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Markus Kelle

Crossing Industry Borders: German Manufacturers as Services Exporters



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Markus Kelle

**Crossing Industry
Borders: German
Manufacturers as
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Abstract

German manufacturing firms increasingly engage in service trade activities. Micro-level data show that producer service exports of German manufacturers amounted to EUR 30 billion in 2005. In particular, construction, engineering and R&D services are exported. The machinery industries and automobile and chemicals producers dominate the overall pattern. The types of services exported vary strongly across industries. Furthermore, export activities are concentrated on a few large exporters. Service exports of advertising, data processing and R&D services are found to likely support foreign affiliates of firms. However, these headquarter services are only infrequently observable. Much more important are construction and engineering services exported by machinery firms. These might represent installation and maintenance services exported to complement the supply of machinery. Beyond the support of foreign production affiliates of firms, R&D services exports generally represent the transfer of knowledge and technology. These might be relevant also in R&D cooperations of firms or when firms have partnerships with foreign suppliers or buyers of intermediate products.

Keywords: *services exports, manufacturing sector, goods trade, multinational firms*

JEL classification: *D22, F14, F23, L80*

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Abstract

German manufacturing firms increasingly engage in service trade activities. Micro-level data show that producer service exports of German manufacturers amounted to 30 billion Euros in 2005. I have found that particular construction, engineering, and R&D services are exported. The machinery industries and automobile and chemicals producers dominate the overall pattern. The types of services exported vary strongly across industries. Furthermore, export activities are concentrated on a few large exporters. Service exports of advertising, data processing, and R&D services are found to likely support foreign affiliates of firms. However, these headquarter services are only infrequently observable. Much more important are construction and engineering services exported by machinery firms. These might represent installation and maintenance services exported to complement the supply of machinery. Beyond the support of foreign production affiliates of firms, R&D services exports generally represent the transfer of knowledge and technology. These might be relevant also in R&D co-operations of firms or when firms have partnerships with foreign suppliers or buyers of intermediate products.

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1 Introduction

Services trade has become an increasingly important issue in the economic literature. One reason for that is the increasing economic relevance of services in modern economies. In 2007, the share of services in GDP in the OECD had grown to roughly 75%. Furthermore, cross-border trade of services accounted for about 20% 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). One important task for academic research is to provide information about the costs and benefits of future deregulation and trade liberalization of services sectors (Hoekman, 2008). In this process, it is crucial to understand the links between services sectors and the manufacturing sector of economies. Services are increasingly important for manufacturing firms as inputs in the production process. For instance, in the EU-15 countries the share of purchased services on total output of manufacturers increased by about 50% since the 1980s and stands now at nearly 20% (Servicegap, 2011). Thus, structural changes in service sectors, through trade liberalization or deregulation for instance, that lead to changes of prices, the variety or quality of services will affect also the business of manufacturers (e.g., Arnold et al., 2011; Francois and Woerz, 2008).

However, focussing the analysis of the links between services and manufacturing on services as inputs might neglect important parts of the international business of modern manufacturers. Services are also more and more an output of modern manufacturers. For instance, Neely et al. (2011) find in a global sample with more than 10,000 firms that 30% of the manufacturers with more than 100 employees stated that they were selling services in addition to their products in 2011. Dell’mour and Walter (2009) find in a large sample of Austrian firms, that many manufacturers also export services to foreign countries. Federico and Tosti (2011) find in an Italian firm-level dataset that roughly 30% of the services exports could be assigned to manufacturing firms. This evidence is supported by Kelle and Kleinert (2010). They show in a firm level analysis using services trade micro data of the Deutsche Bundesbank that producer services export activities in Germany are often carried out by manufacturing firms. These accounted for about 25% of cross-border export volumes in their sample for 2005.

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%), engineering (75%), and construction services (70%).¹ Total services exports of manufac-

¹The group of engineering services includes engineering, architectural, maintenance, and technical support services. Construction services account also for installation and assembly services, which are likely particularly important for manufacturing firms. Table 7 in the Appendix provides a complete list of all services regarded.

turers amounted to nearly 30 billion Euros in 2005 and were showing a tremendous growth at the beginning of this century. Service exports increased by roughly 75% between 2001 and 2005, while cross-border imports increased by only 6%.² Furthermore, the growth of service exports exceeded also by far the growth of goods exports of 25% in the same period. These results show an (increasing) economic relevance of service exports for German manufacturing firms. However, service exports of manufacturers are so far hardly analyzed empirically at all in the international trade literature. There is hardly any systematic evidence about the volume of exports, the types of services exported and the drivers and barriers for service exports of manufacturers, for instance.

The present paper picks up this point and provides first insights into the role of services exports in the international business of German manufacturers. To conduct the analysis, I use 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 the data with information about foreign manufacturing and distribution affiliates of firms from the Micro Database Direct Investment (MiDI) and industry level goods trade data from Eurostat (2009). The analysis is carried out in two steps. First, I describe the data and show the types of services exported by manufacturers, the industries involved, which services are important in the respective industries, and how firm heterogeneity affects the pattern of service exports. Second, I analyze in a regression analysis how service exports are related to foreign manufacturing and distribution affiliates of firms and industries' international goods trade. This aims at identifying the most important motives of firms to export services. Generally, at least three motives to export services for manufacturers might be considered.

