

Hafner, Kurt A.; Kleinert, Jörn

Article — Published Version

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Review of World Economics

Provided in Cooperation with:

Springer Nature

Suggested Citation: Hafner, Kurt A.; Kleinert, Jörn (2021) : Information related service trade within firms: evidence from firm-level data in Germany, Review of World Economics, ISSN 1610-2886, Springer, Berlin, Heidelberg, Vol. 157, Iss. 4, pp. 703-726, <https://doi.org/10.1007/s10290-021-00406-5>

This Version is available at:

<https://hdl.handle.net/10419/286797>

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Information related service trade within firms: evidence from firm-level data in Germany

Kurt A. Hafner¹ · Jörn Kleinert²

Accepted: 6 February 2021 / Published online: 9 March 2021
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Abstract

Multi-unit firms have productivity advantages over competitors because of their use of a non-rival asset—firm-specific knowledge—in several units. Using knowledge-intensive services leads to economies of scope in production by multi-unit firms. Such headquarter are usually supplied by parent companies and serve to link different firm units. Headquarter services are difficult to quantify in statistics or surveys, except when they cross-borders and the exchange of services between MNEs and their offshore subsidiaries becomes apparent. This study therefore focuses on IT service imports to explain productivity differences among foreign affiliates of multinational firms in Germany. The authors base the analysis on the population of foreign multinational firms active in Germany and analyze what effect the import of IT services has on their productivity. They find that IT headquarter service flows have significant impacts on foreign affiliates' productivity in general and US affiliates in particular. As the average IT-service flows (per firm and partner) from parent countries are significantly higher for US affiliates than non-US affiliates, they conclude that the import of IT services from the parent-company is a source of the productivity advantages of US affiliates in Germany.

Keywords Cross-border service flows · Multinational enterprises · Micro-level productivity analysis

JEL Classification L14 · F34 · G21

✉ Kurt A. Hafner
kurt.hafner@hs-heilbronn.de

Jörn Kleinert
joern.kleinert@uni-graz.at

¹ International Business Faculty, Heilbronn University, Max-Planck-Straße 39, 74081 Heilbronn, Germany

² Institut Für Volkswirtschaftslehre, Universität Graz, Universitätsstraße 15/F4, 8010 Graz, Austria

1 Introduction

Productivity growth is a key factor for economic growth and prosperity, because it enables firms to produce each of the goods and services with less resources or more goods and services with the same resources. Generating productivity growth in the firm is a cumbersome, firm-specific trial-and-error process. Consequently, productivity growth differs significantly across countries; even between domestic firms within the same sector. It is not obvious a priori why differences in productivity growth of firms have such a strong country-specific element. There has been an extensive debate over the reasons for Japanese firms' success in the 1980s, for example. Long-run relationships with suppliers, customers and employees, continuous quality improvements and time-saving logistics have been identified as determinants of their success. Since the mid-1990s, however, US firms have become the benchmark once again, while German firms have more recently regained strength and competitiveness.

The success of US firms is often related to their more intensive use of IT. According to Bloom et al. (2012), US firms invest on average more in IT equipment, which has increased their productivity—particularly in the more IT-intensive firms—and allowed aggregate US productivity to outperform European growth in the last two decades. Bloom et al. (2012) analyze foreign affiliates of multinational enterprises (MNEs) in the UK and show that productivity differences at the firm level are related not to the place of production but to the headquarters' country. This study finds that foreign affiliates of US multinationals are more productive than those of non-US multinationals and relate US affiliates' productivity advantage to higher IT-related firm specific capital stocks. Bloom et al. (2012) incorporates firm-specific IT-related capital stocks but ignores the use of IT-related service trade to explain productivity differences, which are usually provided at the company (headquarter) level and are imported by foreign affiliates in their host countries.

According to the theory of the MNE, multi-unit firms have productivity advantages over competitors because of the joint use of a non-rival firm-specific knowledge asset in all their units (Markusen 1995, 2002). Thus, the use of knowledge-intensive services leads to economies of scope in production of multi-unit firms. Knowledge-intensive services are usually supplied by parent companies and serve to link different units of the firm (Zingales (2000)). Adding a new unit does not reduce the marginal return of these services in other units but it does reduce the average cost since fixed costs producing headquarter services can be divided among more units. General equilibrium models with multinational firms relate trade in headquarter services to a trade deficit in goods balanced by a trade surplus in services. An increase in MNEs activities lead to an increase in service exports as service trade provide the network around which operations of multinational firms are organized.

Empirical studies of headquarter service flows within multi-unit firms are rare, mainly due to the lack of data. Hortacsu and Syverson (2007) and Atalay et al. (2014) study the flow of goods in different units within firms, compare them to flows between firms and find intra-firm goods flows to be much smaller than expected. Thus, Hortacsu and Syverson (2007) cannot support their conjecture

and pass the task of finding the link that connects entities of multi-unit firms to further research: "...vertical integration is used to facilitate efficient transfers of inputs, but not necessarily (or even usually) physical inputs along a production chain, as is commonly assumed. We expect that managerial oversight and planning is among the most important of these, although marketing and sales know-how might also be readily transferred among integrated establishments in a firm [...]. In this way, vertical expansion by a firm may not be altogether different than horizontal expansion." (Hortacsu and Syverson (2007): 23).

Headquarter services are difficult to quantify in statistics or surveys, except when they cross borders and the exchange of services between MNEs and their foreign affiliates is therefore recorded. We study information-related services flows to affiliates of foreign MNEs in Germany and rely on two confidential firm-level datasets collected by the Deutsche Bundesbank. The data gives information on cross-border service transactions and balance sheets of foreign affiliates of MNEs in Germany. Based on the entire population of MNEs active in Germany and their cross-border service transactions, the data covers the period 2001–2015 and includes slightly more than half of the affiliate population in Germany. We search for evidence of headquarter service flows from parent firms to their foreign affiliates in Germany affecting affiliates productivity with a particular focus on IT-related services. We assume that service flows are likely to be traded within the same firm (and can be classified as headquarter services) if they are cross-border service transactions between foreign affiliates and partner firms of the affiliate's home country. We document the productivity advantage of German affiliates of US firms and compare our results to the study of Bloom et al. (2012).

We find that cross-border trade in IT-related services (per employee) has a significant impact on foreign affiliates' labor productivity in Germany. In particular: (1) if the cross-border service trade relationship is with the home country (i.e. likely to be a headquarter service) and (2) if the trading partner is located in the USA. Doubling IT-related headquarter services, for example, increases foreign affiliates' labor productivity on average by around 1%. Moreover, we find (3) that US affiliates in Germany show significantly higher labor productivity than foreign affiliates of companies from other countries with an average difference of 10–12%. Estimates confirm that productivity advantages of US affiliates are due to significantly higher IT-service imports (per firm and partner) relative to non-US affiliates. We conclude that US affiliates generates productivity advantages by importing IT headquarter service more intensively.

We also estimate the effect of service flows on total factor productivity (TFP) instead of labor productivity. Assessing TFP is conceptually similar to Atkeson and Kehoe (2005) and their definition of productivity in terms of organizational capital. They calculate that 9% of US manufacturing output is not accounted for as payments to either physical capital or labor. Roughly half of it can be accounted for as payments to organizational capital, and much of this organizational capital can be attributed to multi-unit firms. We test whether service flows are (time varying) determinants of firm's total factor productivity and find that importing IT services from the headquarters has significantly positive impacts on firms' total factor productivity. Doubling the amount of IT service flows imported

from the home country, for example, leads to an increase of the total factor productivity of around 3.5%.

The paper is organized as follows. Section 2 describes the dataset and its different sources, gives an overview of how the data was constructed, and documents some stylized facts about foreign affiliates of MNEs in Germany. In Sect. 3, we discuss the main assumptions of the underlying theoretical framework, outline the empirical model and describe the estimation techniques. Empirical results of the firm analysis of MNEs in Germany are presented and the results of robustness tests are discussed in Sect. 4. Conclusions appear in Sect. 5.

