports of manufacturers in a regression analysis. Section 5 concludes and summarizes issues for future research.

2. Construction of the dataset

The dataset is constructed by merging two firm-level datasets of the Deutsche Bundesbank. These contain nearly the entire population of German service traders. The first dataset records service transactions between residents and non-residents, collected to compile the BoP-Statistics. For every service transaction between a German resident firm and a non-resident, with a value higher than 12,500 euro, firms report to the Deutsche Bundesbank their sector classification, the partner country for the transaction, the classification of the transaction they conducted,

and, on the other side, because affiliate sales of manufacturers appear to be very scarce for the regarded services. See Section 2 for more details about this issue.

and the value of the transaction (Deutsche Bundesbank 2009). The annual data are available for the period 2001 to 2009.

These service transactions in the BoP-Statistics include the three GATS modes 1, 2, and 4 defined by the WTO (2011).[8] These three modes can not be distinguished in the dataset, because only the transactions, their value and the type of service are collected in the data. Thus, I summarize all these transactions in the category "cross-border exports".

Every reporting firm in the BoP-Statistics has been given a firm identifier from the Bundesbank. The same identifier is used in the MIDI (Micro Database Direct Investment) dataset. The MIDI dataset provides a detailed breakdown of the foreign assets and liabilities of German multinational firms abroad and German affiliates of foreign multinational firms (Lipponer 2009).[9] The database contains information on all foreign affiliates of German multinational firms The comprehensive database includes the balance-sheet data of foreign affiliates, including their sales, employment, and total assets in each of over 180 destinations. It also includes information on both the sector of activity of the parent firm and the affiliate at the NACE rev-1 two- or three-digit level and covers activities between 1989 and 2008.

I use the MIDI dataset to account for the manufacturing and distribution affiliates of firms. The manufacturing affiliates are classified the same way as the German manufacturing parents as presented in Table 2. Furthermore, I classifiy all affiliates with the Nace-code 500 ("sales, repair of motor vehicles"), 510 ("wholesale trade") or 520 ("retail trade") as "distribution affiliates". Furthermore, the data MDII dataset provides informations about service affiliate sales of firms. These are generally used to account for service exports through commercial presence, which is mode three in the GATS definition.[10] Hence, combining the BoP-data and the MIDI gives a dataset with comprehensive information about service trade activities of German firms in all four GATS modes.

I aggregate the service transactions from the BoPS to eleven service categories, which mainly contain producer services.[11] The first seven sectors are at the Nace

[8] Mode 1 contains cross-border trade transactions. Both the supplier and the consumer of the service stay in their home country and interact, for instance, through the internet or the post and telecommunication infrastructure. Mode 2 includes service trade transactions when consumers move abroad and consume a service in the foreign country. Mode 4 transactions are cases in which a service supplier moves temporarily abroad and provides a service to a foreigner.

[9] German foreign direct investment is there defined as direct or indirect ownership or control by a single German entity of at least ten percent of the voting rights or capital shares of an incorporated foreign firm or the equivalent interest in an unincorporated foreign firm.

[10] For instance, the OECD (2008) states that foreign affiliate services sales data is the best so far available and is preferable to estimating service trade by commercial presence using FDI stock or flow data.

[11] This facilitates the handling of the different service activities collected in the BoPS and comparing the services regarded with other datasets.

rev-1 two-digit level: construction, transport, auxiliary transport, post & telecommunications, insurance, data processing and R&D services. Four business services I split up into management services, engineering, advertising, and personnel services using the three-digit level classification. Table 9 in the appendix gives an overview of the kind of services included in the different categories and how these are match the classification of services in both datasets.

I use data for only 2005 in the entire paper and restrict the sample to manufacturing firms. There are 1,625 German manufacturers in the sample that sell services abroad either through cross-border or foreign affiliate sales in 2005. These firms account for 15,273 observations at the firm-service-country level for cross-border producer service exports and 91 for foreign service affiliate sales. Thus, foreign affiliate sales represent only 0.6% of the observations. Overall, cross-border exports of manufacturers amount to 28.0 billion euro and foreign affiliate sales to 5.2 billion.[12] In the following, I restrict the sample to cross-border sales and denote them as "services exports". On the one side, this facilitates the analysis, because specific aspects for foreign affiliate sales of firms must not be regarded.[13] On the other side, these are economically less important as described above for German manufacturers.[14] Dropping the firms with only service affiliate sales reduces the number of firms to 1,612. These account for 15,273 cross-border export observations.

3. Descriptive Statistics

The following section provides deeper insights into the service export activities of manufacturers by collecting stylized facts. First, I show the types of services exported and their relative importance for the manufacturing sector. Second, I examine the industry affiliation of exporters and how export participation and sales differ between industries. The third subsection combines these two perspectives and analyzes the importance of different services for different industries. Then I analyze how foreign affiliates affect the pattern of services exported. Finally, I describe in the fifth section characeristics of service exporting firms.

[12]The latter comprise mainly data processing (1.4 billion euro), auxiliary transport (1.3 billion euro), R&D (1.0 billion euro) and engineering services (0.9 billion). Note that I drop firms which are classified as holding companies, but could be assigned to a group of manufacturing firms. These firms show foreign service affiliates sales of 2.8 billion euro but no cross-border exports of services.

[13]The motives of firms to set up a foreign affiliate might be different compared to cross-border service sales. For instance, the affiliate could provide services to the parent firm, which would display some kind of outsourcing activities of firms.

[14]The only exception are financial services, which are not analyzed in the present paper. These accounted for around 25 billion euro foreign affiliates sales of manufacturers in 2005 in the MIDI dataset.

Table 1: Service Sector Variation in Services Exports of German Manufacturers 2005 (billions of euros, number)

Service Type	Cr.-border Obs.	Share (%)	Cross-border Exports	Share (%)
Construction	4,162	27.3	5.87	21.0
Transport	32	0.2	0.00	0.0
Auxiliary Transp.	723	4.7	2.44	8.7
Post & Telecom	49	0.3	0.01	0.0
Insurance	285	1.9	0.11	0.4
Data Processing	1,124	7.4	1.05	3.7
R & D	2,222	14.5	8.15	29.1
Management	1,898	12.4	2.62	9.4
Engineering	2,855	18.7	6.76	24.1
Advertising	1,111	7.3	0.57	2.0
Personnel	812	5.3	0.45	1.6
Total	15,273	100.0	28.05	100.0

Sources: BoP (2009), authors' computation.