First, services could be exported related to an exported product. There are many papers, mainly in the management literature, that emphasize that services provided complementary to sold products constitute an important part of the business activities of firms. Firms provide many different types of services to the buyers of their products to increase the perceived value of the products, differentiate from competitors or building up closer customer relationships (e.g., Vandermeve and Rada, 1988).³ Stille (2003) reports that it has become quite common in the German machinery and electrics industries that firms provide several complementary services to their products like installation and maintenance of products, or the provision of electronic systems to use them. Those complementary services accounted for about 20% of the sales in these two industries in 2000. Horn and Shy (1996) analyze in a theoretical framework how the bundling of products and services may affect international trade with products. They point out that bundling might induce goods

²In particular, engineering services contributed to the large increase of services sales abroad. They nearly tripled between 2001 and 2005.

³See, for instance, Baines et al. (2009) for a review of this so called servitization literature.

market segmentation when services are not tradable across borders. This underlines that services and goods trade can be closely related at the level of single firms.

A second motive for manufacturers to provide services in foreign countries could be the support of the international production and distribution of products. On the one side, this might show up as intra-firm trade between affiliated firms. 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 R&D, management or advertising services or, more generally, as business services and are often referred as headquarter services in the literature (e.g., Davies, 2005; Godart et al., 2009). On the other side, in an internationally fragmented value chain services may also be provided to unaffiliated firms. Services could aim at supporting arm's length trade with intermediate products or the distribution of final products through third-party retailers or wholesalers. The types of services affected might be similar as in the case of headquarter services.

Altogether, services exports may arise at many different stages in the international business of manufacturers. This strengthens the argument that the consequences of the liberalization and deregulation processes for product and services markets are strongly interrelated. One part of understanding these links more deeply is to learn more about the economic relevance of service export activities of firms, the functions of different services and the motives to provide them in foreign countries. Generally, I find that headquarter services provided to foreign affiliates explain only a small part of the observable service exports of German manufacturers. Services exports related to the international supply of products by German machinery producers are more often observable. Furthermore, the trade with technology through R&D services is obviously quite important, in particular for automotive producers.

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, characteristics of exporting firms, and examines the role of firm's foreign affiliates. Section 4 analyzes important determinants of service exports of manufacturers in a regression analysis. Section 5 discusses and summarizes the results. Section 6 draws conclusions.

2 The Data

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 Euros, firms report to the Deutsche Bundesbank their sector classification, the partner

country for the transaction, the classification of the transaction they conducted, and the value of the transaction (Deutsche Bundesbank, 2009). The annual data are available for the period from 2001 to 2010. These service transactions in the BoP-Statistics include the three GATS modes 1, 2, and 4, defined by the WTO (2011).⁴ These three modes cannot 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 of 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).⁵ 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 2009. 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. Firms with a NACE code of their sector classification between 15 (food) and 36 (furniture) are accounted as manufacturers. Furthermore, I classify all affiliates with the Nace-code 50 (sales or repair of motor vehicles), 51 (wholesale trade) or 52 (retail trade) as distribution affiliates.

I aggregate the service transactions from the BoPS to eleven service categories, which mainly include producer services. The first seven sectors are at the Nace rev-1 two-digit level: construction, transport, auxiliary transport, post & telecommunications, insurance, data processing, and R&D services. I split up business services into management services, engineering, advertising, and personnel services using the three-digit level classification. Table 7 in the Appendix gives an overview of the kind of services included in the different categories and how these match the classification of services in both datasets. I use data for 2005 throughout the entire paper and restrict the sample to cross-border service exports of manufacturing firms. Overall, cross-border exports of manufacturers amount to 28.0 billion Euros coming from 1,612 firms. These account for 15,273 observations at the firm-service-country level.

⁴Mode 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 as a natural person and provides a service to a foreign customer (WTO, 2011).

⁵German foreign direct investment is 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.

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

Service Type	Export Observ.	Share (%)	Export Sales	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	28.0	100.0

Sources: BoP (2009), author's computation.

3 Descriptive Statistics

3.1 Types of Services exported

To obtain a better understanding of the 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 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 provide the same information for export sales.

I find that construction services are exported most frequently, with a share of 27.3% of total observations (column two).⁶ The second most important service exported 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, with a share of 29.0% of export sales (column four). The second most important services type is engineering services (24%), and the third most important category is construction services (21%). These three types of services account for nearly 75% of the 28.0 billion Euro service exports. Ad-

⁶Unfortunately, I cannot identify installation or assembly services explicitly, which likely often appear in the construction services group, due to the data aggregation.

vertising and, in particular, management services are relatively more important in terms of the number of observations, but they show only rather small volumes of sales. Transport, post & telecom and insurance services are hardly exported at all by manufacturers.

3.2 Exporting Industries

The present subsection 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 services from 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.

Table 2 shows the industries with at least 20 service exporting firms. Most of the 1,612 service exporting firms come from the machinery and equipment industry, with a share of 35% (column three), followed by the chemical industry, with 10% of firms and the scientific instruments producers (9.0%). With respect to export sales (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 producers (12.7%). These five industries account for about 80% of the services exports.

The Statistical Yearbook (2007) shows that these five industries also dominate 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.⁷ 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 idea is supported by comparing the service export participation ratios in different industries (column five). The export participation ratio is relatively high with a share of 9.2% for the five dominating high-tech industries, but only 2.6% on average in the other industries.

Altogether, only few German manufacturers sell services abroad. The average service exporter participation ratio is 4.2% (column five).⁸ Wagner (2007) states

⁷Following the definition in the Statistical Yearbook (2007), these goods are sold directly to a foreign country or to German intermediary firms that sell them abroad.

