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Exploiting the Potential for Services Offshoring: Evidence from German Firms

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Abstract

Services offshoring is on the rise. Due to recent innovations in communication technologies, many services that used to be non-tradable can be delivered from distance today. Still, German services imports have grown much slower than exports over the past decades, indicating under-exploitation of the potential for services offshoring. To understand this development, the paper uses a newly combined dataset on German firms' services trade, balance sheets, and foreign affiliates during 2001-2012. Estimation of a firm-level gravity model confirms that more productive firms offshore more, reveals complementarities between services imports and exports, and points towards the importance of intra-firm services trade. The paper establishes that the level of services offshoring is lower in industries with greater offshoring potentials, as captured by their task compositions, but offshoring growth tends to be higher there. These findings indicate that there exists a sizeable potential for services offshoring due to remaining trade barriers, which is yet to be exploited.

JEL classifications: F10, F14.

Keywords: offshoring, services trade, offshoring potential, trade in tasks.

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1 Introduction

Services offshoring from high- to low-wage countries is on the rise. Today, many services are tradable internationally that could not be delivered from distance before the revolutionary advancements in information and communication technologies (ICT) of the recent past. As a consequence, the total volume of international trade in services increased from approximately 3% to 6% of world GDP between 1985 and 2007.[1] This increase reflects to a large extent imports of services that are used in the production process by firms, so-called 'services offshoring'. In many advanced economies, the observed steep increase in services offshoring has fuelled the fear of losing domestic jobs to foreign low-wage countries.[2] This development raises the question of how many jobs, and which ones, are threatened by offshoring. Blinder (2009) estimates that about one fourth of all US American jobs were potentially offshorable in 2004. His rough approximation of the offshoring potential initiated an intense debate both by the public and among academics in the US. After the offshoring of intermediate goods production, which has already started decades ago, this 'new wave' of services offshoring (Bardhan and Kroll, 2003) is a particularly sensitive issue because it threatens white collar jobs, which are highly valued in knowledge economies.

The situation is markedly different in Germany, where the public debate on services offshoring is almost entirely absent. A closer look at aggregate services trade statistics reveals one possible explanation for this difference. Despite having ranked among the five largest importers of services for decades and despite a continuous rise of services imports, Germany experienced comparably small growth rates in services offshoring. From 1995 to 2012, the share of services exports in GDP increased by 157%, while the ratio of services imports over GDP rose by only 60% to around 8.3 percentage points. Hence, on the one hand, German service workers may be right not to be overly concerned about their jobs. On the other hand, this development raises the question of whether German firms fail to exploit the existing potential for services offshoring and why this might be the case. Since international wage differences are large, German firms seem to forego large efficiency gains by not exploiting this potential.

This paper seeks to contribute to understanding the factors that foster or hamper the exploitation of the services offshoring potential by German firms and in general. In order to draw a broad picture of these determinants, it considers potential factors influencing services offshoring at the levels of source countries and trading relationships, firms, and individual tasks. First, a number of country-level and bilateral factors, such as distance or language barriers, will determine the costs of trading services internationally. In the tradition of the empirical literature on goods trade, these factors are typically examined in a gravity-type framework (see, e.g. Head et al., 2009). Second, I consider firm heterogeneity along a number of dimensions, most importantly, firm productivity and status as an exporter or a multinational firm. These factors are still not well understood since micro-level data on services has only recently become available. Third, the international tradability of a service will be fundamentally determined by the nature of the tasks that it involves. Hence, this task composition is a crucial determinant of the offshoring potential. This paper therefore examines in detail the relationship between task characteristics and services offshoring, studies how it evolves over time, and which firms succeed in exploiting the offshoring potential.

[1]These figures as well as those in the subsequent paragraph are computed from aggregate service trade data from the WTO and GDP data from the Worldbank's World Development Indicators (WDI).

[2]Mankiw and Swagel (2006) and Amiti and Wei (2005) document the rising media attention to services offshoring for the US and the UK, respectively, over the period 1993-2004.