2 Data

2.1 Firm-level panel data

2.1.1 Main data sources

We merge two confidential micro-level datasets from Deutsche Bundesbank providing cross-border service transactions and balance sheet information from affiliates of foreign multinational firms in Germany. The first dataset is from the International Trade in Service (SITS)-Statistics, which records international service transactions between residents and non-residents, collected to compile the Balance of Payment (BoP)-Statistics (see Deutsche Bundesbank 2018a). For every service transaction with a value higher than €12,500, German residents (firms including financial institutions, private persons and public authorities) report to Deutsche Bundesbank their sector classification (i.e. NACE Rev. 1/Rev. 2), the partner country, the type and direction of cross-border service trade, and the value of the transaction. Service types are officially coded by the BoP-Statistics which distinguish between transactions such as “intellectual property,” “transport,” “insurance transactions” and “transfers amongst others” (Biewen and Lohner (2017)). As every reporting firm (i.e. domestic firms and foreign affiliates) in the SITS-Statistics has been given a firm identifier from Deutsche Bundesbank, cross-border service transactions, which are reported since 2001, can be aggregated to firm-level data on a monthly basis for nearly the entire population of German service exporters and importers. We define 11 service groups representing producer and business services and aggregate the service types in the SITS dataset respectively. The first seven service groups are producer services at the two-digit level service classification (including “IT services” and “communication services”, amongst others). The last four are “financial services,” “personnel services,” “business services” and “other services” at the three-digit level service classification.

The second dataset is from the Microdatabase of Direct Investment (MiDi), which provides a detailed breakdown of assets and liabilities for all foreign affiliates of German multinational firms and German affiliates of foreign multinational firms for each year since 1996 that exceed the rather low reporting limit of a balance sheet total counting more than €3 million (see Deutsche Bundesbank (2018b)). The comprehensive database we use covers the period 1999–2015 and provides balance-sheet

data on each reporting unit, including turnover, employment, capital stock and total assets in each of over 200 partner countries. It also includes information on the firm structure (see Schild and Walter 2017) and reports the sector of activity of the parent firm and the affiliate (i.e. at the NACE Rev. 1.1 and NACE Rev 2). As reporting units have been given the same firm identifier as in the SITS dataset, balance-sheet data and investment relations from the MiDi can be combined with the service transactions from the SITS-Statistics at the firm-level on an annual panel basis. Keeping in mind that the MiDi provides data on foreign firms in Germany (and German firms abroad), a match of datasets from both databases excludes German domestic firms. We group firms using the sector classification of the MiDi and define seven sector categories (“manufacturing,” “construction,” “wholesale/retail trade,” “transport/storage/communication,” “financial intermediation,” “business activities” and “other”).

2.1.2 Other data sources

MiDi data set provides neither information on the reporting units’ use of intermediate inputs nor on value added. Since turnover is not the appropriate outcome variable to estimate firm productivity when no information of the use of intermediate inputs is available, we use value added from a different source. Firm-level information on value added (and intermediate inputs) is reported in the Amadeus database from company balance sheets and income statements of European companies across 43 countries, which is collected and harmonized by Bureau van Dijk/ Moody’s Analytics (Bureau van Dijk 2018). The Amadeus database archive contains information for up to ten years, which provides a firm-level panel on a yearly base.

To account for between-sector variation in productivity, we calculate sector-specific capital stocks using the EU KLEMS database (EU KLEMS Project (2018)). The EU KLEMS database provides yearly data (up to 2017) on gross fixed capital formation, depreciation rates and employment (see Van Ark and Jaeger 2017; Jaeger 2018) broken down by country (Europe and the US) and sector (i.e. at the NACE Rev 2 and ISIC Rev. 4). We calculate sector-specific capital stocks for service trade (i.e. “IT,” “communication” and “other equipment”) by applying the perpetual inventory methods by Griliches (1979).

2.1.3 Data set matching procedures

We define three main service categories (“IT-services,” “communication services” and “other services”), split partner countries of service trade into three categories (“home,” “non-home/us” and “non-home/non-us”) and assign firms to sector categories. For each firm, we aggregate cross-border service transactions in each category for each year, firm, kind of service trade (export or import) and partner country in the SITS dataset to match the structure of yearly firm-level observations in the MiDi dataset. In aggregating the SITS dataset to form annual data, we need to treat different transactions of the same service category with customers of the same partner countries identically, while keeping different categories of services separate. Combining both datasets, we construct a panel for the period 1999–2015 with more

than 2 million matched firm-level observations at an annual level to analyze cross-border service trade transactions by German affiliates of foreign MNEs. In principle, service flows in each observation for a particular year can differ in five aspects: the trading firm, the category of service traded (eleven service categories), the kind of transaction (export or import), the sector the trading firm belongs to (seven sector categories) and the partner country. However, we have eliminated service exports from the matched data set. Our matched dataset provides balance sheet information on reporting firms from 1999 through 2015, thus we adjust the dataset and delete service trade statistics of the years after 2015. Aggregation of the data by firm, year, service type and partner country gives us a dataset with 245,608 yearly firm-level observations covering the 1999–2015 period, for which foreign affiliates in Germany are linked to cross-border service imports from parent and non-parent companies located anywhere.

To measure firm productivity and to control for between-sector variation, we rely on value added, employment, capital and other firm-specific data from the Amadeus database and sector-specific capital stocks from the EU KLEMS database and information from the combined SITS/MiDi dataset. We use the conversion table of firm identifiers from Deutsche Bundesbank to attach Amadeus firm-specific data at the firm-level to the combined SITS/MiDi dataset, while sector-specific stocks from EU KLEMS are included at the sector level. Matching firm-level data from different sources leads to a dataset with 127,445 matched annual observations for the period of 2001–2015. Table A.6 in the appendix online gives a detailed overview of the datasets, variable definitions and matching procedures.

2.1.4 Cross border service flows

More than 400,000 cross-border service trade transactions by German affiliates of foreign multinational firms account for more than 556 billion euros in service imports between 2001 and 2015. The bulk of service imports in terms of both number and volume are recorded for affiliates in the manufacturing sector and reported for the “other services” category—as shown by Table A3 in the appendix online. Moreover, the share of cross-border service imports (in value terms) from non-home partner countries is 2/3 (386 billion €). Thus 1/3 comes from the affiliates’ home countries (170 billion €)—as shown in Table A4 in the appendix online. For affiliates of non-US-multinational firms, IT services are the most prevalent service imports from US-firm partners, with US firms supplying a share of almost 20% of all IT services imported by German affiliates of non-us parent companies. Imports of communication or other services from the US account for 10% and 13% of all imports of their group, respectively.