3.1. Types of Services exported

To get a better understanding of service trade activities of manufacturers it is useful to look at the different types of services that firms are exporting. As already mentioned in the data description, the sample contains eleven types of producer services. Table 1 shows the relative importance of these different services for service exports of manufacturers. The first column presents the number of cross-border export observations for the different types of services. The second column shows the share of the observations in the total number of observations. Columns three and four display the sales of the different services and the respective share on total exports of the manufacturing sector.

I find that construction services are exported most frequently with a share of 27.3% on total observations (column two). In second place are engineering services (18.7%), followed by R&D (14.5%) and management services (12.4%). Considering export sales instead of the number of observations, I find R&D exports dominating. 29.0% of cross-border export sales are associated with R&D services (column four). The second most important services type are engineering services, and the third most important category construction services. These three types of services account for nearly 75% of the 28.1 billion euro cross-border exports.

Advertising and in particular management services are more important when the number of observations is regarded, but show only rather small volumes of sales. In addition, I find that transport, post & telecom and insurance services are hardly exported by manufacturers. This is a little bit surprising, because activities

like transporting goods for instance directly related to international activities of manufacturers. However, this might simply reflect that the costs for delivering a good are not charged the customer separately from the goods price and consequently do not appear in the BoPS.

3.2. Industries exporting

After presenting the volume and frequency of different producer services exported by manufacturers, the present subsection changes the perspective and investigates the industry affiliation of service exporters and their contribution to service exports. To assign firms to the different industries, I use the sector classification of the firms in the dataset on the Nace-rev 1 two-digit level.

Table 2 shows the number of German firms in the different industries (column one) with more than 20 employees in 2005. The data are from the *Statistical Yearbook 2007*. Column two presents the number of firms exporting at least one of the eleven services categories in the sample. Columns three and four contain each industry's share of the total number of service exporters and the volume of cross-border service exports. The ratio of service exporters to the total number of firms in the industry (service export participation ratio) is displayed in column five.

The most service exporters of the 1,612 exporting firms come from the machinery and equipment producer sector with a share of 35% (column three), followed by the chemical industry with 10% of firms and the instruments producers (9.0%).[15] With respect to the volume of cross-border exports (column four), the electrical machinery producers dominate with a share of 19.7%, followed by the automobile industry (18.9%), the machinery and equipment (15.2%), the chemicals industry (14.1%) and the "other transport equipment" industry (12.7%). These five industries account for about 80% of the services exports.

The Statistical Yearbook (2007) shows that these industries dominate also goods exports of the German manufacturing sector. They account for about 70% of the foreign sales of goods produced in Germany by the manufacturing sector.[16] This points to a positive relationship between the international goods and service export activities of industries. Furthermore, these five industries can be classified as high-tech industries (e.g., Hatzichronoglou, 1997), which implies that service exports might be more important for knowledge intensive industries. This presumption is supported by two facts: first, the share of services exports on goods exports, calculated from the data of the Statistical Yearbook (2007), is 5.5% in these high-tech industries, but only 2.7% on average for the remaining industries. Second, the

[15]This industry comprises the production of medical, precision and optical instruments as well as watches and clocks.

[16]Following the definition in the Statistical Yearbook (2007), these goods are sold directly to a foreign country or to intermediary firms that sell them abroad.

Table 2: Number of German Manufacturers and Service Exporters and Sales by Industry in 2005 (number, %)

Industry	Firms in Germany	Services Exporter	Share in Exporters (%)	Share in Exports (%)	Exp. Particip. Share Ind. (%)
Food	5,245	36	2.2	0.6	0.7
Tobacco	23	d	d	d	d
Textiles, Apparel & Leather	1,454	20	1.2	0.1	1.4
Wood	1,316	17	1.1	0.1	1.3
Paper	827	d	d	d	d
Publishing & Printing	2,515	88	5.5	1.7	3.5
Coke, Petroleum	52	7	0.4	0.7	11.5
Chemicals	1,397	161	10.0	14.1	11.5
Rubber & Plastic	2,687	61	3.8	1.4	2.3
Mineral Products	1,778	31	1.9	0.3	1.7
Basic Metals	904	38	2.4	0.2	4.2
Metal Products	6,258	103	6.4	1.1	1.6
Machinery & Equip.	6,014	574	35.6	15.2	9.5
Computers	164	7	0.4	2.2	4.3
Elect. Machinery	1,954	106	6.5	19.6	5.4
TV & Comm. Equ.	559	56	3.4	4.6	10.0
Instruments	2,112	145	9.0	4.2	6.9
Automobile	1,007	74	4.6	18.9	7.3
Oth. Transp. Equ.	313	54	3.3	12.7	17.3
Furniture	1,555	25	1.6	0.3	1.6
Total	38,134	1,612	100.0	100.0	4.2

d: values not displayed for confidentiality reasons.

Sources: BoP (2009), Stat. Yearbook (2007), authors' calculations.

service export participation ratio (column five) is 9.2% for the five industries, but only 2.4% for the rest.

Generally, I find large variance between the different industries with respect to the export participation ratio (column five). For instance, only 0.7% of the firms in the food and 0.8% in the paper industries export services, but 17.3% of other transport equipment and 11.5% of the chemicals and coke and petroleum producers. Altogether, only few German manufacturers sell services abroad. The average service exporter participation ratio is 4.2%.[17] Wagner (2007) states for a comparable sample of German manufacturers with more than 20 employees that roughly 60% of the firms exported goods in 2004. This ratio is much larger than the service export participation.

Obviously, goods exporting firms often do not export any services at all. On the one side, this suggests that manufacturers still might focus very much on producing and selling goods and weakens presumptions that many manufacturers are today rather services than manufacturing firms (e.g., Gage and Lesher, 2005). On the other side, the underlying BoP-Statistics likely underreport the true volume of service exports and exporters. As already mentioned above, the price for complementary services provided to exported goods might be included in the goods price and consequently would not appear in the BoP-Statistics. Furthermore, the threshold of 12,500 euro might affect firms with small values of service exports.

So far, I highlighted the dominance of R&D, E&A and construction services in cross-border exports and I found that few high-tech industries account for the majority of service export activities of manufacturers. The following subsection analyzes whether there is heterogeneity across different industries concerning the kind of services exported.