⁸This 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

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 Exp. Sales (%)	Exp. Particip. Share Ind. (%)
Food	5,245	36	2.2	0.6	0.7
Publishing & Printing	2,515	88	5.5	1.7	3.5
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
Elect. Machinery	1,954	106	6.5	19.6	5.4
TV & Comm. Equ.	559	56	3.4	4.6	10.0
Scient. 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

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

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, even many goods exporting firms do not export any services at all. The total value of goods exports by German manufacturers was roughly 600 billion Euros in 2005 (Statistical Yearbook, 2007). Thus, the value of services exports amounted to roughly 5% of total goods exports.

3.3 Types of Services Exported by Industry

So far, I have highlighted the dominance of R&D, engineering and construction services in exports, and I found that a 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 type of services exported.

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 Types of Service Exports in Different Industries in 2005, (billions of Euros, %)

Industry	Most imp.	Share (%)	Second imp.	Share (%)	Third imp.	Share (%)	Export Sales
All Firms	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. Tra.	63.5	Eng.	26.3	R&D	5.0	3.56

Sources: BoP (2009), author's calculations.

Table 3 shows the three most important services exported by the five most important manufacturing industry that I highlighted in the previous section. The most important type of service in the respective industries is displayed in column one and its share on the service export sales of this industry in column two. The columns three and four provide this information for the second most important type of service and columns five and six for the third most important service type.

Generally, table 3 shows that the types of services exported are obviously strongly affected by the individual characteristics of the respective industries. In the machinery and equipment industry (line three), I find mainly construction service exports, with a share of 62% of total service exports (columns two and three). Together with engineering services (columns four and five), these account for 85% of the export sales. In the electric machinery sector (line four), construction and engineering services make up about 70% of service export sales. These findings confirm the observations of Stille (2003). He states that installation, assembly, maintenance, and other technical support services are important services provided by the machinery and electrics industries as complementary services to the sold products. These services are likely represented in the BoPS data by construction and engineering services, but they are not clearly identifiable because of the data aggregation.⁹

The automobile industry's service export activities (line five) 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. The "other transport equipment" industry (line six) provides mostly auxiliary transport services. Further disaggregating the data shows that the repairing of transport vehicles, which

⁹This statistical caveat is taken into account in the NACE rev. 2 classification, which explicitly reports installation and maintenance of machinery. However, this information is not available in the datasets used here.

Table 4: Deciles of Service Export Sales 2005 (million Euro, number)

Decile	Exports (mill. Euro)	Share (%)	Average Number of		No. of	No. of Manuf.
			Countr. Served	Serv. Types	MNEs	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), author's computations.

reside in Germany to be repaired, can primarily be found here.¹⁰ In all industries, engineering services play an important role, in particular in the chemical industry (line two). Obviously, providing engineering, maintenance and technical consultancy services in foreign countries is a widespread activity of German manufacturers.

3.4 Firm level Heterogeneity

The previous analysis was showing that industry characteristics strongly influence the pattern of service exports by manufacturers. However, the international trade literature states that beyond industry characteristics, firm or within-industry heterogeneity is more important to explain the trade pattern (e.g., Eaton et al., 2004). One important result 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; Kelle and Kleinert, 2010). Table 4 gives information about the 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 ten deciles depending on the volume of their sales.

The first important result is that there is a 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 (columns one and two).¹¹ Second, columns

¹⁰These activities are collected within the KNZ 560 in the BoPS (Deutsche Bundesbank, 2009).

¹¹The large concentration can also be found when single industries are considered. 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.

three and four show that the concentration is driven by both extensive margins. The number of countries a firm is serving is on average 6.8 (column three) and the number of service types a firm is exporting is 1.9 (column four). Both margins strongly increase from the 1st to the 10th decile.¹² Obviously, manufacturing firms that export services are strongly internationalized. This suggests that these belong also to the largest goods exporters in their industries. Unfortunately, I am not able to analyze this because there is thus far no possibility to combine the underlying service trade data with goods trade data at the firm level.

However, the data provide information about the foreign affiliates of firms. Table 4 shows that 339 of the service exporting firms had at least one manufacturing affiliate in 2005 (column five). Thus, roughly 20%, 339 out of 1,612, of the service exporters are manufacturing MNEs. Many large service exporters have no manufacturing affiliates abroad. Nevertheless, column six shows that the large service exporters have on average many more manufacturing affiliates than the smaller ones. This points to a positive relationship between the volume of firm's international production activities and their service exports.

3.5 The Role of Firm's Foreign Affiliates

To understand the motives of firms to export services, it would be very useful to identify the recipients of the services. One potential group of recipients is the affiliates of German firms in foreign countries. In this case, services would aim at supporting affiliates with headquarter services. The previous section was showing that firms with a large number of foreign affiliates shows larger volumes of services exports, which suggests that foreign affiliates are very important drivers of services exports.

However, looking more deeply into the data shows that foreign affiliates can explain only a small part of the observable service exports of firms in the underlying sample. The number of observations in which a firm exports a service to a country with a foreign affiliate is rather small compared to the cases in which the firm has no affiliate. I find that firms have a manufacturing affiliate in the destination country for only about 12% of the 15,273 observations. Distribution affiliates of firms appear in 9% of the observations. These two groups of observations are partially overlapping. In 4% of the observations, firms have at least one manufacturing and one distribution affiliate. Altogether, for more than 80% of the observations, firms show neither a distribution nor a manufacturing affiliate abroad. This share is varying across industries. It is relatively small for chemicals firms with a share of 65% and quite large in the machinery and equipment industry, which shows for more than 90% of observations no affiliate in the destination of the services exported. Although

¹²The intensive margin is contributing even more to the concentration and is on average nearly 350 times larger for firms in the 10th compared to the 1st decile.

affiliates are only scarce, they show a positive impact on the observed volume of service export sales in the destinations for the total sample. The roughly 16% of observations with an affiliate account for 30% of the total export sales.