The assumption that “service flows are likely to be traded within the same firm (and hence can be classified as headquarter service provision) if they are cross-border service transactions with the affiliate’s home country” is crucial to our analysis. However, MiDi/SITS database has no specific information about the parent company of the affiliate except the country of origin. We get a slight sense of the scale (and diversification of service flows origin) if we look at the average share across firms of imports from the home country as a share of their total imports. We find

Table 1 Descriptive analysis of MNEs in Germany (firm-level data from 2001–2015) *Source:* Research Data and Service Centre of the Deutsche Bundesbank, MiDi /SITS-Statistics, 2001–2015; EU KLEMS database; Amadeus database. Authors' calculation

	Importer (no.)	MNEs (mean, thousand)				Productivity (mean, log)		
		Value ad. (€)	Labor (no.)	Capital (€)	Turnover (€)	lab	tfp_1	tfp_2
All MNEs								
France	6385	65,357	0.591	263,558	281,187	11.397	7.749	7.593
United Kingdom	6477	71,805	0.557	284,027	352,148	11.516	7.767	7.610
Switzerland	9793	35,823	0.395	111,642	163,414	11.326	7.584	7.432
United States	8863	79,815	0.663	424,077	277,045	11.458	7.845	7.688
Other Countries	41,863	46,112	0.485	170,224	225,396	11.433	7.710	7.554
Total	73,381	51,962	0.509	209,105	241,546	11.426	7.716	7.561

that almost 30% of all imports (i.e., 10,907 Mio. €/38,597 Mio. €, Table A4 in the appendix online) are related to home countries and probably to parent companies. Moreover, the Bureau of Economic Analysis (BEA) lists various tables of service trade between parent companies and US affiliates across different service categories and partner countries (BEA 2020), where service exports and imports are broken down by type of service and, in some cases, by affiliation of the partner. In particular, intra-firm import shares of “charges for the use of intellectual property” are more than 75% of total imports of US affiliates in Germany over the period 2006–2019 and more than 70% of all US imports of “charges for the use of intellectual property” are related to affiliates trade since 2014 (i.e. see Figures A1 and A2 in the appendix online). Hence, we conclude that imports from the home country are likely to be predominantly intra-firm trade.

2.2 Summary statistics and stylized facts

We report four basic facts found in the data for MNEs in Germany, which helps to identify the main determinants of productivity differences amongst German affiliates of foreign firms and the role that service flows within firms might play.

2.2.1 Fact 1: US affiliates are on average larger and more productive

US affiliates are on average larger and more productive than affiliates from other countries' parent firms; they use more labor and capital as input factors to produce more value added than other MNEs in Germany. This is shown in Table 1 by the descriptive analysis of MNEs for the period 2001–2015, where the mean of value added, labor and capital are highest for US affiliates (followed by German affiliates of multinational firms from the UK and France). The capital/value added ratio is highest for US firms, the turnover over/value added ratio is lowest for US affiliates.

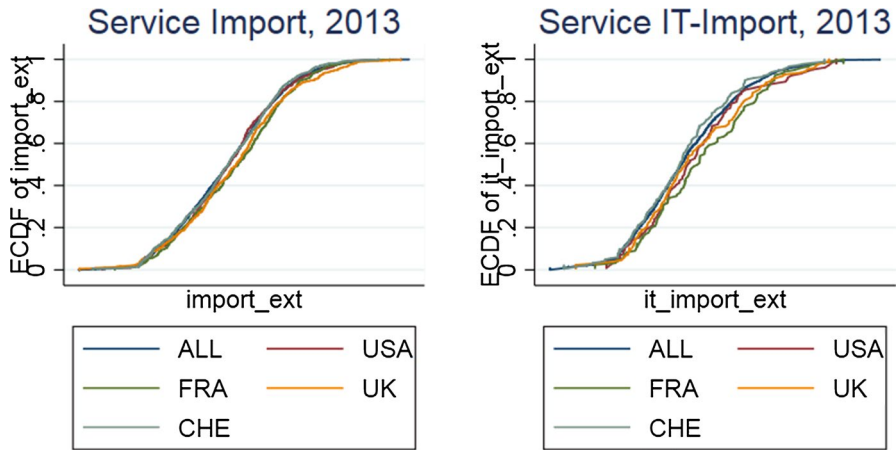


Fig. 1 Cumulative distribution of MNEs in Germany, 2013. *Source:* Research Data and Service Centre of the Deutsche Bundesbank, MiDi /SITS-Statistics, 2001–2015. Authors' calculation

We see a pronounced country pattern with respect to firm productivity in terms of labor productivity (i.e. defined as value added per employee (lab)) and total factor productivity (i.e. calculated as a residual from Olley and Pakes (1996) production function estimation). US affiliates rank first in terms of total factor productivity and second in terms of labor productivity slightly below foreign affiliates from the UK.

2.2.2 Fact 2: Size differences across distributions are distinct

Firms differ with respect to size (value added, capital stock, employment, and imported services) and productivity (labor productivity) across sectors and trade partner countries. Figure 1 shows firm distributions by home countries. Accordingly, distributions look fairly similar, however, Kolmogorov–Smirnov test results in Table A.5 in the appendix online show first-order stochastic dominance of US affiliates over non-US affiliates for value added and labor productivity (as we reject the null hypothesis of equality) Moreover, there is first-order stochastic dominance of IT imports by US affiliates over all non-US affiliates, French affiliates and over UK affiliates.

2.2.3 Fact 3: Country of origin matters for IT-imports

Average IT service flows (per firm and partner) are higher if imported from home countries than from non-home partner countries. This is shown in Fig. 2 for US firms' and non-US firms' affiliates in Germany for the period 2001–2015 by the two upper lines for IT imports from the home country and the two lower lines for IT imports from all other countries, respectively. We differentiate US firms from the others because US firms import larger values of IT services on average. While IT imports from home countries declined during the financial crisis in 2009—in particular among US firms—the finding remains robust over the 2001–2015 period and

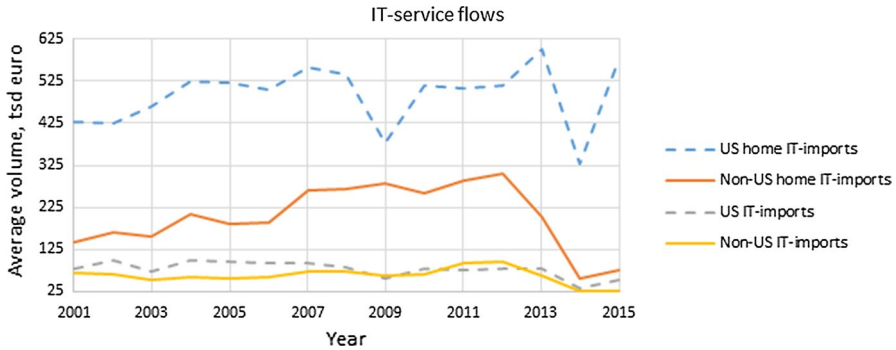


Fig. 2 IT service flows of MNEs in Germany, 2011–2015. *Source:* Research Data and Service Centre of the Deutsche Bundesbank, MiDi /SITS-Statistics, 2001–2015. Authors' calculation

across all foreign affiliates. The average IT imports from all other (non-US) countries are only one third of imports from home countries.

2.2.4 Fact 4: IT headquarters' service flows are higher for US affiliates

Average IT-service flows (per firm and partner) from home countries are remarkable higher for US affiliates. As shown by Fig. 2, IT-imports of headquarter services are higher if related to US-multinational firms than to non-US multinational firms. Moreover, if we relate the average value of IT imports to the number of employees—as shown by Figure A.3 in the appendix online, the results are the same. Hence, the finding that US affiliates import on average more IT services from their parents is not the result of their firm size (discussed by fact 1 and fact 2).