3.3. Types of Services exported by Industry

Table 3 shows the three most important services exported by a given manufacturing industry. I display results for the total sample of manufacturers and for the five most important industries that I highlighted above. The second column shows the type of service with the largest share on total cross-border exports of the firms in the respective industries, which are given in column eight. The third column shows its share in exports of this industry. Columns four to seven give the same information for the second and third most important service.

For the entire sample of firms, the share of the most important type of service on total service exports stands at 29% (column two). The two most important services account for about 53% of sales. Investigating individual industries, I find

[17] This value is upward biased, because the Statistical Yearbook (2007) accounts only for firms with more than 20 employees. A less restrictive measurement in the Statistical Yearbook (2008) counts 296,811 firms in the manufacturing sector in 2005. Using this value reduces the service export participation ratio to 0.5%.

Table 3: Most important Cross-border Service Exports in different Industries in 2005, (billions of euros, %)

Industry	Most imp.	Share (%)	Second imp.	Share (%)	Third imp.	Share (%)	Total Exp. of Industry
Manufacturing	R&D	29.1	Eng.	24.1	Constr.	21.0	28.0
Chemicals	Eng.	47.1	R&D	35.4	Manag.	12.2	3.95
Machinery & Equipment	Constr.	62.1	Eng.	23.3	R&D	6.6	4.26
Electr. Mach.	Constr.	50.0	Eng.	20.2	Data	10.7	5.50
Motor Vehicles	R&D	79.8	Manag.	7.0	Eng.	6.8	5.31
Other Transp.	Aux. Trans.	63.5	Eng.	26.3	R&D	5.0	3.56

Sources: BoP (2009), authors' calculations.

a stronger concentration of industries on few services exported. In all industries presented, the share of the most important type of service achieves at least 47%. In the automobile industry it is even almost 80%. The share of the two most important services varies between 70% in the electric machinery and nearly 90% in the other transport equipment industry. The types of services exported are obviously strongly shaped by the individual activities of the respective industries. This suggests a close relationship between the goods produced and sold in the different industries and service exports.

In the machinery and equipment industry we see mainly construction service exports, with a share of 62% of total cross-border exports. Together with engineering services these account for roughly 85% of service exports. This confirms Preissl (2007) who states that installation and maintenance services might be important services provided to foreign buyers of machinery. The automobile industry's service export activities are dominated by R&D services with a share of around 80%. The transfer of technological knowledge concerning production procedures or the design of motor vehicles seem to be important for the international activities of this industry.

In the electric machinery sector, we see beside the dominating construction and engineering services relatively large data processing exports, though the share of 10.7% in cross-border exports is still small, but much larger than for the entire sample of firms (3.7%). This could reflect the supply of software needed to use the exported machines or training of staff that uses the software. The "other transport equipment" industry provides mostly auxiliary transport services. Further disaggregating the data shows that mainly the repairing of transport vehicles that are in

Germany to be repaired can be found here.[18] Logistic services and other supporting activities are less important.

In all industries engineering services play an important role, particularly in the chemical industry. Obviously, transferring technological knowledge and know-how to foreign customers by providing engineering and technical consultancy services is a widely spread activity of German manufacturers.

Altogether, the finding of different types of services that seem to be important for the different industries suggests that also the service trade barriers for firms might differ across industries. One source for these differences are the different modes of supply that are most prevalent for the differnt types of services. Construction and engineering services might mainly rely on mode four transactions, because workers and engineers need to travel abroad to install an exported machine, for instance. R&D services however could be often provided through mode one, because the results of research can be more easily transferred through the post & and telecom infrastructure. Auxiliary transport services mainly represent mode two transactions, when foreign transport firms use domestically provided repairing services.[19] Thus, different industries might be affected completely different by service trade liberalization agreements in the GATS, because these distinguish the different modes of service supply (e.g., Francois and Hoekman, 2010). This underlines the requirement for more empirical research to guide future liberalization and deregulation efforts.

3.4. Manufacturing and Distribution Affiliates of Firms

In this section, I analyze how the pattern of service exports is affected by foreign affiliates. This may help to identify which role headquarter services play and which services might represent them. I account for manufacturing and distribution affiliates of firms, because both are economically meaningful.

In general, the number of observations in which a firm exports a service to a country with a affiliate is rather small compared to the cases in which the firm has no affiliate there. I find that firms have only for about 12% of the 15,273 observations a manufacturing affiliate in the destination country. Distribution affiliates of firms appear in only 9% of the observations. Altogether, firms show for nearly 85% of the observations neither a distribution nor a manufacturing affiliate abroad when it exports services to this country. Obviously, having a foreign affiliate abroad is often not the driver for service exports of a firm.

Table 4 gives some insights into the impact of foreign affiliates on the types of services exported. It is constructed in a similar manner as Table 3 and displays again the three most important services exported per industy, but it shows the share on the number of observations instead of the share on the sales. Furthermore, the

[18] These activities are collected within the "KNZ" 560 in the BoPS (Deutsche Bundesbank, 2009).

[19] See also the WTO webpage for discussions about the role of different modes for different types of services (WTO, 2011).

Table 4: Most important Services exported when Firm has Affiliate in Country or not in 2005 (numbers, %)

Industry	Manuf. Aff. in Coun.	Most imp.	Share (%)	Second imp.	Share (%)	Third imp.	Share (%)	No. of Obs.
Chemicals	yes	R&D	33.1	Data	16.8	Manag.	12.5	423
	no	R&D	34.9	Manag.	27.4	Pers.	9.6	1,312
Machinery &	yes	Constr.	35.1	Eng.	15.5	R&D	14.9	322
Equipment	no	Constr.	58.7	Eng.	19.8	R&D	5.3	5,444
Electr.	yes	Data	14.9	Eng.	14.1	R&D	13.4	410
Machinery	no	Constr.	31.6	Eng.	22.3	Manag.	11.0	1,187
Motor	yes	R&D	34.2	Data	13.6	Manag.	13.2	243
Vehicles	no	R&D	24.8	Adv.	22.9	Manag.	15.3	809

Sources: MIDI (2007), BoP (2009), authors' calculations.

observations are distinguished by whether or not a firm has an affiliate in the country it exports to. This allows us to check whether having an affiliate abroad induces specific types of service exports. I analyze three scenarios: (i) whether the firm has a manufacturing affiliate in the destination country or not, (ii) whether it has a distribution affiliate or not, and (iii) whether it has a distribution and manufacturing affiliate or no affiliate in the destination country. Table 4 presents only the results for manufacturing affiliates. The general results including distribution affiliates are similar and available on request.[20]