To address these questions, I set up a one-sided firm-level gravity model for services trade.[3] Different specifications of the model are used to analyze the effects of country-, firm-, and task-level determinants on services offshoring. It is estimated in a rich dataset comprising the universe of German firms' services imports, together with information on their balance sheets and other important firm characteristics, as well as their foreign affiliates during the period 2001-2012. These confidential datasets have been combined for the first time at the German central bank for the purpose of this study. To measure the fundamental potential for services offshoring, a representative German employment survey is exploited, which captures important characteristics of the typical tasks conducted by the workforce: the requirement of physical proximity, interactivity, ICT intensity, the requirements of German writing skills and legal knowledge, as well as how routine and codifiable tasks are. These task characteristics are weighted by principal component analysis, as proposed by Brändle and Koch (2014), and aggregated to obtain an index of the task composition of industries in terms of their offshoring potential.

By confronting the gravity model with these data, I first generally confirm previous results on macroeconomic influences in the German data. While services offshoring decreases with distance, it is found to increase with time zone differences. This result was previously found in aggregate data by Head et al. (2009) and may be attributed to the advantage of delivering a service continuously around the clock. In contrast to standard results for goods trade, German firms trade services less with direct neighbors but more with landlocked countries. Second, at the micro level, larger and more productive firms are found to offshore more services, as do those firms that are also services exporters or own a foreign affiliate. These findings point towards complementarities between exporting and importing of services and they are strongly indicative of an important role for intra-firm services trade. Third, I show that the task composition is an important factor explaining services offshoring. In particular, the paper establishes the empirical fact that German firms offshore less services in industries that exhibit a higher offshoring potential. This result, which may seem counter-intuitive at first, reflects the fact that firms performing many tradable activities domestically do not need to import them. It is robust to using alternative measures of multiple or single dimensions of the offshoring potential, but the negative relationship seems to become weaker over time. I also show that the growth of services imports at the firm level is higher in those sectors where the offshoring potential is high, which suggests an adjustment towards an equilibrium. Also, more productive firms exploit the potential more successfully, but only in the service sector. These findings indicate that there exist substantial barriers that continue to prevent German firms from exploiting the potential for services offshoring.

This paper is closely linked to three strands of literature concerned with international trade in services, offshoring, and the potential for future offshoring.

The first line of research, which studies services trade, is rather small compared to the literature on goods trade due to its historically smaller empirical relevance.[4] It stresses the intangible and non-storable nature of services, which traditionally could be delivered only face to face (Hill, 1977). By relaxing this requirement, advancements in ICT, in particular the telephone and the internet, have contributed to a steep decline of trade costs in some service sectors over the past decades (Hoekman and Braga, 1997; Freund and Weinhold, 2002). Despite these peculiarities, previous studies found that aggregate trade in services is surprisingly well explained

[3]The terms 'services imports' and 'services offshoring' are used interchangably in this paper. Observed services imports reflect the decision to offshore a service, irrespective of whether it has previously been conducted domestically. Alternatively, one may view the *increase* in services imports as offshoring. Such growth rates will also be considered below.

[4]See Francois and Hoekman (2010) for an overview of the most important research themes.

by the traditional gravity equation, but the estimates of distance elasticities and other influences vary.[5]

Only recently, firm-level data on international service transactions have become available. Breinlich and Criscuolo (2011) conclude from UK data that service trade is governed by similar patterns of firm heterogeneity as those found for trade in goods: Both exports and imports of services are conducted by few large and productive firms. These results have in general been confirmed for other countries, but nevertheless the micro-level determinants of services trade are not very well understood yet.[6] This paper is the first to analyze German services trade in combination with data on key firm characteristics, which allow for an in-depth assessment of firm heterogeneity.