3 Empirical modeling

3.1 Assumptions

We rely on two main assumptions: (1) Knowledge-intensive service import is a determinant of firm productivity and (2) service flows from the home country represent imports of headquarter services for the offshore affiliates. According to MNE theory, multi-unit firms have productivity advantages over competitors because of their use of a non-rival asset: firm-specific knowledge used in all their units (Markusen 1995, 2002). Such knowledge-intensive services are usually supplied by headquarters and lead to economies of scope in production by multi-unit firms. We assume that (knowledge-intensive) service imports are a determinant of establishment-specific efficiency A_{it} . In Bloom et al. (2012), which we use as a benchmark for our estimates, establishment-specific efficiency depends on a firm-specific effect and observable terms like firm age, geographical region and/or corporate units a firm belong to. The efficiency term is parameterized by: $a_{it} = a_i + \gamma'z_{it} + \varepsilon_{kt} + u_{it}$, where a_i are establishment (i) fixed effects, z_{it} are other time (t) varying observable

factors influencing efficiency, ε_{kt} are industry (k) time specific shocks, u_{it} is the error term and lower letters denote the natural logarithm variables. Introduction of service flows as determinants of efficiency would make them a part of z_{it} , while industry dummies interact with time dummies control for industry-time-specific shocks ε_{kt} . Data on service flows between units are available as cross-border service flows, where the exchange of headquarter services between MNEs and their foreign affiliates become observable and recorded. We assume thereby that service flows are likely to be traded within the same firm (they therefore can be seen as headquarter services) if service imports are reported with the same country as the foreign affiliate's home country.¹

3.2 Estimation model

Consider the following production function:

$$Q_{it} = A_{it}(SF_{it})F(K_{it}, L_{it}) = A_{it}(SF_{it})K_{it}^{\beta^k}L_{it}^{1-\beta^k}, \quad (1)$$

where value added Q of firm i (belonging to industry k) in year t is characterized by a Cobb–Douglas functional form with constant returns of scale. K is capital stock, L is the number of employees and SF denotes service flows as a determinant of the efficiency term A . Note that firm-specific components are introduced through firm-specific productivity and that factor intensities are sector-specific assuming factors to be homogenous.² We differentiate service flows as IT service flows (SF_{it}) if the service category is “IT services,” communication service flows (SF_{com}) if the service category is “communication/postal/courier services”, or other service flows (SF_{other}) if the firm imports a different “other service” category. As discussed above, we are particularly interested in services imports from the home country. In this case, we assume that service imports are likely to be traded between parent companies and their foreign affiliates, and can thus be classified as headquarter services. We therefore distinguish between service flows from the home country (SF^{h}) and those from non-home countries (SF^{nh}). For the latter, we differentiate between partner firms located in the US (SF^{nh-us}) and those located in other countries (SF^{nh-re}) to analyze if US services are superior in their use by German affiliates of non-US parent firms.

Moreover, we are interested in the impact of service imports by foreign affiliates of multinationals on their productivity. We are particularly interested in service imports by US affiliates, which might explain their productivity advantage in Germany.³ Hence, we differentiate service flows from the country of origin by

¹ Reported cross-border service transaction in the SITS-Statistics includes the partner country, the type and direction of cross-border service trade, and the value of the transaction, but no specific information on the partner firm (see Deutsche Bundesbank 2018a).

² For the empirical analysis, size differences will be captured by the number of employee. We account for firm heterogeneity in the data by a two stage fixed effects estimation and rely for non-systematic variation on the data's large number of observations.

³ A serious problem with the transfer of intangible goods and services within firms is that they are possibly mispriced for tax avoidance reasons. In our case of within-firm service flows, we analyzed the relationship of effective tax burdens of firms (foreign affiliates) in Germany and the ratio of imported ITC

a US dummy (*US*) and distinguish the effects of IT, communication or other service flows from headquarters for US firms (i.e. $US \times SF_{it}^h$, $US \times SF_{com}^h$ and $US \times SF_{other}^h$, respectively) from those of the average firm's service imports. The introduction of both US service flows and US dummy allows us to analyze whether the use of imported US service flows affects firm productivity of US firms' affiliates in Germany differently, and whether this is a reason why "Americans do I.T. better" (Bloom et al. 2012) than their counterparts. We introduce different service flows as determinants of the efficiency term A and control for several other influences. We include sector-specific capital stocks as a per-(sector-) employee variable (i.e. SC_{it} , SC_{com} and SC_{other}) or a full set of three-digit industry dummies (i.e. d_{sec}) to control for differences at the sector level and interact them with time dummies (i.e. d_{year}). The latter represents industry-time specific shocks, as in Bloom et al. (2012). Thus, we proxy the efficiency term A_{it} from Eq. (1) by a product of a constant term and a vector of weighted service imports, controlling for industry and time specific effects.

Using lower letters for natural logarithm transformed variables ($q_{it} \equiv \ln(Q_{it})$ etc.), we write the per-employee notation of Eq. (1) after including sector-specific capital stocks as:

$$(q - l)_{it} = \beta^0 + \beta^k(k - l)_{it} + \beta^{sf'}(sf - l)_{it} + \beta^{sf,USA'}[(sf - l)xUSA]_{it} + \beta USA + d_{sec} + d_{year} + u_{it}, \quad (2)$$

where $\beta^{sf'}$ denotes a transposed coefficient vector of service flows categories, sf is a vector of different service flows (according to service categories and country of origin, respectively), USA is a dummy for US affiliates, d_{sec} are industry sector-dummies, d_{year} are time dummies and u is the error term. Using sector-specific capital stocks to account for between-sector variation, sc as a vector for sector-specific capital stocks (per-sector-employee) enters Eq. (2) instead of industry dummies d_{sec} .

3.3 Efficiency term

In some specifications, we estimate the firm-specific productivity term directly A_{it} (i.e. a_{it} in logs). We use three different service import categories (IT-, communication-, and other services) differentiated by the country of origin (home, non-home/US and non-home/non-US) to determine firm-specific efficiency a_{it} . Moreover, we add a constant, a US dummy for structural firm differences and time specific effects, and define the determinant of firm's efficiency term (total factor productivity) in the same way as in Eq. (2) explaining labor productivity. Using the same low letter notation, we write the firm efficiency term as:

Footnote 3 (continued)

service flows to the GDP in the partner country in 2012. We do not find evidence for a systematic mispricing of services flows for tax avoidance reasons at the country level data.

$$a_{it} = \beta^0 + \beta^{sf'}(sf)_{it} + \beta^{sf \cdot USA'}[(sf)xUSA]_{it} + \beta^{USA} + \beta_{it}^{sc'}(sc)_{it} + d_{year} + u_{it}, \quad (3)$$

where all variables are log-transformed variables and sc is a vector for sector-specific capital stocks. Note that Eq. (3) determines the impact of service flows on total factor productivity in absolute terms—in contrast to the per-employee estimation of labor productivity by Eq. (2). Again, we are particularly interested in the impact of imported service flows on both US affiliates and Non-US affiliates.

3.4 Import elasticities

We assess the larger input of imported services by affiliates of US firms and estimate a service “demand function”, which is rather ad-hoc since it is unclear how service flows affects the efficiency term. Controlling for the size of the foreign affiliate and the USA as a home country (and taking into account sector and time effects), we use again low letters for natural logarithm transformed variables (but do not use per-employee normalization) to write the following import demand function (imp) as:

$$(imp)_{it} = \beta^0 + \beta^q(q)_{it} + \beta^l(l)_{it} + \beta^c(c)_{it} + \beta^{USA}USA + d_{sec} + d_{year} + u_{it}. \quad (4)$$

with value added (q), total employment (l), capital stock (c), US dummy (USA) and a full set of industry sector (d_{sec}) and time dummies (d_{year}), respectively. We distinguish import services for the import demand function as import services (total), IT-services (total; home and non-home), communication services (total) and other services (total). We argued that the demand for IT-related services in general and for IT-related services from home countries in particular is higher for US-affiliates (compared to non-US affiliates), which explains partly their productivity advantages in Germany.

3.5 Estimation technique

For our baseline estimations, we rely in the first set-up on repeated cross-section OLS to estimate the impact of service flows on labor productivity. We run repeated cross-section OLS estimations with robust (clustered) standard deviation to account for serial correlation and heteroscedasticity for our baseline estimation. We estimate the impact of service imports on labor productivity according to Eq. (2) and on total factor productivity according to Eq. (3). Our estimations use time dummies and include either a full set of industry dummies or sector-specific capital stocks to account for between-sector variations. We compare this to a set up where we account for firm-specific efficiency by using an (affiliates) fixed effect estimator. Since, we are interested in the affiliates’ fixed effects—reflecting the firms’ efficiency term A_{it} —we regress our explanatory variables on the affiliate-specific terms from the fixed effects estimation. This is in line with the theory which assumes the efficiency term A_{it} to be a product of a constant term and a vector of weighted service imports. As we are not interested in the time-series variation of the fixed effects estimation, we focus on the variation of the fixed effects and use the cross-affiliate variance to

analyze the effects of service imports on affiliates productivity. For the estimation of the import demand functions of Eq. (4), we use again cross-sectional OLS with robust (clustered) standard errors controlling for firm size and taking into account a full set of industry and time dummies.