The results for the different industries in line one till eight show that the pattern of services exported is relatively similar for observations with and without an affiliate within industries. I find only for the electric machinery industry that the most frequently exported type of service is changing when a manufacturing affiliate exists in the country where data processing services are in this case most frequently exported (line five and six). This points to only small effects of foreign affiliates on service export activities of firms. Nevertheless, I find for all industries except the machinery & equipment industry that data processing services are one of the most frequently exported services when there is an affiliate in the destination country. However, it does not appear when there is no affiliate. Obviously, firms occasionally support foreign affiliates with software programs related to production, distribution or administrative processes or provide training of foreign employees that have to use

[20]Note that I drop the other transport equipment industry, because it has only a very small number of observations with a foreign affiliate in the destination country.

the software.[21] Furthermore, R&D services show generally a larger percentage share in observations when the firm has a production facility in the country, except for the chemicals industry. This is not surprising, because one would expect to find that firms transfer knowledge about production processes or product innovations more often to own affiliates. However, the effects are not very strong.

Finally, I find that roughly 25% of cross-border exports can be assigned to the 12% of the observations in which the firm has a manufacturing affiliate in the country. The average sales per observation are around 2.5 times larger when an affiliate is in the country. However, the pattern of service exports seems to be altogether only to a small extent influenced by foreign affiliates of firms.

3.5. Characteristics of Firms that export Services

So far, I have shown that industry characteristics strongly influence the pattern of service exports by manufacturers. However, the international trade literature indicates that beyond industrial characteristics, firm or within-industry heterogeneity is most important to explain the trade pattern (e.g., Eaton et al., 2004). The present subsection shows some stylized facts about characteristics of services exporters and how these affect the pattern of trade.

3.5.1. Large and Small Firms

One important result in the international trade literature is that trade is strongly dominated by few large trading firms. This evidence can be found also for services trade (e.g., Breinlich and Criscuolo, 2011 and Kelle and Kleinert, 2010). Table 5 gives information about heterogeneity of German manufacturing service exporters related to the size of their export activities. I add up total service exports at the level of the firm and rank the firms in deciles depending on the volume of the sales.

The first important result is that there is very pronounced concentration of export activities. The firms in the 10th decile, which are the 10% largest firms, account for 91% of total service exports (column three).[22] Second, column four and five show that the concentration is driven by both extensive margins. The number of countries a firm is serving is on average 6.8 (column four) and the number of service types a firm is exporting 1.9 (column five). Both margins strongly increase from the 1st to the 10th decile. The average extensive margins even exceed these of service firms found by Kelle et al. (2011) in a similar sample of services. In particular, they export a larger variety of services. Obviously, manufacturing firms that export services are strongly internationalized, which suggests that these belong also to the dominating goods exporters in their industries. Unfortunately, I cannot

[21] This result holds in general when distribution affiliates are regarded.

[22] The large concentration can be found also when single industries are regarded. The share of sales of firms in the 10th decile ranges from 77% in the machinery & equipment industry to 97% for the automobiles and electric machinery producers.

Table 5: Deciles of Service Exporters 2005, (million Euro, number)

Decile	Exports (mill. Euro)	Share (%)	Average Number of Countr. Served	Serv. Types	No. of MNEs	No. of Manuf. Affil. per Firm
1	3.34	0.0	1.20	1.08	19	0.26
2	8.89	0.0	1.56	1.14	15	0.29
3	19.3	0.1	2.40	1.26	18	0.34
4	36.9	0.1	2.73	1.45	23	0.40
5	69.4	0.2	4.39	1.79	35	1.19
6	136.3	0.5	5.75	1.88	39	0.68
7	252.9	0.9	7.88	1.88	38	0.73
8	521.0	1.9	10.2	2.31	42	0.61
9	1,448.2	5.5	11.1	2.68	56	0.67
10	25,500.0	91.1	21.0	3.65	54	4.61
Total	28,000.0	100.0	6.81	1.91	339	1.08

Sources: MIDI (2007), BoP (2009), authors' computations.

analyze this, because there is so far no possibility to combine the underlying service trade data with goods trade data at the firm level.

3.5.2. Manufacturing MNEs and Non-MNEs

Furthermore, Table 5 shows that 339 of the exporting firms have at least one manufacturing affiliate abroad and thus could be classified as manufacturing MNE (column six). Thus, roughly 21%, 339 out of 1,612, of the service expoters are manufacturing MNEs. Analyzing the distribution of MNEs over the different deciles shows that the MNEs are relatively equally distributed in the ten deciles. Obviously, not only MNEs dominate service exporters. This may indicate that also the so called small- and medium-sized enterprises (SMEs), which are found to play an important role for the strong performance of Germany in goods exports, are among the largest service exporters.[23] Nevertheless, column seven shows that the larger service exporters have on average much more manufacturing affiliates than the smaller one.

Table 6 displays the different margins of service exports for both MNEs in line one and non-MNEs in line two. Column two and three show the extensive margins and column four the average sales per observation at the firm-service-country level, which is an intensive margin. On average, MNEs show larger values for all export margins. In particular, MNEs serve on average twice as many countries as non-MNEs (column three). Altogether, I find that the 20% of firms that are MNEs

[23]For instance, Barba Navaretti et al. (2010) find that the concentration of goods exports on few large firms is less pronounced in Germany compared to other important EU countries.

Table 6: Service Export and Manufacturing Affiliate Activities of different Types of Firms, 2005 (thousands of euros, number)

Services Exporters	No. of Serv. Exported	No. of Dest. Countries	Avg. Sales per Obs.	No. of Firms
MNE	2.55	11.51	1,057.9	339
Non-MNE	1.74	5.56	913.1	1,273
Manufact. MNEs	No. of Affil. per firm	No. of Affil. per Country	Avg. Sales per Affiliate	No. of Firms
Service Exporter	5.12	1.39	59,072.1	339
Non-Exporter	1.95	1.13	45,980.4	838

Sources: MIDI (2007), BoP (2009), authors' calculations.

account for nearly 50% of service export sales.