At least since Jones and Kierzkowski (1990), the academic community has discussed the international fragmentation of production via offshoring of services. Numerous theoretical and empirical papers study the impact of offshoring on domestic employment and wages, in particular for low-skilled labor facing competition from abroad. In their seminal contribution, Grossman and Rossi-Hansberg (2008) provide a formalization of the idea that firms import activities, so-called 'trade in tasks', which they use as intermediate inputs in the production process. In addition to the adverse effects of offshoring on the tradable factor of production, they identify a positive productivity effect, which may benefit the entire domestic labor force. In this study, I apply the trade in tasks paradigm to services offshoring, where it seems to provide an even more appropriate description of reality than for intermediate goods. While material offshoring reflects the *indirect* trading of tasks embodied in goods, services offshoring means that the *task itself* is truly traded. This literature also shows that offshoring is conducted mainly by the most productive firms, which succeed to cover the associated fixed costs.[7]

Due to possible repercussions on the domestic labor market, it has been a major endeavor to quantify the potential future extent of offshoring, i.e. the offshoring potential. For this purpose, it is essential to identify the characteristics of jobs that are threatened by relocation. Blinder (2006) first hypothesized that the traditional distinction between high- and low-skilled jobs is not the crucial divide in the case of offshorability. Instead of education or skills, he defines the possibility to deliver a task from distance without loss of quality as the critical determinant of whether an activity can be offshored. In Blinder (2009), he implements a subjective ranking of occupations by their offshorability based on this requirement. A number of further studies have tried to classify occupations by their degree of offshorability, adding additional task characteristics to the list of determinants of the offshoring potential.[8] I draw on this literature to identify the task-level determinants of the offshoring potential that I seek to analyze. While most of the existing studies predict or observe changes in the labor market in response to offshoring, it has so far not been tested whether firms employing more tradable tasks ex ante will indeed engage in more offshoring.

The remaining paper is organized as follows: Section 2 introduces the dataset used, which is described in Section 3. The fourth section sets up the firm-level gravity model, the estimates of which are presented in Section 5. The final section concludes.

[5]Such gravity-type studies have been conducted for example by Kimura and Lee (2006), and Head et al. (2009).

[6]Such firm-level studies of service trade are conducted by Ariu (2012) for Belgium, Federico and Tosti (2012) for Italy, Gaulier et al. (2010) for France, Kelle and Kleinert (2010) for Germany, as well as Walter and Dell'mour (2010) for Austria.

[7]See Antràs and Helpman (2004) for the theoretical foundation and Kohler and Smolka (2014) for recent empirical confirmation of the predicted sorting pattern.

[8]These papers include Bardhan and Kroll (2003), Abramovsky and Griffith (2006), and Brändle and Koch (2014).

2 Data

This section provides an overview of the data used in this study. It describes the sources of the data and how they are combined and used to measure both services offshoring and offshoring potential.

2.1 Data sources

I use a combined dataset of German firms that draws on three different sources: the Statistics on International Trade in Services (SITS), the Corporate Balance Sheet Statistics (USTAN), and the Microdatabase Direct investment (MiDi). These data are provided by the German central bank only on site for research purposes and, to the best of my knowledge, they have been combined at the firm level for the first time for this study. The offshoring potential is measured by the task composition of industries from the German BIBB/BAuA Employment Survey. The combined dataset is complemented by aggregate data on country characteristics and bilateral variables as well as industry-level labor costs for the subsequent analysis.

Statistics on International Trade in Services (SITS)

The Statistics on International Trade in Services provides transaction-firm-level data on trade in services (both imports and exports) by partner country and service type (see the documentation by Biewen et al., 2013, for a full list of countries and service types). Service trade flows are defined as transactions between German residents and non-residents, which correspond to the GATS modes 1 (cross-border trade), 2 (consumption abroad), and 4 (presence of natural persons). Sales via foreign affiliates (GATS mode 3, commercial presence) are not included in this definition. This feature is advantageous for this study, which is interested in services offshoring defined as cross-border services flows. Since SITS reports international services transactions on a monthly basis, I aggregate the data by year in order to merge them with the firm-level datasets described below.[9]

The dataset contains the universe of German firms' services trade above the reporting threshold of 12,500 €. Following Biewen et al. (2013), I group services transactions in twelve broad categories[10] (see Table A.1) and I drop incidental payments, private transfers, as well as payments of general government from the analysis. Also, non-identified countries and international organizations are ignored. For the main analysis, I further exclude travel and transport services because transactions in these categories presumably follow very different regularities than the types of services that may be offshored and delivered from distance. The residual category may be labeled 'other commercial services', which is the main subject of this paper and the offshoring debate.[11]

Corporate Balance Sheet Statistics (USTAN)

The Corporate Balance Sheet Statistics (Deutsche Bundesbank, 1998; Stöss, 2001) comprise detailed balance sheets and income statements of a large number of German firms. They further contain important firm characteristics such as the number of employees, the firm's founding year, and its legal form.