Regarding the estimation of total factor productivity, which we use in the OLS regressions as an endogenous variable proxying the efficiency term, we rely on the method of Olley and Pakes (1996) and use two different investment variables (total assets and tangible assets) to deal with unobserved firm-specific productivity shocks. We calculate an exit variable for survival probabilities (a dummy variable in which 1 indicates the firm exited in the current period and 0 if not) to deal with the selection bias (see Yasar et al. 2008). We then apply the Olley and Pakes (1996) method to estimate the production function parameters using labor as a freely variable input factor, capital as a quasi-fixed input factor, one of the two investment variables and the exit variable. The residual as the difference between observed output and output predicted by the method defines total factor productivity.

4 Results

In order to assess the impact of IT service flows on foreign affiliates' labor productivity in Germany, our econometric assessment starts with Eq. (2) using a repeated cross-section OLS estimation for the period 2001–2015 as the baseline and includes some robustness tests regarding structure (shortening the period to 2008–2013) and model specifications (using total factor productivity by Eq. (3)). Next, we test the robustness of our baseline estimation by using a fixed effect estimation of the impact of service flows on labor productivity for the period 2001–2015 in two stages. We are particularly interested in the second stage which gives the service import effect on productivity. Finally, we run repeated cross-section OLS again to estimate affiliates' service import function by Eq. (4)

4.1 Baseline OLS estimation

Estimation results are given in Table 2. We show the impact of service flows (“IT-services,” “communication services” and “other services”) from home countries (baseline estimation; column (i)) and service flows from non-home countries (trade partner estimation; column (ii)–(iii)). We differentiate depending on cross-border service trade being related to the US as a partner country (column (ii) and any other (non-US) partner country (column (iii))). We include a US dummy to analyze whether US affiliates are more productive than non-US affiliates and interact the US dummy with the service flows to assess whether the effect of service trade differs for German affiliates of US firms. We control for industry-time-specific shocks and include industry dummies and year dummies. We restrict the sample to a smaller period (2008–2013) to analyze whether the financial crisis and its aftermath have a different impact on our baseline estimates. We report these results in column (iv). Estimates using sector-specific capital stocks instead

Table 2 Firm analysis of MNEs in Germany; repeated OLS (firm-level data from 2001–2015). *Source:* Research Data and Service Centre of the Deutsche Bundesbank, MiDi/SITS-Statistics, 2001–2015; EU KLEMS database; Amadeus database. Authors' calculation

Dependent Variable:	q-1	q-1	q-1	q-1	q-1	q-1	q-1	q-1	q-1
	(i) ^a	(ii) ^a	(iii) ^a	(iv) ^a	(v) ^a	(vi) ^b	(vii) ^b	2001–2015	2001–2015
ln (K)	0.5120*** (0.0098)	0.5115*** (0.0099)	0.5122*** (0.0099)	0.5234*** (0.0117)	0.5227*** (0.0117)	0.0356*** (0.0111)	0.0351*** (0.0109)	2001–2015	2001–2015
Capital stock	0.0100*** (0.0035)	0.0088** (0.0034)	0.0071** (0.0034)	0.0116*** (0.0042)	0.0115*** (0.0042)	0.028 (0.0238)	0.027 (0.0234)		
ln (SF_it_h)	0.013 (0.0086)	0.010 (0.0093)	0.003 (0.0080)	-0.0034 (0.0011)	-0.002 (0.0113)				
Home it	0.0039*** (0.0017)	0.002 (0.0018)	0.0037*** (0.0018)	0.0042* (0.0022)	0.0042* (0.0022)	-0.001 (0.0064)	-0.001 (0.0062)		
ln (SF_com_h)		0.0091** (0.0045)	0.004 (0.0046)	0.0027 (0.006)	0.003 (0.0059)	0.0630*** (0.0164)	0.0620*** (0.0162)		
ln (SF_it_us)		0.010 (0.0111)	0.000 (0.0118)	-0.0042 (0.0145)	-0.002 (0.0152)	0.0628* (0.0337)	0.0613* (0.0331)		
Non-h./US it		0.0075*** (0.0024)	0.0091*** (0.0025)	0.0087*** (0.0031)	0.0097*** (0.0031)	0.0412*** (0.0091)	0.0405*** (0.0090)		
ln (SF_com_us)			0.0088*** (0.0033)	0.0072* (0.004)	0.0079*** (0.0040)	0.0522*** (0.0102)	0.0515*** (0.0101)		
Non-h./US com			0.0156* (0.0082)	0.0208* (0.0106)	0.0223*** (0.0108)	0.033 (0.0213)	0.032 (0.0210)		
ln (SF_other_us)			-0.0041*** (0.0017)	-0.005** (0.0021)	-0.0055*** (0.0021)	0.0734*** (0.0061)	0.0720*** (0.0060)		
Non-home/Non-US it		0.008 (0.0084)	0.007 (0.0081)	0.007 (0.0085)	0.008 (0.0085)	-0.0485* (0.0254)	-0.0477* (0.0250)		
ln (SF_com_re)									
Non-home/Non-US com									
ln (SF_other_re)									
Non-home/Non-US other									
USAXln (SF_it_h)	0.007 (0.0084)	0.008 (0.0083)	0.007 (0.0081)	0.007 (0.0085)	0.008 (0.0085)				
USAXln (SF_com_h)	-0.003	-0.001	0.000	0.0124	0.011	0.1490***	0.1465***		

Table 2 (continued)

Dependent Variable:	q-1 (i) ^a	q-1 (ii) ^a	q-1 (iii) ^a	q-1 (iv) ^a	q-1 (v) ^a	tfp_1 (vi) ^b	tfp_2 (vii) ^b
	2001–2015	2001–2015	2001–2015	2008–2013	2001–2015	2001–2015	2001–2015
USA×home com	(0.0189)	(0.0192)	(0.0196)	(0.0224)	(0.48)	(0.0497)	(0.0488)
USA×ln(SF _{other_h})	-0.001 (0.0056)	0.001 (0.0055)	0.001 (0.0055)	-0.0065 (0.0061)	-0.006 (-0.95)	0.010 (0.0166)	0.010 (0.0163)
USA	0.0993*** (0.0235)	0.1039*** (0.0236)	0.1045*** (0.0235)	0.122*** (0.0261)	0.1242*** (0.0261)	0.1204* (0.068)	0.1193* (0.0669)
ln(SC _{it})					-0.188 (-0.65)	0.152 (0.4753)	0.153 (0.4637)
IT-sector capital stock					0.185 (1.01)	0.5924** (0.2947)	0.5794*** (0.2897)
ln(SC _{com})					-0.270 (-1.20)	0.431 (0.3650)	0.426 (0.3613)
Com-sector capital stock					16,221	27,519	27,519
Other-sector capital stock					0.5861	0.1489	0.1485
Number of observations	27,538	27,538	27,538	16,221	16,221	27,519	27,519
Adjusted R-square	0.5802	0.5808	0.5814	0.5878	0.5861	0.1489	0.1485

All variables are natural logarithm transformed variables. The estimation model is repeated cross-sectional OLS with robust (clustered) standard errors to account for serial correlation and heteroscedasticity. All estimations include industry dummies (or sector-specific capital stocks), time dummies and (unreported) constant term. Robust standard errors are reported in brackets. * (**) [***] denotes that the coefficient is significantly different from zero at the 10% (5%) [1%] level

^aAll variables are expressed as per-employee (see Eq. (2)). The dependent variable is the log of value added per employee

^bAll variables are expressed in absolute terms (see Eq. (3)). The dependent variable is the log of total factor productivity

of industry dummies for the complete period 2001–2015 are given in column (v). To test our assumption that service flows are determinants of the establishment-specific efficiency term, we use two total factor productivity estimates from Olley and Pakes (1996) employing either tangible assets or total assets as investments variables and report the results in column (vi) and (vii), respectively.