3.5.3. Service Exporting and Non-Exporting MNEs

Regarding not the pool of service exporters and instead but the group of all manufacturing MNEs in the MIDI dataset, I find that many manufacturing MNEs show no service exports at all. Altogether, the MIDI dataset contains 1,177 manufacturers that had at least one foreign manufacturing affiliate in 2005.[24] But only 30% of them, 339 out of 1,117, are exporters of producer services as well.[25] This fact appears to contradict the theory of multinational firms, which states that international knowledge and capability transfer between the headquarter and the production units of a firm are an essential part of the international business of MNEs. However, this result should be interpreted with caution, because headquarter services might not appear in the data For instance, it could be that affiliates do not pay the headquarter for providing headquarter services and, instead, the headquarter bears the costs.[26]

Beyond these limitations of the data, I find that the size of a manufacturing MNE shows a positive relationship with the service export activities of firms. Table 6 gives insights into the size of foreign activities of MNEs that export services (line three) and firms that do not (line four). I find that, on average, the service exporters have three times more affiliates than Non-Exporters (column two), they have more

[24]That means that roughly 3% of German manufacturers are manufacturing multinationals. This ratio varies considerably across industries.

[25]Note that there are about 800 holding firms which have manufacturing affiliates abroad, but have no cross-border service exports. Accounting for them would increase the share of MNEs that does not export services.

[26]This explanation is in line with the theory, which assumes that knowledge serves as a public good within the firm and would consequently be provided for free to foreign subsidiaries (e.g., Markusen, 2002).

affiliates per country in which a firm has an affiliate (column three), and larger manufacturing affiliate sales per affiliate (column four). This indicates that rather MNEs with affiliates in many countries are services exporters. Whether this is driven by a larger productivity of these firms or whether this means, vice versa, that firms with a strong service expertise are more successfull in international product markets is an interesting question that I leave open for future research.

4. Regression Analysis

The descriptive statistics gave some ideas about the determinants of the service export pattern of manufacturers. I found pronounced industry heterogeneity and few high-tech industries dominating overall exports. These show large concentration on specific types of services exported. Furthermore, service exports are strongly dominated by few large firms. Altogether, service exports seem to be aimed to support foreign affiliates only to a rather small extent. This raises the question whether there can be found a strong linkage to goods exports instead. Thus, I apply in this final empirical section a regression analysis in particular to find whether and how service exports of firms are related to goods exports and foreign affiliates when I control for a large set of other influencing factors.

4.1. Estimation Approach

I examine the export behavior of firms with two different estimation approaches. First, I estimate the service export market entry decision of firms. I include all manufacturers in the sample and assume that every firm could potentially export to any country and try to find out what determines if a firm exports services to the country or not. I estimate this discrete choice with a probit regression. Second, I go one step further and estimate the determinants of the intensive margin of service sales. I presume that this latter approach can obtain more precise information about the determinants of service exports of firms, because it describes firm behavior more deeply within a particular country. Variables that show significant effects also for the intensive margin should be particularly important. Altogether, I expect in general that variables affect the participation and sales decision in the same direction, but the latter giving more information about the strength of the impact.

The evidence shown so far suggests that only a small part of service exports may be provided as headquarter services to foreign affiliates. To be able to make more precise statements about whether and how foreign affiliates affect the observed services exports, I examine whether foreign affiliates have a significant impact on the service export behavior of manufacturers in the regression analysis. I account for different measurements of affiliate activities of firms in the destination countries. I test the dummy variables whether a firm has a manufacturing or distribution affiliate in the country, the number of the respective affiliates and the volume of affiliate sales. These measures are highly positively correlated and can all be expected to have a

positive impact. In general, I apply the affiliate sales of a firm in a country (*Manuf. Affil. Sales* and *Distrib. Affil. Sales*), because these contain the most information about the volume of affiliate activities of firms.

The presumingly small impact of foreign affiliates on service exports of firms leaves different possible explanations for the exports of firms: First, the services could be provided rather independent of manufacturing activities of firms if these were diversified suppliers of both products and services. Then the determinants of their export behavior should be very similar to the one of service firms. Second, services could be exported as complements to goods sold abroad. This idea is supported by several facts described above. In this case one would expect to find a close positive relationship between goods exports and service exports of a firm in a country.

Unfortunately, I am not able to combine the service trade data with information about goods trade activities of German manufacturers at the firm level. Instead, I use the volume of goods exports of a particular industry to a particular country as a proxy at the industry-country level (*Goods Exports*). I apply 8-digit goods trade data from Eurostat (2009) and aggregate it to match the 2-digit Nace-rev. 1 categories of German manufacturing industries. Then I assign this data to the respective industry-country observations. Thus, I assume that, for instance, automobiles or automobile parts are only exported by the automobile industry.

Of course, this industry level measurement is only a rough proxy for goods exports of the individual firm. Its quality depends, among other things, on how much the service exporters in the sample really contribute to the goods exports of their industries. However, the descriptive facts shown above make me optimistic that these firms indeed belong to the large goods exporters in their industries, because the firms show international activities for a very large number of countries and service categories. I expect a positive sign of *Goods Exports* and interpret it as evidence for a complementary relationship of service and goods exports. However, this evidence would be of course only weak. Yielding stronger evidence required the use of both goods and service export data at the firm level.[27]

Additionally to goods exports, I account also for the imports of goods. Lennon (2009) finds for some services exported a positive relationship to imported goods. I apply the same method as for goods exports also to goods imports data from Eurostat (2009) to control for the effect of *Goods Imports* at the industry-country level. This measure may represent intra-industry imports of intermediate inputs,

[27]Note that even finding a positive relationship of goods and service exports at the firm level does not necessarily mean that these are complements or bundled services for an exported product. This positive relationship could arise also, for instance, when market entry costs for providing services reduce if the firm already exported goods to the country. Furthermore, controlling for endogeneity of a firm's goods and service exports in a country would be useful. However, this requires using firm level data for both goods and services.

for instance.

The descriptive analysis suggested that firm heterogeneity plays an important role to describe the observed service export pattern. Table 5 and 6 display that MNEs show on average larger service export activities than Non-MNEs and. In particular they export to much more countries. Furthermore, I found that service exports of firms might be positively related to the number of foreign affiliates of firms. To control for this I include a dummy for the MNE-status (*Manufacturing MNE*) of a firm and the number of manufacturing affiliates (*Numb. of Manuf. Affil.*). I expect both variables to have positive signs.