These data are obtained by the German central bank to assess the value of securitized, non-marketable claims or bills of exchange presented as collateral to the central bank by commercial banks (see Deutsche Bundesbank, 2006). The full USTAN dataset includes 24,000-30,500 firms per year during the period 2001-2012.

[9] Since some firms reporting different main activities during the year, the most frequently reported industry is chosen.

[10] The only exceptions that I make is treating engineering separately from other business services and grouping disposal services as well as rents/operational leasing with the residual category of 'other services'.

[11] The same approach is taken by Head et al. (2009).

The sample is selective and overrepresents large manufacturing firms in Western Germany, while coverage of smaller firms, those in other sectors, and those located in Eastern Germany is weaker. Due to this selectivity, however, USTAN represents a substantial fraction of German firms' overall turnover, in particular in manufacturing (cf. Stöss, 2001). Since not all USTAN firms import services (more on this in Section 3), the combined dataset covers only around 7,000 firms.

Note that the reporting requirement changed in 1999, before the time period considered in this study. As a consequence of this adjustment, the number of firms in USTAN was still decreasing from 2000 to 2001. Also, at the time of this study, the dataset for the year 2012 was not yet fully complete, hence the number of firms observed is slightly smaller than in 2011. These differences might introduce an additional selection bias. Data from both years are still used in the main analysis, but they need to be interpreted with caution.[12]

Microdatabase Direct investment (MiDi)

The Microdatabase Direct Investment (Lipponer, 2009) contains all inward and outward stocks of Foreign Direct Investment (FDI) by German firms above a reporting threshold. This threshold has been unchanged since 2002 at a minimum of 10% shares or voting rights in a foreign affiliate with a balance sheet total of at least 3 million €.[13] MiDi includes a rich set of information on each foreign affiliate, most importantly, the country and industry in which it operates as well as key items from its balance sheet. I exploit outward FDI stocks reported in MiDi to determine whether German firms own an affiliate in the country from which they import services.[14]

Employment Survey of the Working Population on Qualification and Working Conditions (BIBB)

I use detailed information on the task composition of the average workforce in a given industry from the most recent waves of the BIBB/BAuA Employment Survey of the Working Population on Qualification and Working Conditions in Germany conducted in 1999, 2006, and 2012 (see Hall et al., 2014, for the most recent wave). It contains representative samples of 17,000-22,000 employees in each wave, but does not follow sampled individuals over time.

The survey contains a large set of questions on the employees' qualifications, their occupations, working conditions, and the tasks conducted at work. Most questions are identical over the last three waves, but some of them change over time or are asked only in some waves. I exploit a number of questions from the BIBB survey referring to the nature of employees' tasks, the tools used at work, and the specific skills required to perform their tasks. The specific questions used to measure various dimensions of the offshoring potential are described in Subsection 2.3.

Country- and industry-level variables

Data on GDP and GDP per capita for partner countries come from the Worldbank's World Development Indicators.

Gravity control variables varying across country pairs are taken from the CEPII gravity dataset (Head et al., 2010): great circle distance (unweighted) between Berlin and the most populous cities in kilometers, time zone

[12]The main results presented in this study are robust to excluding those years from the sample.

[13]In 2001, the old reporting thresholds of 5 million € (if $\geq$ 10%) and 500,000 € (if $\geq$ 50%) apply (see the documentation by Lipponer, 2009, for details).

[14]MiDi has previously been used in combination with USTAN, e.g. by Jäckle and Wamser (2010) as well as Muendler and Becker (2010).

difference in hours, and a set of dummies indicating a whether Germany shares a border, an official language, a colonial link, the currency, or the origin of the legal system with the respective country.

From the WTO website, I extract information on Germany's bilateral Free Trade Agreements (FTA) that include provisions for services trade.