4.1.1 Baseline estimation: column (i)–(iii)

Estimates in Table 2 show that capital intensity and imported IT service flows from home countries are significant at least at a 5% level with the expected (positive) sign. Coefficients vary across model specifications but are relatively robust. Doubling IT-related headquarter services (i.e. an increase of 100%), for example, results in an average increase of around 1% in foreign affiliates' labor productivity. While there is no such significant impact from headquarter communication services from the home country, the impact of other headquarters' service flows is reported to be positive and significant at a 5% level in two (out of three) model specifications. The estimated coefficients, however, are less than half the size of IT headquarters' coefficients. US affiliates do not differ significantly from other foreign affiliates in the marginal effect of service imports from their parent companies: None of the interaction coefficients of US ownership with home service trade are significant, regardless of whether we relate the US dummy to IT, communication or other service flows. In this respect, we conclude that foreign affiliates of US multinational are not different in their marginal effect of headquarters' service imports. As the US dummy is significant at a 1% level in all model specifications, labor productivity of US affiliates is on average 10% higher than that of non-US affiliates, which is in line with the finding of Bloom et al. (2012).

4.1.2 Trade partner estimation: column (ii)–(iii)

We like to know if service imports from the USA are superior to service imports from other countries, which might also explain the higher home country imports by German affiliates of US firms. Estimations in column (ii) include cross-border trade with the USA as a partner country by non-US affiliates in Germany. Coefficients for both IT-related services and other services are at around 0.9% and 0.8%, respectively, and are significant at least a 5% level. The effect of IT-related service imports from the USA, however, is not robust: If we add service imports from all non-home countries other than the USA, estimates in column (iii) show a coefficient of IT-related service imports from other than US partner firms of around 0.9% at a 1% significant level. Hence, IT service imports from non-home countries are important for all German affiliates no matter if the trade partner is from the USA or somewhere else. In contrast, estimates of the coefficient of other services, confirm that imports from the USA as a partner country have significant

impacts of around 0.9% for the productivity of non-US affiliates, but is negative for imports of other services when imported from non-US partner firms.

4.1.3 Sub-period 2008–2013: column (iv)

We shorten the time period to 2008–2013 to analyze whether the financial crisis and its aftermath have a different impact on our baseline estimates. Estimates in column (iv) are comparable to the results from our baseline estimations in column (i)–(iii): coefficients of home service flows and non-home cross-border trade with countries other than the USA are almost the same in terms of magnitude, sign, and significance. Interaction terms of US ownership with home service flows are not significant, while being a US affiliates matters in terms of a 12% higher labor productivity. Hence, the data do not confirm a different impact of service imports on labor productivity of foreign affiliates in Germany due the financial crisis and its aftermath.

4.1.4 Sector-specific capital stocks: column (v)

Column (v) shows estimation results of the 2001–2015 period using sector-specific capital stocks instead of industry dummies to control for between-sector variation. Again, estimation results are not significantly different: IT service and other services from home countries have a positive (1% and 0.4%, respectively) and significant (at least at a 10% level) impact on labor productivity for foreign affiliates in Germany. If services are imported from non-home partner countries, cross-border trade of IT services with non-US partner increases (by almost 0.8%) significantly labor productivity of German affiliates. Estimates confirm that US affiliates in Germany have on average higher productivities than their counterparts (at around 12%) as the US dummy is positive and significant. In short, both sector-specific capital stocks and industry dummies control in the same way for between-sector variation and lead to same results.

4.1.5 TFP estimation: column (vi)–(vii)

To test the results of our baseline estimation, we rely on the methodology of Olley and Pakes (1996) and compute two total factor productivity estimates (tfp_1 and tfp_2) from the residuals of a Cobb–Douglas production function using tangible or total assets as investments to control for unobserved productivity shocks. The estimation results from repeated cross-section OLS regressions of Eq. (3) are shown in column (vi) and (vii).⁴ Note that Eq. (3) determines the impact of service flows on total factor productivity in absolute terms—in contrast to the per-employee estimation of Eq. (2). The use of IT headquarters service imports has a significant effect at

⁴ The model specification includes time dummy and sector-specific capital stocks. We choose the number of bootstraps replications to 250. We started with 50 as the default and increased the number up to 250 with no further (significant) change of results. Estimation results are robust to changes in the dummy structure and are available upon request.

a 1% level. Doubling the amount of IT service flows imported from parent companies, leads to an increase in total factor productivity of 3.6% for both cases. Coefficients are higher if IT (and other) service flows are traded with non-home countries and, in particular, with firms from the USA: If the trading partner is located in the USA, for example, the impact on labor productivity vary around 6% in the case of importing IT services and 4% for importing other services. Hence, the marginal effect on (total) firm productivity of non-US affiliates is higher when service flows are imported from US partner firms than from their parent countries. The US dummy is significant and coefficients are comparable to the estimations on labor productivity. Total factor productivity of German affiliates of US firms is on average about 12% higher than that of non-US affiliates.

4.2 Fixed effects estimation

Given the heterogeneity among firms, we control for fixed effects at the establishment level using a two stage approach. In the first stage, we estimate Eq. (2) but include a firm dummy variable to control for time-invariant firm-specific effects in our heterogeneous firm sample. The variance left allows to analyze the short-run effects. As the time dimension is (very) small compared to the cross-section dimension we refrain from explaining the short-run effects. We turn to the time-invariant firm-specific effects in the second stage, explain the fixed effects by the variation between the firms and interpret the results as the long run effects. We have much more variance in the second stage than in the first stage and present the results in Table 3. The first-stage results are reported in column (i)–(iii), while estimation results of firm-level fixed effects are presented in column (iv)–(vi).

As expected, the variance in the time-series model in the first stage is limited as confirmed by the estimates in column (i)–(iii). While capital intensity is shown to have a significant impact on labor productivity (with an estimated coefficient comparable to our baseline estimation), all other coefficients are not significant in the short run. According to the estimates in column (iv)–(vi), variation in the fixed effects is explained by service imports from both home and non-home countries, by the US dummy, the interaction terms of US ownership with home service trade, by sector and by time dummy variables. In particular, IT-related service imports have a significantly positive effect on the firm fixed effects in all regressions and from all partner countries (home, non-home but the USA and, other countries). US-owned affiliates in Germany benefit from IT service imports from their headquarters as interaction term are significant in all model specifications at a 1% level: Doubling IT-related US headquarter services (an increase of 100%), for example, results in an average increase between 1–2% in US-owned affiliates' labor productivity (column (iv): $0.0193 = 0.0064 + 0.0125$). Again, the US dummy is significant and robust with coefficients comparable to the baseline estimation.