Beyond these two measurements of firm heterogeneity or size respectively, I include a dummy of whether a firm is also a *Service Importer* or not. Kelle and Kleinert (2010) find that there might be a positive relationship between service exports and imports of a firm. Furthermore, the literature emphasizes that importing firms are on average significantly more productive than not importing firms. For instance, Breinlich and Criscuolo (2011) find this effect also for services trade. Thus, taking the import-status of firms into account might be an important control for heterogeneity of firms for both their service and goods exports preformance. Hence, I expect a positive sign of the variable *Service Importer*. In the sample analyzed here, about 75% of manufacturers also import services. Finally, I include a dummy which indicates whether a firm belongs to a foreign owner or not (*Foreign MNE*). Firms that are foreing owned are often found to show, ceteris paribus, larger trade activities.

A further important group of control variables are country variables. I include usual gravity controls like GDP, GDP per capita and geographical distance and border effects to control for country determinants of the firms' behavior.[28] These are found to be important for the service export decision of service firms in the literature, for instance by Kelle et al. (2011). I expect a positive sign for both *GDP* and *GDP per cap*, because a larger market and a higher income level are used to foster trade, and a negative one for *Distance*, because trade becomes more costly with a larger distance. Consequently, I expect a positive sign for the *Border* dummy. Finally, I also the foreign service affiliate sales of German MNEs in the foreign country relative to countries GDP (*Rel. Serv. Aff. Sales*). This measure might reflect, among other things, the services demand in an economy and should have a positive impact.

Finally, I control for the industry of a firm with an industry dummy at the 2-digit level, because the stylized facts show that export participation varies strongly across industries. In the intensive margin regression I include also dummies for the type of service exported.

[28]GDP and population data come from the World Development Indicators of the Worldbank (2009). The distance between countries is available in the distance database of the CEPII (2005).

In the next two subsections, I present first the results for the service export entry and then for the export sales of firms. Furthermore, I show also results of individual regressions for construction and data processing services. The former likely present complementary and the latter headquarter type services. Following the argumentation in the introduction, complementary services should show a closer relationship to goods exported while headquarter services are more affected by foreign affiliates.

4.2. Export Market Entry

The export market entry decision is estimated by a probit regression approach. The sample contains all 1,612 firms that export services and all countries the firms could potentially export to, except the countries that show less than three observations of cross-border exports by any firm. The discrete choice variable on the left-hand side of the estimation equation is equal to zero, if a firm does not export services to the country and is one, if it does so. Because the country variables are only available for 116 countries, the sample reduces to 185,845 observations. 10,741 observations, or nearly 6% of total observations, show service exports; for these cases the discrete choice variable is equal to one.

Table 7 displays the regression results for the whole sample (column one), construction (column two) and data processing services (column three). The standard errors of the coefficients are corrected for clusters at the country level. The way of clustering affects the significance of the coefficients. Generally, the z-values of the country and the goods trade variables are smaller when clustering of countries is accounted for, while the firm and foreign affiliate variables show smaller z-values when clusters at the firm level are taken into account. Altogether, the most variables show significant coefficients with the expected signs independent of the chosen procedure.

The coefficients of *Goods Exports* and *Goods Imports*, however, are not significantly positive at the 5%-level. They are only significant when standard errors are corrected for clusters at the firm level. Thus, goods trade is positively correlated with the service exports of firms, but its impact beyond the impact of the large number of additional control variables is not so strong for the export market entry decision. The five times larger coefficient of *Goods Exports* indicates that these are more important than *Goods Imports*.

The two variables describing the foreign affiliate activities of firms in the destination, *Manuf. Affil. Sales* and *Distrib. Affil. Sales*, have significant and positive coefficients.[29] Thus, larger activities through foreign affiliates in the destination increase the likelihood that a firms export services to this country.

Additionally, the results show an important impact of firm characteristics. I find that *Manufacturing MNEs* export to significantly more countries than non-MNEs.

[29] I find also significant positive coefficients for the respective dummy variables, but slightly stronger effects of the sales variables.

Table 7: Probit Regression Result: Service Export Market Entry Decision of Manufacturers in Foreign Countries

Explanatory Variables	Total Sample	Construction Services	Data Proc. Services
ln(*Goods*	0.0042	0.0012**	0.0001
Exports)	(1.92)	(3.21)	(1.50)
ln(*Goods*	0.0008	0.000	-0.000
Imports)	(1.67)	(0.20)	(0.24)
ln(*Manuf.*	0.0029**	-0.00006	0.0001**
Affil. Sales)	(11.10)	(1.72)	(8.04)
ln(*Distrib.*	0.0028**	0.0001**	0.00007**
Affil. Sales)	(9.57)	(2.69)	(7.57)
Manufact.	0.010**	0.003**	0.0002**
MNE	(11.99)	(3.50)	(3.29)
Numb. of	0.0008**	0.0001**	0.00003**
Manuf. Affil.	(20.40)	(14.34)	(21.76)
Service	0.0187**	0.0037**	0.0008**
Importer	(26.10)	(21.91)	(9.57)
Foreign	0.002**	-0.001**	0.0001*
MNE	(3.30)	(5.95)	(2.35)
ln(*Distance*)	-0.0040*	-0.00003*	0.00003
	(2.03)	(2.35)	(0.49)
ln(*GDP*	0.0019**	0.0002	0.0001**
per Cap)	(2.59)	(1.61)	(3.73)
ln(*GDP*)	0.0093**	0.0010*	0.0003**
	(3.65)	(2.51)	(3.32)
Border	0.007	0.0013*	0.0004**
	(1.81)	(2.01)	(2.74)
ln(*Rel. Serv.*	0.0022**	0.0002	0.0001**
Aff. sales)	(3.24)	(1.87)	(5.79)
Observations	185,845	167,260	181,593
Pseudo-R^2	0.29	0.30	0.37

Table reports marginal effects. All regressions include dummies for industryof the firm. Z-values in brackets are cluster robust. **, * significantly different from 0 at 1% level and 5%, respectively.

The coefficient of *Numb. of Manuf. Affil.* is significantly positive as well. Firm size affects the service export market entry positively. The *Service Importer* dummy has a significant and positive coefficient. Firms that import services export services significantly more likely to foreign countries. Foreign owned firms show also larger export activities. The coefficient of *Foreign MNE*, however, turns insignificant when standard errors are clustered at the firm level.

Finally, I find that *GDP*, *GDP per capita* and *Rel. Serv. Aff. Sales* have significantly positive and *Distance* a negative coefficient. Hence, firms export significantly more likely to countries that are nearby, have a large market size, a high income level and larger German foreign service affiliate sales. These results are qualitatively very similar to the foreign market entry decision of producer service firms in Kelle et al. (2011).