I obtain industry-specific net labor costs from the German Statistical Office. These data are only available in every fourth year and not for each industry, so they need to be imputed for missing years, which may introduce measurement error.

For estimation of Total Factor Productivity (TFP), inputs and outputs need to be deflated. For this purpose, I use industry-level price indices, which are also provided by the German Statistical Office. They are replaced by the (chained) consumer price index if missing.

2.2 Data management

The three firm-level datasets are combined via firm identification numbers, which are identical in SITS and MiDi and matched to USTAN via a correspondence table provided by the German central bank. For the main analysis, all firms that do not report any imports of the service types of interest are dropped. Therefore, and since dealing with a very large number of zeros at the firm-country-service type level is infeasible, the results in this study should be interpreted as concerning the intensive margin of services offshoring. Also, if a firm does not show up as an investment enterprise in MiDi, it is assumed not to own any foreign affiliates. The resulting, combined dataset is smaller and differs from the original ones along a number of dimensions, which are described in Section 3.

The estimated task-based measures of offshoring potential from the BIBB survey are aggregated at the level of 2-digit NACE Rev. 1 industries and merged to the combined firm-level dataset. Two comments on the industry classifications are in order. First, a non-standard industry classification was used in the BIBB data until 1999. Thus, indicators including data from the BIBB wave of 1999 have to be matched via a modified classification in which some NACE sectors are grouped together, resulting in 49 instead of otherwise 61 industries (see Table A.2 for the resulting classification). Second, industry classifications in all three firm datasets do not always agree because different persons completing the data requests or surveys (depending on their positions) may have different perceptions of the main activity of the firm, which might even change during the year. Throughout this paper, I choose the main activity of the firm reported in SITS to classify firms since it is (almost) always available whenever I observe positive services imports.

Consistency checks reveal that firms in USTAN sometimes report numbers of employees that seem inconsistent with their labor costs (total wage bill) and turnover. Due to the nature of the reporting, which requires certain items of the income statements, but not necessarily the number of employees, the former information is more reliable. Hence, I use labor costs instead of the number of employees as measuring labor input in the TFP estimation as well as for the computations of capital intensity and labor productivity.

Total Factor Productivity (TFP) has been established as an important determinant of firms' offshoring decisions and volumes. Since TFP is unobserved, it is estimated as the residual from a Cobb-Douglas production function. At least since Olley and Pakes (1996), it is well known that estimation of such production functions suffer from two major problems that might bias the estimates: first, firms simultaneously choose inputs and outputs, and second, due to exit of the least productive firms there is a selection issue. I estimate TFP from all available USTAN data over the time period 1996-2012 using the method proposed by Levinsohn and Petrin (2003) to address the simultaneity issue. I use value added as the dependent variable and labor costs and the value of the physical capital stock as the only inputs in the production function. As proposed by Levinsohn and Petrin (2003), I exploit the value of material input purchases as a proxy to control for the correlation between unobserved TFP and the firm's input choice. All variables are deflated using industry-specific producer price indices. I prefer the Levinson-Petrin method over the alternative algorithm by Olley and Pakes (1996) since information on investment, used as a proxy in the latter method, is often zero or missing, and since firm exit from the sample cannot be used to correct for selection.[15]

2.3 Measuring the offshoring potential

There exists a considerable range of methods for measuring the offshoring potential and a similarly wide range of estimates seeking to quantify the existing potential for offshoring in terms of workers employed in offshorable jobs. In this section, I first summarize the task characteristics that have been identified as crucial determinants of the potential for offshoring and I describe how they can be captured in the BIBB data. Second, I show how these characteristics are used to construct the main measure of offshoring potential used in this study. I also discuss alternative measures used for robustness checks.

Task characteristics affecting the offshoring potential

Blinder (2006, 2009) stresses the requirement of physical presence as the main determinant of the potential to offshore a certain task. According to this view, it is an inherent characteristic of some occupations that they can be performed only in physical proximity to the client or work station. This is obvious when comparing the activities of a nurse with those of a call-center worker, but the ranking of occupations may be less clear in other cases. Since an alternative, direct measure of this proximity requirement is not available in the BIBB data, I use Blinder's (2009) original indicator for this purpose. It has been transferred to German data by Schrader and Laaser (2009) and ranks occupations according to their requirement of physical proximity on a 4-level scale.