Table 3 Firm analysis of MNEs in Germany; fixed effects (firm-level data from 2001–2015). *Source:* Research Data and Service Centre of the Deutsche Bundesbank, MiDi /SITS-Statistics, 2001–2015; EU KLEMS database; Amadeus database. Authors' calculation

Dependent Variable	q-1 (i)	q-1 (ii)	q-1 (iii)	FE (iv)	FE (v)	FE (vi)
	2001–2015	2001–2015	2001–2015	2001–2015	2001–2015	2001–2015
ln (<i>K/L</i>)	0.6517***	0.6516***	0.6516***			
Capital stock	(0.0063)	(0.0063)	(0.0063)			
ln (<i>SF_it_h/L</i>)	0.003	0.004	0.003	0.0068***	0.0054**	0.0039*
Home it p.e	(0.0024)	(0.0024)	(0.0025)	(0.0021)	(0.0022)	(0.0022)
ln (<i>SF_com_h/L</i>)	0.000	– 0.001	– 0.002	0.0080*	0.0098**	0.0079*
Home com p.e	(0.0049)	(0.0051)	(0.0050)	(0.0043)	(0.0045)	(0.0047)
ln (<i>SF_other_h/L</i>)	0.000	0.000	0.000	0.001	0.000	0.0034***
Home other p.e	(0.0012)	(0.0012)	(0.0012)	(0.0010)	(0.0010)	(0.0010)
ln (<i>SF_it_us/L</i>)		– 0.004	– 0.005		0.0113***	0.0077**
Non-home/US it p.e		(0.0040)	(0.0041)		(0.0030)	(0.0032)
ln (<i>SF_com_us/L</i>)		0.010	0.008		– 0.0134**	– 0.0168**
Non-home/US com p.e		(0.0075)	(0.0077)		(0.0064)	(0.0068)
ln (<i>SF_other_us/L</i>)		0.000	– 0.001		0.0064***	0.0111***
Non-home/US other p.e		(0.0018)	(0.0018)		(0.0014)	(0.0015)
ln (<i>SF_it_re/L</i>)			0.003			0.0076***
Non-home/Non-US it p.e			(0.0022)			(0.0021)
ln (<i>SF_com_re/L</i>)			0.005			0.003
Non-home/Non-US com p.e			(0.0043)			(0.0042)
ln (<i>SF_other_re/L</i>)			0.000			– 0.0092***
Non-home/Non-US other p.e			(0.0011)			(0.0009)
USA×ln (<i>SF_it_h/L</i>)	– 0.007	– 0.008	– 0.009	0.0125***	0.0141***	0.0134***
USA×home it p.e	(0.0066)	(0.0066)	(0.0067)	(0.0048)	(0.0048)	(0.0047)
USA×ln (<i>SF_com_h/L</i>)	– 0.021	– 0.019	– 0.019	0.0196*	0.018	0.017
USA×home com p.e	(0.0189)	(0.0190)	(0.0191)	(0.0114)	(0.0115)	(0.0115)
USA×ln (<i>SF_other_h/L</i>)	0.001	0.001	0.001	– 0.001	0.000	0.002
USA×home other p.e	(0.0035)	(0.0036)	(0.0036)	(0.0030)	(0.0029)	(0.0029)
USA	– 0.008	– 0.009	– 0.010	0.1242***	0.1290***	0.1307***
USA ownership	(0.0227)	(0.0230)	(0.0228)	(0.0117)	(0.0117)	(0.0117)
Sector fixed effect	Capital	Capital	Capital	Dummy	Dummy	Dummy
Time dummy	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	27,538	27,538	27,538	27,538	27,538	27,538
Adjusted R-square	0.8508	0.8508	0.8509	0.111	0.113	0.115

All variables are natural logarithm transformed variables and expressed as per-employee (see Eq. (2)). The dependent variable is the log of value added per employee. The estimation model is repeated cross-sectional OLS with robust (clustered) standard errors to account for serial correlation and heteroscedasticity. All estimations include industry dummies (or sector-specific capital stocks), time dummies and (unreported) constant term. Robust standard errors are reported in brackets. * (**) [***] denotes that the coefficient is significantly different from zero at the 10% (5%) [1%] level

4.3 Import intensity estimation

In search for the source of the productivity advantages of US affiliates over non-US affiliates in Germany, we test if the average use of imported services, particularly imported IT-related services from the home country, differs among the German affiliates of foreign firms. We therefore explain service imports by size variables (i.e. value added, capital input, employment) and estimate an ad hoc service import demand function. In particular, we are interested if US affiliates have higher import intensities and estimate Eq. (4) controlling for firm size and taking into account a full set of industry sector and time dummies. Cross-section OLS estimation results are reported in Table 4 in column (i) for import services (total), column (ii)–(iv) for IT-services (total; home and non-home), column (v) for communication services (total) and column (vi) for other services (total).

Larger firms import more services in general and from home countries in particular. Coefficients of total employment and capital stocks reported in column (i) are positive and significant at a 1% level. Almost the same results for both input factors (in terms of sign and significance) are shown in column (ii)–(iii) regarding IT-services (total and headquarter services). As discussed, including size variables combined with firm fixed effects separates the nationality of the parent firm from all other effects. We find significant import intensity differences between German affiliates from US firms and those from other countries, but only for IT-related service import. In particular, service imports matter if imported as headquarter services from the USA (i.e. column (iii)), while non-US imports of US firms' affiliates are not different to other firms importing services from non-parent countries (i.e. column (iv)). The difference in IT imports from home is economically important: the average US affiliate imports 64% (i.e. $\exp(0.497) = 1.64$) more IT-related services and 140% (i.e. $\exp(0.877) = 2.40$) more IT-related headquarter services than the average non-US affiliate. Hence, IT-related service imports and particularly IT-related service imports from the parent country are larger by German affiliates of US firms. Interestingly, no such impact for the US dummy is found in the case of imports in communication and other services (i.e. column (v)–(vi)).

4.4 Discussion of main results

German affiliates of US multinational firms rely more on IT-related service imports from the home country than affiliates from other firms, which positively affects their value added per employee and total factor productivity. Given the (huge) heterogeneity of firms, we refrain from assessing the direct effect of service inputs on sales as no information of the use of intermediate inputs are available. We find that indirect effects from cross-border service trade on value added runs through productivity. The (higher) intensity in the use of IT headquarter services is explained by the nationality of the parent country and not by sector specialization and/or affiliate size. However, no such evidence is found for communication services and other services not matter the partner country. In particular, the positive effects of IT-related service imports from the home country on labor productivity or total factor productivity

Table 4 Service imports of MNE's in Germany; repeated OLS (firm-level data from 2001–2015). *Source:* Research Data and Service Centre of the Deutsche Bundesbank, MiDi /SITS-Statistics, 2001–2015; EU KLEMS database; Amadeus database. Authors' calculation

Dependent Variable	Services total (i)	IT-services total (ii)	IT-services home (iii)	IT-services, non-home (iv)	Com. Services total (v)	Other services total (vi)
$\ln(Q)$	-0.0893*** (0.0365)	0.1946*** (0.0671)	0.1520* (0.0849)	0.139 (0.0906)	0.1870 (0.1389)	-0.1250*** (-0.04)
Value Added	0.3283*** (0.0274)	0.2480*** (0.0625)	0.1334* (0.0695)	0.2970*** (0.0897)	-0.0908 (0.0868)	0.3134*** (0.03)
Total employment	0.2638*** (0.0351)	0.0979* (0.0583)	0.073 (0.0777)	0.096 (0.0705)	0.0877 (0.1176)	0.3131*** (0.04)
Capital stock	0.115 (0.0992)	0.4969** (0.2484)	0.8768*** (0.3321)	0.066 (0.1944)	0.2666 (0.3256)	0.078 (0.10)
USA Ownership	16,408	3,574	1,826	2,285	1,028	15,948
Num. of observations	0.1096	0.1238	0.0915	0.1194	0.1858	0.1075
R-square						

All variables are natural logarithm transformed variables and expressed in absolute terms [see Eq. (4)]. We distinguish import services for the import demand function as import services (total), IT-services (total; home and non-home), communication services (total) and other services (total). The estimation model is repeated cross-sectional OLS with robust (clustered) standard errors to account for serial correlation and heteroscedasticity. All estimations include industry dummies, time dummies and (unreported) constant term. Robust standard errors are reported in brackets. * (**) [***] [****] denotes that the coefficient is significantly different from zero at the 10% (5%) [1%] level

are robust and significant for all German affiliates of foreign multinational firms. Regardless of the specification, IT-related service imports from the home country increase productivity positively at least in the long run. We analyze the long-run by assessing the variance in the affiliates' fixed effects. We find the positive effect of IT-related service imports from parent countries to be robust, but only for IT-related service imports. Moreover, we do not find a similarly robust pattern for non-home imports from the USA as a partner country or from the rest of the world. Thus, the intensity in the use is based on cross-border trade with the parent country and not, for example, with countries that offers superior IT-related services like the USA.