The results in column two and three generally support the idea that the construction and data processing services represent complementary and headquarter services, respectively. In the regression with only construction service exports *Goods Exports* have a highly significant positive coefficient. The variable *Manuf. Affil. Sales* does not significantly affect the export participation and even has a negative sign. Furthermore, *Distrib. Affil. Sales* has no significant impact when standard errors are corrected for clusters at the firm level. For data processing services (column five), however, I find in all specifications for both affiliate variables highly significant coefficients with the expected signs while goods exports seem to be not important.

4.3. Intensive Margin of Exports

After investigating the extensive margin of export destinations, I now analyze the determinants of the intensive margin of service exports. I use the aggregated sales at the firm-service-country level and regress them on the explanatory variables using the OLS method. I use the same variables as in the participation estimation to explain the volume of exports and add dummies for the types of services exported. The sample contains 14,839 observations of cross-border sales of firms.

Table 8 presents the estimation results, which display coefficients for which the standard errors have been corrected for clusters at the firm level. Clusters at the country level are less important for the estimation of the intensive margin.

For the entire sample in column one, if find for *Goods exports*, in opposite to the market entry decision, a positive and significant relationship to the volume of services export sales of firms. When the industry exports 10% more goods to a country the firm's export sales of services are by 1.3% larger on average. This suggests an important role of goods exports for service export sales of firms. *Goods imports* show now instead a negative but insignificant coefficient.[30] Furthermore, I find that both *Manuf. Affil. Sales* and *Distrib. Affil. Sales* have positive and

[30]The z-value further decreases when clusters of countries are accounted for.

Table 8: OLS Regression Results: Determinants of Int. Margin of Service Exports

Explanatory Variables	Total Sample	Construction Services	Data Proc. Services
ln(*Goods*	0.134**	0.361**	0.072
Exports)	(4.34)	(3.99)	(0.59)
ln(*Goods*	-0.033	-0.138**	0.028
Imports)	(1.95)	(5.49)	(0.63)
ln(*Manuf.*	0.046**	0.065*	0.056*
Affil. Sales)	(4.45)	(2.13)	(2.27)
ln(*Distrib.*	0.032**	0.032	0.054**
Affil. Sales)	(3.43)	(0.93)	(4.25)
Manufact.	-0.033	-0.025	-0.208
MNE	(0.31)	(0.14)	(0.82)
Numb. of	0.015**	0.028**	0.018**
Manuf. Affil.	(4.64)	(6.76)	(2.84)
Service	0.527**	0.865**	0.415
Importer	(6.44)	(6.73)	(1.18)
Foreign	0.259**	0.025	0.203
MNE	(2.81)	(0.14)	(0.89)
ln(*Distance*)	0.036	-0.006	0.064
	(1.62)	(0.14)	(0.96)
ln(*GDP*)	-0.013	-0.031	-0.012
per Cap)	(0.64)	(0.86)	(0.18)
ln(*GDP*)	0.086**	-0.019	0.139*
	(3.84)	(0.34)	(1.99)
Border	0.141**	0.137	0.291
	(2.74)	(1.57)	(1.91)
ln(*Rel. Serv.*	0.014	-0.014	0.053
Aff. Sales)	(0.83)	(0.63)	(0.84)
Observations	14,839	4,054	1,093
R^2	0.154	0.187	0.280

Table reports marginal effects. All regressions include dummies for industryof the firm. Z-values in brackets are cluster robust. **, * significantly different from 0 at 1% level and 5%, respectively.

significant coefficients, while the coefficient of manufacturing sales is slightly larger. Larger foreign affiliate sales of firms are related to larger service export sales abroad.

Firm heterogeneity plays again an important role to explain the outcome. The variable *Numb. of Manuf. Affil.* has a highly significant coefficient .This confirms that larger MNEs show larger service export activities. In addition, the *Service Importer* variable has a positive and significant coefficient. Firms that import services export larger volumes of services. The same is true for firms that are owned by a foreign investor. The country variables instead are less important compared to the foreign market entry decision. Only the *GDP* of countries and the *Border* dummy have significant impact on the intensive margin of service exports of firms.[31]

The results for construction and data processing services in column two and three confirm the results from the last section that they may indeed represent different groups of services. Construction services are obviously strongly driven by *Goods Exports*, which have a highly significant coefficient (column four), that is nearly three times larger than for the whole sample of services. This suggests a complementary character of construction service exports. Data processing services instead are much more affected by foreign affilate activities of firms. Both *Manuf. Affil. Sales* and *Distrib. Affil. Sales* have significant and positive coefficients. *Goods Exports* instead seem to play no important role. This supports the notion that data processing services are often exported to support own foreign affiliates.

The distinct results for these two different types of services raise the question whether also for other types of services different drivers of service exports can be identified. Table 8 shows in column four and five the regression results for samples with only engineering and R&D services, respectively. Engineering services show a similar pattern like construction services. *Goods Exports* have a highly significant and positive coefficient. Furthermore, *Manuf. Affil. Sales* has as well a significant positive coefficient, but *Distrib. Affil. Sales* has not. Country variables in turn are less important. This indicates that also engineering services are closely linked to goods exports of firms and are often exported as complementary services. Altogether, I find that construction and engineering services strongly drive the overall positive impact of goods exports. When I drop these two types of services from the sample, the coefficient of *Goods Exports* turns insignificant also for the estimation of the intensive margin.[32]

R&D services (column five) show a very different pattern. On the one side, they seem to be strongly affected by foreign manufacturing affiliates. *Manuf. Affil. Sales* has a highly significant positive coefficient. This supports the idea that R&D service exports may serve, for instance, to transfer knowledge about production procedures to foreign affiliates. Thus, as presumed in Section 3, R&D services might represent

[31]The effect of a joint border turns also insignificant when I cluster error terms for countries.
[32]The results for estimations mentioned but not shown are available on request.

also partially headquarter type of services. Furthermore, the results show that also goods imports seem to be strongly linked to R&D service exports. *Goods Imports* has a significant positive coefficient. As already stated above, in the applied specification goods imports likely represent, at least partially, the import of intermediate products of industries. Following this reasoning, the exported R&D services could represent knowledge transfer of German firms to foreign third-party suppliers of intermediate inputs or foreign production affiliates of firms. This presumption is supported by the result that the importance of goods imports is even increasing when I analyze only the R&D exports of the automobile industry, which is likely relying very much on foreign intermediate inputs.