Altogether, supporting foreign manufacturing and distribution affiliates with headquarter services seems to be less important to explain the service exports of German manufacturers. The relationship of firms' service exports with international trade of German industries with products is analyzed more deeply in the following regression analysis.

4 Regression Analysis

The descriptive statistics gave some insights into the service export activities of German manufacturers. Foreign affiliates of firms play only a minor role to explain the observable service trade flows. Other motives to export services like the bundling of goods with complementary services might be more relevant. The following regression analysis aims at analyzing this issue more deeply by taking both foreign affiliates of firms and goods trade as explanatory variables of firms services exports into account.

4.1 Regression Approach

I examine the service exports of manufacturers with two different estimation approaches. First, I analyze determinants of whether firms export any services to a given country or not. I account for all manufacturers in the sample and assume that every firm could potentially export a service to any country. 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 it is one, if the firm does. I can make use of 172,067 observations in 116 countries in the probit regression. 10,573 or nearly 6% of total observations show service exports; for these, the discrete choice variable is equal to one. I use the probit regression method to estimate the discrete choice of firms.

Second, I go one step further and examine the determinants of the intensive margin of service export sales. Variables that show significant effects for the intensive margin should be particularly important, because the intensive margin describes firm behavior more deeply within a particular country. I use the aggregated sales at the firm-service-country level and regress them on the explanatory variables using the OLS method. The sample contains 14,672 observations of firm's export sales.

I account for the same explanatory variables in both regression approaches. These variables can be roughly subsumed in four groups of variables: the foreign affiliate sales of firms in the destination of service exports, intra-industry goods trade between Germany and the destination country of services, and important charac-

teristics of both the exporting firms and the destination countries. To sum up the described estimation approach, one can formalize the estimation equation for the intensive margin in the following way:

$$ExportSales_{ijkl} = \beta_0 + \beta_1 \ln(ForeignAffiliateSales_{ijl}) + \beta_2 \ln(GoodsTrade_{jl}) \\ + \beta_3 FirmCharacteristics_i + \beta_4 CountryCharacteristics_l + u_{ijkl}.$$

The export sales of firm i in industry j of service k in country l are explained by the foreign affiliate sales of firm i of industry j in country l , the goods trade of products by industry j with country l , characteristics of firms i and country l .¹³

To account for the large heterogeneity of industries and the potentially different roles of services for the international activities of firms, I also further disaggregate the regression samples. First, I run separate regressions for the potential head-quarter services types data processing, advertising, management and R&D services. Second, I analyze the most important services in the sample, R&D, construction and engineering services, in greater depth. I do this by focussing specifically on R&D service exports by automobile firms and the construction and engineering service exports of machinery producers.

4.2 Explanatory Variables

To account for the scale of firm's activities through foreign affiliates in the destination, I use the information from the MIDI about the sales of firm's foreign affiliates. I distinguish between manufacturing and distribution affiliates and sum up the affiliates' sales for every firm in a given foreign country. Generally, I expect that both manufacturing and distribution affiliates (*Manuf. Affil. Sales* and *Distrib. Affil. Sales*) induce service exports whenever firms support foreign production and distribution activities with domestic services. The types of services that support the respective two kind of activities might be different.

The descriptive evidence showed that foreign affiliates can explain only a small part of firm's service exports. Many exports are independent of any affiliates. This points to other international activities of firms as potential drivers of service exports. One important activity of firms might be the support of international goods trade with services. Unfortunately, I am not able to combine the service trade data with information about goods trade activities of German manufacturers at the firm level. To overcome this caveat, I use instead industry-level trade data for both goods exports and imports. 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

¹³The estimation equation for the probit regression is quite similar. Only the dimension for the types of services exported needs to be dropped and the sales variable on the left-hand side needs to be replaced with the discrete choice variable.

industries. Then I assign this data to the respective industries. This gives an intra-industry measurement for both *Goods Exports* and *Goods Imports* at the industry-country level.

In the case of *Goods Exports*, I expect that these show a positive relationship with service exports. This relationship should be particularly strong when firms sell bundles of products and complementary services. Hence, the larger the product exports of industries to foreign countries are the larger should be their service exports to this country. For *Goods Imports*, an economic interpretation is more difficult, because the economic link between the German service supplier and intra-industry imports is less clear. Firms may often do not import any products from the same industry at all. Furthermore, the data include both final and intermediate products. However, the volume of goods imports likely reflects the depth of the economic relationships of Germany with foreign countries and industries in general. Closer relationships that are reflected in large volumes of goods trade should have a positive impact on services trade activities of firms.

The third important group of variables are firm-level controls. The descriptive analysis in section 3.4 revealed that firm's are very heterogeneous with respect to the scale and scope of their service export activities. This might be affected by different characteristics of firms. For instance, I found that the volume of service exports of firms is positively related to their number of foreign manufacturing affiliates. To control for the impact of firm's internationalization on their service export activities, I include a dummy for the MNE-status (*Manufacturing MNE*) of a firm and a measurement of the number of its manufacturing affiliates (*Numb. of Manuf. Affil.*). I expect that both variables affect service exports of firms positively. Beyond these two measurements, I take into account whether or not a firm is also a *Service Importer*. Kelle and Kleinert (2010) find a positive relationship between service exports and import activities of a firm. Furthermore, the literature emphasizes that importing firms are, on average, significantly more productive than non-importers. For instance, Breinlich and Criscuolo (2011) find this effect also for services imports. Thus, taking the import-status of firms into account might be a further relevant control for heterogeneity of firms for both their services and goods exports performance. Consequently, I expect a positive sign of the dummy variable *Service Importer*. Finally, I include a dummy that indicates whether a firm belongs to a foreign owner or not (*Foreign MNE*). Firms that are foreign-owned are often found to show, ceteris paribus, larger trade activities (e.g., Breinlich and Criscuolo, 2011).