There is some support for the presumption that the more intensive use of imported IT-related services contributes to the remarkably robust productivity advantage of German affiliates of US firms over those from other countries. US affiliates have significantly higher productivity than other foreign affiliates in Germany. On average their productivity is between 10–13% higher than of non-US affiliates. While Bloom et al. (2012) show that US multinationals generates significantly higher (IT-related) productivity from IT capital stocks in their host country, we find support for our hypothesis that the import and usage of IT headquarter service flows from the USA explain the productivity advantages of US affiliates. IT-related service imports from the home country are not only larger for German affiliates of US firms, the effect of these imports on productivity is also larger for US firms in our fixed effect regressions. The interaction effects of the US dummy variable and IT service imports related to the home country are positive and highly significant. Hence, IT-related service imports are not only larger for affiliates from US firms they also have a more pronounced effect on productivity in those affiliates. Our empirical findings are in line with Bloom et al.'s (2012) "Americans do I.T. better" but we identify a different channel. We find that the import and use of IT-related headquarter services from the US explain—at least in part—the productivity advantages for US firms' affiliates in Germany.

5 Conclusion

We study the relationship of firm level productivity and service imports by German affiliates of foreign multinational firms. Micro-level productivity studies often ignore the effects of imported inputs, particularly imported services. We make progress in this respect and combine the firm-level MiDi database with the cross-border transaction-level BoP-statistics to study the relationship between firm productivity and the use and origin of service flows. Thereby, we provide a first step towards an empirical analysis of headquarter services. According to Zingales (2000) and Hortacsu and Syverson (2007), intra-firm service flows serve to link the different units of a firm, with management, financial, and personnel services flows being the glue that holds multi-unit firms together. So far, there is no empirical evidence that intra-firm service flows play such an important role, because data is hard to come by. There is one exception: cross-border service transactions between MNE parent firms and their foreign affiliates. We assume that service flows are likely to be traded within a

firm (and can be classified as headquarter services) if there are cross-border service transactions with the same country as the foreign affiliate's country of origin.

We find that IT-related headquarter service imports have significant impacts on foreign affiliates' productivity in general and on US affiliates in particular. German affiliates of US firms generate part of their productivity advantages from the import of IT-related headquarter services from their parent companies at a larger scale than foreign affiliates of parents from other countries do. Our findings are in line with Bloom et al.'s (2012) "Americans do I.T. better" but we identify a different channel. We find that the imports and use of IT-related headquarter services from the US explain in part the productivity advantages for US firms' affiliates in Germany.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10290-021-00406-5>.

Acknowledgements The authors would like to thank the Research Data and Service Centre (RDSC) and Mr. Harald Stahl for their support using the micro data collected by the Deutsche Bundesbank.

Funding Open Access funding enabled and organized by Projekt DEAL.

Data Availability Data subject to third-party restrictions: The data that support the findings of this study are available from Deutsche Bundesbank. Restrictions apply to the availability of these data, which were used under license for this study. Local or remote access to data is subject to research proposal approval by the Deutsche Bundesbank: <https://www.bundesbank.de/en/bundesbank/research/rdsc/data-access>.

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References

- Alfaro, L., & Charlton, A. (2009). Intra-Industry Foreign Direct Investment. *American Economic Review*, 99(5), 2096–2119.
- Alfaro, L., Antras, P., Chor, D., & Conconi, P. (2019). Internalizing Global Value Chains: A Firm-Level Analysis. *Journal of Political Economy*, 127(2), 508–559.
- Atalay, E., Hortacsu, A., & Syverson, C. (2014). Vertical Integration and Input Flows. *American Economic Review*, 104(4), 1120–1148.
- Atkeson, A., & Kehoe, P. (2005). Modeling and Measuring Organization Capital. *Journal of Political Economy*, 113(5), 1026–1053.
- Biewen, E., & Lohner, S. (2017). *Statistics on international trade in services, Data Report 2017–07 – Metadata Version 1*. Deutsche Bundesbank Research Data and Service Centre.
- Bloom, N., Sadun, R., & Van Reenen, J. (2012). Americans Do I.T. Better: US Multinationals and the Productivity Miracle. *American Economic Review*, 102(1), 167–201.
- Bureau of Economic Analysis (2020). *International trade and Investment—International Services*. <https://www.bea.gov/data/intl-trade-investment/international-services-expanded>.
- Bureau van Dijk (2018). *Amadeus—European Company Data*. <https://www.bvdfinfo.com/en-gb/our-products/data/international/amadeus>.

- Deutsche Bundesbank (2018a). *Statistics on International Trade in Service (SITS)*. <https://www.bundesbank.de/en/bundesbank/research/rdsc/research-data/statistics-on-international-trade-in-services-sits--618084>. <https://doi.org/10.12757/Bbk.SITS.0116.01.01>.
- Deutsche Bundesbank (2018b). *Mikrodatenbank Direktinvestitionen (MIDI)*. <https://www.bundesbank.de/en/bundesbank/research/rdsc/research-data/microdatabase-direct-investment-midi-mikrodatenbank-direktinvestitionen--618076>. <https://doi.org/10.12757/Bbk.MiDi.9915.03.04>.
- EU KLEMS Project (2018). EU KLEMS Database. <http://www.euklems.net/>.
- Forman, C., & McElheran, K. (2012). *Information Technology and Boundary of the Firm: Evidence from Plant-Level Data*. Harvard: Harvard Business School.
- Griliches, Z. (1979). Issues in assessing the contribution of R&D to productivity growth. *Bell Journal of Economics*, 10, 92–116.
- Hortacsu, A., & Syverson, C. (2007). *Vertical Integration and Production: Some Plant-Level Evidence*. International Monetary Fund. (2020). *Extended Balance of Payments Services (EBOPS)—Trade in Services by Partner Country*. https://stats.oecd.org/Index.aspx?DataSetCode=TISP_EBOPS2010.
- Jaeger, K. (2018). *Growth and Productivity Accounts 2017 release—Description of Methodology and General Notes*. <http://www.euklems.net/>.
- Kelle, M., & Kleinert, J. (2010). German Firms in Service Trade. *Applied Economics Quarterly*, 56(1), 51–72.
- Markusen, J. (1984). Multinationals, Multi-plant Economies, and the Gains from Trade. *Journal of International Economics*, 64, 1263–1297.
- Markusen, J. (1995). The Boundaries of Multinational Enterprises and the Theory of International Trade. *Journal of Economic Perspectives*, 1, 169–189.
- Markusen, J. (2002). *Multinational Firms and the Theory of International Trade*. London: MIT Press.
- O'Mahony, M., & Timmer, M. P. (2009). Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database. *Economic Journal*, 119(538), F374–F403.
- Olley, G. S., & Pakes, A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica*, 62, 1263–1297.
- Schild, C.-J., & Walter, F. (2017). *Microdatabase Direct Investment 1999–2015*, Data Report 2017–01 - Metadata Version 4, Deutsche Bundesbank Research Data and Service Centre.
- Van Ark, B., & Jaeger, K (2017). Recent Trends in Europe's Output and Productivity Growth Performance at the Sector Level, 2002–2015, *International Productivity Monitor*, Number 33, Fall 2017.
- Yasar, M., Raciborski, R., & Poi, B. (2008). Production function estimation in Stata using the Olley and Pakes method. *Stata Journal*, 8(2), 221–231.
- Zingales, L. (2000). In Search of New Foundations. *The Journal of Finance*, 55(4), 1623–1653.

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