Altogether, the regression analysis shows that service exports are indeed strongly affected by the international production and sales of goods. However, the different types of services are very differently connected to the international activities of firms. Construction and engineering services show a strong positive relationship with goods exports. Data processing services instead are closely connected to foreign affiliates of firms. Thus, the former services likely represent complementary services and the latter rather headquarter type of services. R&D services in turn do not fit these two categories. They show a strong positive relationship with imported goods and manufacturing affiliates. Hence, they may represent the international knowledge flows between firms and their affiliates and in particular the foreign producers of intermediate goods. This shows that it is not so easy to disentangle the observable service export activities of firms and identifying clearly their determinants. Altogether, the evidence presented is still weak. To make more precise statements about the way service and goods exports are connected at the firm level data about goods exports of firms as well as information about intra-firm trade would be necessary.

5. Conclusions

The present paper analyzed service export activities of German manufacturers in 2005. These account for around 30% of cross-border producer service exports of German firms. The most important services exported are construction, R&D, and engineering services. Service exports are dominated by the machinery, automobile and chemical industries, which represent high-tech industries. The types of services exported vary strongly across industries. Generally, only few manufacturers export services. These serve often many countries and various types of services. Altogether, export sales of manufacturers are strongly dominated by few large exporters. Generally, manufacturers export services more often to countries close-by, with large market size and a high income level, which is in line with the evidence in other service trade studies. Furthermore, I find that large, and likely more productive, multinational firms sell larger volumes of services.

Altogether, the regression analysis shows that service exports are indeed strongly affected by the international production and sales of goods. The motives to export

services seem to vary strongly with the type of service regarded. Construction services and to a smaller extent engineering services are closely related to exports of goods. Construction services are very important for the machinery sectors. Thus, the installation and implementation of exported machineries and equipment seem to be an important complementing service that German manufacturers provide to their foreign customers.

The support of foreign affiliates with headquarter services, in turn, seems to explain only a small part of the cross-border services exports of manufacturers. Many manufacturing MNEs do not export any services at all. However, the data likely underestimate the role of headquarter services for activities of MNEs, because I observe only services for which the affiliate was paying. Nevertheless, I find that data processing services exports are positively related to both foreign manufacturing and distribution affiliates of firms. Hence, providing software solutions to foreign affiliates might be a relevant type of headquarter services. R&D services finally show even a strong positive relationship to imported goods. This may show that also the knowledge flow between firms and their foreign suppliers of intermediate inputs might be an important driver of observable service export activities of manufacturers. This might be particularly important for the automobile industry which is mainly exporting R&D services.

Generally, the results should be interpreted with caution, because I cannot observe intra-firm trade directly and goods trade data are not available at the firm level. The descriptive nature of the analysis does not allow strong causality statements. Furthermore, I likely do not account for the whole bunch of service activities of manufacturers, because a lot of them might not appear in the BoP-Statistics due to combined accountancy with exported products.

Nevertheless, the results underline that liberalization commitments should take into account that the different industries trade different types of services and the motives might be very different. Consequently, these industries are affected by service trade regulations in a different way. Horn and Shy (1996) claim that service trade barriers might be entry barriers for the export of goods in foreign markets when goods are bundled with services, which can lead to goods market segmentation. Hence, service import restrictions of countries could hamper the import of knowledge-intensive goods and services and the activities of productive goods exporters and MNEs, which might impact welfare negatively.

Furthermore, it is important to note that the different types of services are likely relying on different modes of services trade, which are very important for the negotiations within the GATS. While R&D exports might mainly represent mode one activities, which are suggested to be relatively much liberalized, construction might rely mainly on mode four trade. The latter is found to be most restricted in international services trade (e.g., Francois and Hoekman, 2010). This underlines that a more detailed understanding of service trade activities is necessary to get an idea of benefits and costs of reducing barriers to services trade.

Future research should focus even more on specific industries like the chemicals, machinery or automobile industry to obtain more precise statements about the role of services in the business of manufacturers and relevant service trade barriers. An analysis that is guided by a more advanced theoretical model may facilitate the interpretation of the results. Country comparisons might help to understand whether my findings are specific for the German economy. Generally, one would expect to find different results in other countries, because of different industry structures. For instance, Breinlich and Criscuolo (2011) find in a slightly larger set of services that manufacturers account only for about 10% of services exports and imports in the UK. An international comparison could help to find out in a next step whether the service expertise of German firms might be one partial explanation for the strong position of German manufacturers in international markets.

6. References

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7. Appendix

Table 9: Service Categories from BoPS and MIDI

Sector	MIDI (Nace rev. 1)	BoP-Statistics (KNZ's)
Construction	4500: Construction	Construction, Installation: 570, 580
Transport	6000: Land Transport, Pipelines 6100: Water Transport 6200: Air Transport	Rail & Road: 013, 215, 226, 233, 234, 240; Maritime and Inland: 081, 210, 216, 220; Air: 014, 020, 225, 244, 270; All Transp.: 015, 016, 080, 260, 271
Auxiliary Transport	6300: Supporting and Auxiliary Transport Activities, Travel Agencies	Logistics & Other Support: 300, 310, 320, 340, 360 Repairing Transport Means: 560
Post & Telecommunications	6400: Post & Telecommunications	518: Communication Services (Satellite, Telephone, Wire) 591: Post & Courier Services
Insurance	6600: Insurance and Pension Funding, except Social Security	Life, Pension and Reinsurance: 400-461
Data Processing	7200: Computer & rel. Activ.	513: Electronic Data Processing
R&D	7300: Research & Development	501: Artistic Copyrights 502: Patents, Licenses, Inventions 511: R&D for products, procedures
Management Services	7411: Legal Advice 7412: Accounting, Bookkeeping and Auditing Activities, Tax Consultancy 7413: Market Research, Public Opinion Polling 7414: Business and Management Consultancy	516: Entrepreneurship, Management, Organisation, Administration, Market Research 519: Other Entrepreneurial Activities

Source: Lipponer (2009), Deutsche Bundesbank (2009)

Table 9: continued

Sector	MIDI (Nace rev. 1)	BoP-Statistics (KNZ's)
Engineering Activities	7420: Architectural and Engineering Activities and related technical Consultancy	512: Engineering, Inspection, Technical Consultancy, Architect Royalties
Advertising	7440: Advertising	540: Advertising and Fair Costs
Personnel	7450: Labour Recruitment and Provision of Personnel	517: Personal Leasing 521: Non-self-employed Work

Source: Lipponer (2009), Deutsche Bundesbank (2009)