The fourth group of control variables are country variables. I add the usual gravity variables like GDP, GDP per capita, geographical distance, and a border dummy to control for country determinants of the firms' behavior.¹⁴ These are found

¹⁴GDP 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).

to be important for the service export decision of service firms in the literature, for instance, by Kelle et al. (2012). I expect a positive sign for both *GDP* and *GDP per cap*, because a larger foreign 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.

Furthermore, I control for the industry of a firm with an industry dummy at the 2-digit level, because the stylized facts show that export activities of firms vary strongly across industries. In the intensive margin analysis, I include also dummies for the type of service exported in the regression for the entire sample to take into account that the volume of exports per observation may vary across services. Finally, I account for clusters of both countries and firms in the data in the probit regression. Those clusters can lead to a downward bias of standard errors of the estimated coefficients (e.g., Wooldridge, 2003). Standard errors of the coefficients in the OLS regressions are adjusted for clusters of firms.

4.3 Regression Results

Table 5 displays the results for the entire sample of observations and subsamples of data processing, advertising and management services. Table 6 shows the outcome for R&D services, R&D exports by the motor vehicle industry, and the construction and engineering service exports of machinery firms. For every subsample, I first present the results for the probit regression of firm’s export destination entry decision. Then I show the OLS regression for the intensive margin of service sales. The explanatory variables are listed on the left-hand side of the tables. The respective t-values are presented in brackets below the coefficients and are, as explained in the previous section, corrected for clusters of firms and countries in the data. The coefficients in the probit regressions represent marginal effects.

Columns one and two of table 5 show the regression results for the entire sample of firms and services. In the probit regression for the export market entry decision (column one), both affiliate sales variables, *Manuf. Affil. Sales* and *Distrib. Affil. Sales*, have a positive and significant coefficient with nearly the same size. In addition, *Goods Exports* and *Goods Imports* show a significant positive coefficient, which is nearly 5 times larger for goods exports. The firm level variables all have a positive and significant coefficient, except the dummy for foreign-owned firms (*Foreign MNE*). Regarding the country variables, I find a significant positive coefficient for the *GDP* and the *GDP per capita* of destination countries.

The results of the OLS regression for the intensive margin are similar (column two). However, fewer variables show a significant coefficient. Again, both the manufacturing and distribution affiliate sales of firms have a positive and significant relationship with service exports. The same can be found for *Goods Exports* of industries. *Goods Imports* instead show no significant coefficient and even a negative sign. Of the firm variables, the *Service Importer* dummy, the number of manufac-

Table 5: Regression Results for Probit Regression of Export Participation and OLS of Intensive Margin of Services Exports by German Manufacturers, 2005

Explanatory Variables	Total Sample		Data Proc. Serv.		Advert. Serv.		Manag. Services	
	Probit	OLS	Probit	OLS	Probit	OLS	Probit	OLS
<i>ln Manuf. Affil. Sales</i>	0.064** (8.06)	0.044** (4.23)	0.072** (5.05)	0.055* (2.30)	0.014 (1.33)	0.031* (2.05)	0.074** (6.19)	0.057** (3.88)
<i>ln Distrib. Affil. Sales</i>	0.063** (5.73)	0.032** (3.41)	0.044** (3.40)	0.054** (4.30)	0.047** (3.64)	0.053* (2.17)	0.049** (4.24)	0.027 (1.24)
<i>ln Goods Exports</i>	0.177** (5.93)	0.126** (3.82)	0.266** (5.85)	0.053 (0.47)	0.201** (4.80)	0.091 (1.09)	0.191** (5.15)	0.135 (1.78)
<i>ln Goods Imports</i>	0.038** (4.35)	-0.022 (1.28)	0.025 (1.39)	0.047 (0.98)	0.027 (1.57)	0.040 (1.11)	0.050** (3.26)	-0.000 (0.01)
<i>Manufact. MNE</i>	0.208** (3.81)	-0.031 (0.29)	-0.041 (0.32)	-0.205 (0.81)	0.265* (2.21)	0.387 (1.52)	-0.155 (1.92)	-0.225 (1.17)
<i>No. of Manuf. Affil.</i>	0.019** (5.29)	0.015** (4.43)	0.019** (4.26)	0.017** (2.84)	0.010* (2.49)	-0.003 (0.96)	0.008** (2.65)	-0.002 (0.35)
<i>Service Importer</i>	0.548** (11.62)	0.527** (6.45)	0.479** (3.65)	0.409 (1.17)	0.302 (1.64)	0.169 (0.54)	0.534** (4.22)	-0.079 (0.23)
<i>Foreign MNE</i>	0.054 (1.20)	0.256** (2.79)	-0.111 (1.22)	0.208 (0.91)	0.053 (0.48)	0.148 (0.64)	0.276** (3.65)	0.663** (3.31)
<i>ln Distance</i>	-0.048 (1.62)	0.035 (1.55)	0.03 (1.71)	0.057 (0.85)	-0.07 (1.19)	0.091 (1.32)	-0.050 (1.08)	-0.071 (0.99)
<i>ln GDP per Cap</i>	0.048** (3.28)	-0.003 (0.15)	0.117** (3.21)	-0.001 (0.02)	0.126** (3.53)	0.171* (2.41)	0.080** (2.94)	0.079 (1.53)
<i>ln GDP</i>	0.119** (3.18)	0.084** (4.74)	0.093* (4.87)	0.120* (2.16)	0.120** (2.64)	0.117* (2.21)	0.130** (3.03)	0.128* (2.24)
<i>Border</i>	0.147 (1.89)	0.137** (2.68)	0.261* (2.02)	0.292 (1.88)	0.130 (0.92)	0.123 (0.89)	0.156 (1.62)	0.265* (2.09)
Observations	172,067	14,672	27,081	1,094	23,248	1,076	50,147	1,848
R^2	0.29	0.15	0.39	0.28	0.36	0.27	0.33	0.12