The necessity of interacting with customers (or, to a lesser extent, with co-workers) is also commonly thought of making a task harder to offshore. Intuitively, the need to interact personally with others constitutes a barrier to relocate an employee and thus decreases the offshoring potential (Bardhan and Kroll, 2003). In my baseline analysis, I measure interactivity by exploiting a survey question in the BIBB data on whether daily work involves negotiations. Alternative measures of interactivity are considered as well. Namely, when restricting the BIBB sample to 2006 and 2012, I can additionally use the question asking whether the employee has regular contact with clients or patients. Also, the classification of tasks by Spitz-Oener (2006) contains one category indicating interactivity. Finally, I consider also the share of tools indicating interactive tasks, as classified by Becker et al. (2013), which relies only on the BIBB wave of 1999.

The use of modern information and communication technologies (ICT) has been established as another crucial feature affecting the offshoring potential. International tradability of a task is arguably easier if it is ICT-enabled and can be delivered across the globe through a telephone wire or via the internet. Several studies confirm that increasing use of the internet stimulates services trade (Freund and Weinhold, 2002) and that ICT-intensive firms offshore more services (Abramovsky and Griffith, 2006). Van Welsum and Wickery (2005) also identify ICT use as a crucial determinant of services offshoring. Unfortunately, the BIBB data do not include information on the use of communication technologies, such as telephones or e-mail, in each of the recent

[15] There might be a variety of reasons for why firms leave the sample.

waves. Thus, I approximate ICT use by a dummy indicating whether an employee uses a computer at work.[16] This amounts to assuming that computer-enabled tasks are more easily delivered from distance through ICT than non-computerized tasks.

In addition to the task characteristics mentioned above, Brändle and Koch (2014) conjecture that cultural linkages, in particular the requirement to speak the local language, will constitute a barrier to offshoring. Hence, the offshoring potential of a certain task in Germany will be lower if it requires German language skills. This assumption appears quite plausible and it seems particularly relevant in a country like Germany, as opposed to anglophone or hispanic countries, since German is not an official language in any of the typical low-cost offshoring source countries. To pick up the typical examples, call center workers in the Philippines or radiologists reading x-rays in India might fail to overcome the language barrier when delivering their services to Germany, but not in case of the US. I capture the language dimension in the data by the level of German writing skills required for the employees to perform their tasks.

As a further measure capturing cultural linkages, I include the requirement of legal skills, as introduced by Brändle and Koch (2014). Since legal systems vary substantially across countries, performing a task that requires knowledge of law in Germany is presumably tied quite closely to knowledge of the German legal system. Similar to the variable measuring German writing skills, jobs that require legal knowledge are hence less easily delivered from a foreign country. Thus, the legal skill requirement enters negatively in the offshoring potential indicator.

Finally, several authors have argued that more routine and codifiable tasks are more likely to be offshored because they are more easily communicated and monitored across distance. It has been shown by Becker et al. (2013) that offshoring leads to a shift in domestic employment towards non-routine tasks, which suggests that routine tasks have been moved abroad. These characteristics can also be captured in the BIBB data by two explicit questions asking whether the employee's tasks are constantly repeating (routines) and whether the execution of tasks is stipulated in detail (codifiability). However, these characteristic do not seem to be specifically tied to the *international* relocation of tasks, but may more strongly influence the tradability of a task on markets, i.e. the potential to outsource the task, either domestically or internationally (see also the discussion in Brändle and Koch, 2014). Codifiability and routines are therefore not included in the baseline measure for offshoring potential, but they enter with a positive weight in the alternative measure computed for 2006-2012. Also, the classifications proposed by Spitz-Oener (2006) as well as Becker et al. (2013) are also used in robustness analyses.

Table 2.1 summarizes the task characteristics that are predicted to affect the offshoring potential and how they are captured in the BIBB data waves of 1999, 2006, and 2012.

[16] In the surveys of 2006 and 2012, computer use can be measured as a continuous variable (percent of working time), which is used for my alternative measure.