All regressions include dummies for industry of the firm and service category whenever possible. Z-values in brackets are adjusted for clusters at the firm level and country level in probit and at firm level in OLS. **, * significantly different from 0 at 1% level and 5%, respectively.

turing affiliates of firms (*No. of Manuf. Affil.*) and the dummy for foreign-owned firms (*Foreign MNE*) have a positive and significant coefficient. Altogether, the results for the total sample are in line with the expectations. Firms' service exports to foreign countries are positively related to foreign affiliate sales of firms in the destination, intra-industry trade volumes and firm's internationalization.

The next results in Table 5 are for data processing services exports (columns three and four). The probit regression shows a positive and significant coefficient for both the *Manuf. Affil. Sales* and *Distrib. Affil. Sales* (column three). Furthermore, *Goods Exports* also have a significant positive impact. In the estimation of the intensive margin of exports (column four), I find only for the foreign affiliate sales of firms in the destination a significant coefficient. Most of the other variables show no significant impact. This suggests that data processing services may primarily aim at supporting both the production and distribution of products through foreign affiliates of firms.

Columns five and six show the results for advertising services. In the probit analysis (column five), *Distrib. Affil. Sales* and *Goods Exports* show a positive significant coefficient whereas *Manuf. Affil. Sales* and *Goods Imports* do not have a significant impact. However, the intensive margin estimation gives only support for a positive relationship between advertising service sales and distribution affiliates (column six). Most of the other variables are less relevant. One intuitive explanation for these results is that advertising service exports support the distribution of goods in foreign countries, in particular, when firms show a permanent foreign presence.

Columns seven and eight present evidence for management services. The probit regression shows positive and significant coefficients for all affiliate sales and goods trade variables. In the OLS regression, however, only *Manuf. Affil. Sales* show a significant positive relationship with management service export sales. Furthermore, the variable *Foreign MNE* has a significant coefficient. Thus, export sales are significantly larger for foreign-owned firms. Altogether, management services seem to support of different international activities of firms. They might be particularly important when firms produce goods in foreign countries.

Table 6 presents the results for R&D services in columns one and two. In the export market entry analysis, R&D services exports show a significant positive relationship with *Manuf. Affil. Sales*, *Distrib. Affil. Sales*, *Goods Exports* and *Goods Imports*. Turning to the intensive margin in column two, only *Manuf. Affil. Sales* and *Goods Imports* keep their significant positive coefficient. Altogether, R&D services sales are positively associated with foreign production activities of firms. In particular, these services may aim at transferring knowledge about products and procedures to the foreign subsidiaries. However, this function of R&D services might be important also for other activities of firms. In particular, when the German imports of products from the same industry are large R&D service exports to these countries are particularly large.

The R&D service exports of the motor vehicle industry are analyzed separately

Table 6: Regression Results for Probit Regression of Export Participation and OLS of Intensive Margin of Services Exports by German Manufacturers, 2005

Explanatory Variables	R&D Services		R&D Services by Automobile Firms		Constr. Serv. by Machinery Firms		Engr. Serv. by Machinery Firms	
	Probit	OLS	Probit	OLS	Probit	OLS	Probit	OLS
<i>ln Manuf. Affil. Sales</i>	0.081** (8.91)	0.087** (4.98)	0.104** (5.59)	0.098 (1.83)	0.000 (0.03)	0.066* (2.12)	0.028* (2.11)	0.044 (1.78)
<i>ln Distrib. Affil. Sales</i>	0.039* (2.41)	0.034 (1.52)	0.016 (0.87)	-0.054 (1.29)	0.056** (3.05)	0.027 (0.77)	0.004 (0.26)	-0.041 (0.95)
<i>ln Goods Exports</i>	0.163** (3.83)	0.098 (1.76)	0.266** (3.65)	0.289 (1.39)	0.224** (4.51)	0.377** (3.66)	0.235** (6.14)	0.292** (2.60)
<i>ln Goods Imports</i>	0.074** (4.14)	0.100** (3.23)	0.039** (4.00)	0.301** (4.54)	0.016 (1.22)	-0.160** (5.48)	0.013 (0.86)	-0.106* (2.37)
<i>Manufact. MNE</i>	0.019 (0.31)	-0.226 (1.36)	-0.149 (0.57)	-0.920* (1.96)	0.423** (4.66)	0.023 (0.13)	0.235* (2.32)	-0.098 (0.48)
<i>No. of Manuf. Affil.</i>	0.011** (4.29)	0.012** (4.45)	0.022 (1.41)	-0.010 (0.56)	0.015** (3.37)	0.027** (6.63)	0.017** (3.16)	0.031** (10.9)
<i>Service Importer</i>	0.222* (2.40)	0.488** (2.66)	0.551* (2.54)	1.76* (2.44)	0.595** (6.48)	0.726** (5.07)	0.183 (1.71)	0.542** (4.10)
<i>Foreign MNE</i>	0.064 (1.06)	0.248 (1.36)	-0.105 (0.51)	-1.01* (2.41)	0.042 (1.22)	0.062 (0.32)	0.096 (0.94)	0.733** (2.60)
<i>ln Distance</i>	0.048 (1.21)	0.204** (2.87)	0.148** (2.65)	0.351* (2.18)	-0.075* (2.25)	-0.003 (0.08)	-0.07 (1.19)	0.077 (1.15)
<i>ln GDP per Cap</i>	0.029 (1.29)	0.119** (3.05)	-0.111* (1.98)	0.124 (0.76)	0.022 (1.35)	-0.025 (0.67)	-0.038 (1.42)	-0.10 (0.20)
<i>ln GDP</i>	0.164** (3.52)	0.041 (0.91)	0.129** (2.35)	-0.152 (1.08)	0.090* (2.00)	-0.011 (0.20)	0.104** (3.44)	0.049 (0.90)
<i>Border</i>	0.068 (0.84)	0.148 (1.23)	0.004 (0.02)	-0.043 (0.15)	0.164 (1.90)	0.135 (1.50)	0.138 (1.69)	0.082 (0.61)
Observations	62,939	2,160	4,559	284	41,922	3,637	31,633	1,425
R ²	0.33	0.17	0.40	0.19	0.26	0.19	0.26	0.28

All regressions include dummies for industry of the firm and service category whenever possible. Z-values in brackets are adjusted for clusters at the firm level and country level in probit and at firm level in OLS. **, * significantly different from 0 at 1% level and 5%, respectively.

in columns three and four. Motor vehicle producers account for only a small number of observations of R&D exports (column four). However, they are responsible for more than 50% of the total value of foreign cross-border R&D service sales of manufacturing firms. The probit regression results are similar to the entire sample of R&D service exporting firms: *Manuf. Affil. Sales*, *Goods Exports* and *Goods Imports* have significant and positive coefficients.¹⁵ In the OLS regression (column four), however, only *Goods Imports* still have a significant coefficient. Obviously, the positive relationship of R&D services with intra-industry goods imports found for the entire sample is particularly affected by the motor vehicle firms.

Columns five and six present evidence for the construction service exports of machinery producers. These firms are either from the machinery and equipment or the electric machinery industry. The probit regression shows a significant and positive coefficient of *Distrib. Affil. Sales* and *Goods Exports*. The latter keeps a significant coefficient in the estimation of the intensive margin and is three times larger than the coefficient for the entire sample in table 5. When machinery exports to a foreign country increase by 10%, construction service exports of machinery firms are, on average, nearly 4% larger. Thus, German machinery exports and installation or assembly service activities of machinery firms in the foreign countries are obviously closely linked.

The columns seven and eight show the results for engineering service exports of machinery firms. The results are similar to those for construction services. In the probit regression, *Manuf. Affil. Sales* and *Goods Exports* show a significant coefficient whereas, again, only *Goods Exports* show a significant positive relationship with the volume of service export sales. Thus, there is also a close relationship of machinery exports to foreign countries and engineering and maintenance or technical support services provided by German machinery producers in these countries.

Finally, for both construction and engineering services *Goods Imports* show a significant negative coefficient in the regressions of the intensive margin (columns six and eight). This is exactly the opposite result compared to the results for R&D services (columns two and four). This fact points out that the economic forces driving the export of these types of services are obviously very different.

5 Discussions

The presented evidence shows that many different economic forces are at work to explain the observable service exports of German manufacturers. Altogether, service exports are mainly implemented by few high-tech industries, which dominate also Germany's export of products. The three most important types of services

¹⁵The pattern of the country variables is slightly different. The results show that firms are more likely exporting to countries far away and with a low income level. This might reflect that firms operate in low wage countries that are often very distant from Germany.

exported are R&D, construction and engineering services. The motives to export different types of services can be manifold. On the one side, these are affected by the characteristics of the specific services. On the other side, also the individual characteristics of industries affect the functions of services. Generally, I find that services exports are positively related to the numerous international operations of firms and industries. These can be the production and distribution of goods abroad through foreign affiliates or trade with final and intermediate goods.

Analyzing different types of services individually, I find that data processing, advertising, and management services are obviously complementary to foreign affiliate sales of firms. Data processing services are positively associated with both manufacturing and distribution affiliates. Advertising services seem to be important to support foreign distribution of products, whereas management services show a positive relationship with production activities of firms in foreign countries. However, the magnitude of those headquarter types of services exports is only small. The number of foreign affiliates of firms in the destination of service exports is scarce. Furthermore, potential headquarter services like data processing, advertising and management services account for less than 15% of total service export sales of German manufacturers.

R&D services instead are economically very important. They constitute for nearly 30% of the total service export sales of manufacturers. On the one hand, the evidence shows that these are positively affected by foreign manufacturing activities of firms. Having in mind that R&D services sales mainly reflect the transfer of knowledge and information about technology, it is not surprising to find that these sales are larger in countries where firms produce goods through affiliates. Firms may need to transfer knowledge about product designs and characteristics or production procedures to their affiliates where goods are produced. On the other hand, R&D services are also often exported to countries in which firms have no affiliates. The regression analysis showed that the import of goods from the same industry has a positive relationship with R&D service sales in the foreign country. This result is particularly driven by the motor vehicle firms. These facts raise the question how a positive relationship of R&D service exports and the volume of motor vehicle imports or parts of them could be explained.

Generally, any kind of co-operation between firms might induce the transfer of knowledge and ideas, which are transferred through R&D services or sales of patents, for instance. On the one side, these co-operations might be horizontal R&D partnerships of firms. For instance, many European motor vehicles producers are organized in the European council for automotive R&D, which comprises 14 of the largest global automotive firms. These large firms have likely also relatively large sales of motor vehicles in Germany. Thus, Germany's imports of automotive products would be relatively large from countries where R&D partners of German firms reside. On the other side, firms may have also vertical partnerships with foreign suppliers and buyers of intermediate. The international fragmentation of

production is particularly pronounced in the motor vehicle industry. For instance, Miroudot and Ragoussis (2009) find for OECD countries that the motor vehicle industry belongs to the industries with the largest share of intermediate inputs in industry's imports. This share was nearly 45% in 2005. In those relationships, firms may also start joint R&D projects.¹⁶ Furthermore, sharing information about product design and characteristics or production procedures with the producer of intermediate inputs might be a requirement for a successful business relationship. In both described scenarios of R&D co-operations and buyer-supplier relationships, there is potentially a positive relationship between the import of motor vehicles and parts of them and R&D service exports of German motor vehicle producers.

The second major group of service exports are services provided by German machinery firms. The by far largest part of the service export activities of German machinery firms is associated with construction services. The second most important group are engineering services. Construction and engineering service exports by machinery firms account for more than 25% of the total service export sales in the sample. The regression analysis shows that exports of these two types of services by German machinery producers show a strong positive relationship with German machinery exports to foreign countries. Other variables are much less important. As already mentioned above, the economic interpretation of these two types of service is hampered by the high-level of aggregation of the service categories in the data. However, it seems to be reasonable to presume that construction services provided by machinery producers represent to a large extent installation or assembly services provided in a bundle with an exported product. Engineering services exports might often represent the maintenance of exported products by German firms or more general technical support in handling them. Both interpretations are supported by the presented evidence.

It is important to note that the presented evidence gives only first ideas about the motives of firms to export services and the role of services for the international business of firms. The most important caveat of the analysis is the lack of goods trade data at the firm level and that intra-firm trade is not directly observable. Furthermore, there are at least two serious biases in the data. First, the data cover only headquarters services for which the foreign affiliate is paying the German parent firm, which might often not be the case. Second, many services that are exported related to an exported product are likely not invoked separately from the product. In this case, these services would not appear in the BoPS. For instance, Stille (2003) states that the share of the services not invoked separately was about 50% in the German machinery and electrics industries in 2000. Thus, product-related services are likely economically much more important than the data show. These caveats of the data call for a cautious interpretation of the presented evidence.

¹⁶This idea is supported, for instance, by Baldwin and Gu (2004) who find that Canadian product exporters often started R&D co-operations with the customer firms.

6 Conclusions

The present paper analyzed service export activities of German manufacturers at the firm level with data from the Balance of Payments Statistics provided by the *Deutsche Bundesbank*. Service exports of German manufacturers strongly increased in the first decade of this century and amounted to nearly 30 billion Euros in 2005. However, service exports of manufacturing firms have hardly been analyzed thus far in the international trade literature.

I identify three main motives why manufacturers may export services. First, firms support both foreign manufacturing and distribution affiliates with domestic services. Examples for this are advertising and data processing services. However, the overall economic relevance of those headquarter services is rather small in the analyzed sample. Many observations of services exports are independent of foreign affiliates of firms abroad. Second, services aim at complementing the supply of products in foreign countries. This can be mainly found for machinery producers. German machinery industries provide large volumes of installation, maintenance and technical support services to countries that receive large volumes of German machinery products. Obviously, firms often deliver bundles of products and product-related complementary services to foreign customers to increase the perceived value of the products, for instance. Consequently, product-related services might be constituting an important part also of the international competitiveness of firms. Third, R&D services play an important role to support the international knowledge flow and technology transfer. On the one hand, firms often transfer information about products and production procedures to foreign production subsidiaries of firms. On the other hand, also unaffiliated trading partners are affected. In particular, motor vehicle producers show large volumes of R&D sales in countries from which Germany imports large volumes of motor vehicles and parts of them. This points to R&D cooperations as a driving force of R&D service exports, but also relationships between suppliers and buyers of intermediate products might often induce the international transfer of technical knowledge. The latter might be particularly relevant for motor vehicle firms, because this industry strongly relies on imports of intermediate inputs.

Altogether, the analysis shows that different types of services may have different functions in the international business of firms, which vary also across different industries. The economic importance of services is likely even larger than captured by the dataset, because it captures headquarter and product-related services only incompletely. This points out that a deeper understanding of the service export activities of manufacturers will be relevant to obtain a deeper understanding of the welfare costs and benefits of future service and product market deregulations and liberalization. Future research should focus even more on specific industries, such as the machinery or motor vehicle industries, to obtain more precise statements about the role of services in the business of manufacturers and relevant service trade barriers. In particular, using both service and goods trade data at the firm level will

be important to understand the links of services and goods trade more in depth.

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Appendix

Table 7: 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 & Tele- communications	6400: Post & Telecommuni- cations	518: Communication Services (Satellite, Telephone, Wire)
Source: Lipponer (2009), Deutsche Bundesbank (2009)		

Table 7: continued

Sector	MIDI (Nace rev. 1)	BoP-Statistics (KNZ's)
		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, Book-keeping 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
Engineering Activities	7420: Architectural and Engineering Activities and related technical Consultancy	512: Engineering, Maintenance, 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)		

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