Table 2.1: Task characteristics affecting offshoring potential

characteristic	measurement in BIBB data	influence on offshoring potential
proximity	Blinder (2009) classification of occupations by the requirement to conduct their typical tasks physically close to the work station or customer, transferred to Germany by Schrader and Laaser (2009) (4-scale)	-
interactivity[a]	Daily work involves bargaining. (0-1)	-
ICT[b]	Use of computer (0-1)	+
writing	Level of German writing skills required (3-scale)	-
legal[c]	Level of knowledge of German law required (2-scale or 3-scale)	-
routines[d]	The operation cycles of work are exactly and constantly repeating. (4-scale)	+
codifiability[d]	Every step of the execution of tasks is stipulated in detail. (4-scale)	+

[a] The BIBB data also contain a question on contact with clients and patients in the most recent waves of 2006 and 2012, allowing for a 2-scale measure to be used in computing $\Omega_{2006-12}$.
[b] Binary coding of ICT is used for Ω_A, but a continuous measure, available only in 2006 and 2012, was used in generating $\Omega_{2006-12}$.
[c] A 3-scale measure of legal knowledge requirements is available only in 2006 and 2012.
[d] Routineness and codifiability are not included in Ω_A, but only in $\Omega_{2006-12}$.

Main measure of offshoring potential used in this study

Due to the variety of relevant task characteristics affecting the offshoring potential, this study takes a broad approach to measuring it. As a baseline indicator, I adopt a variant of the measure developed by Brändle and Koch (2014), which accounts for several different aspects of offshoring potential and can be implemented with the rich and representative BIBB data for Germany. Several previously used measures that capture a subset of the dimensions are used as alternatives.

I have established above that several task characteristics, grounded in the offshoring literature, may affect the offshoring potential. Due to this multi-dimensionality, the question arises how to weight these components when constructing an index of offshoring potential.

Instead of using equal weights or some subjective weighting scheme, I follow Brändle and Koch (2014) by employing principal component analysis (PCA), a data-driven method, to weight the individual task characteristics. The method helps to reduce the information contained in a large number of potentially correlated variables by creating uncorrelated linear combinations of them. Technically, the first component received from the PCA maximizes the overall explained variance in the data, whereas the second maximizes the variance among all unit length linear combinations that are uncorrelated with the first component, and so forth. If all resulting principal components are taken together, they contain exactly the same information as the underlying variables. For the purpose of this study, the second principal component from the PCA, which fulfills the expectations imposed by theory (as indicated in the last column of Table 2.1), is used to weight the individual task characteristics. Against the background of the rich information on task characteristics that potentially affect the offshoring potential, it is therefore my preferred method for computing the index of offshoring potential. Moreover, this approach has the advantage of not requiring some arbitrary choice of weights by the researcher, which would otherwise be necessary in this context.

For my baseline measure Ω_A, the resulting index is computed at the level of the individual employee as follows:

$$\Omega_A = -0.8301 \text{ proximity} - 0.2959 \text{ interactive} + 0.3721 \text{ ICT} - 0.0395 \text{ writing} - 0.2886 \text{ legal} \quad (1)$$

and then aggregated over all individual employees at the industry level.[17]

Table A.3 lists the ten sectors with the highest and those with the lowest offshoring potentials according to the baseline measure Ω_A. The greatest potential for offshoring based on the task composition is predicted for the computer and insurance industries, which seems quite intuitive, followed by a number of manufacturing industries. The lowest offshoring potentials are measured in the hotel and restaurants, education, and health industries, which is in line with intuition as well. Only the relatively low rank of research and development may be somewhat surprising from an economist's point of view. However, it seems less of an outlier if we think of experimental research or similar activities, which are closely tied to a location in some cases. All in all, the preferred measure Ω_A, which uses an objective method to weigh the several dimensions of offshoring potential, delivers results that appear in line with subjective judgement.

Alternative measures of offshoring potential

Due to the large variety of alternative measures available and the lack of consensus in the literature on an ideal measure, I also employ several alternative approaches to measuring offshoring potential, which are used to examine the robustness of my results. These are summarized in Table 2.2. As a first alternative, I construct a measure similar to the main one, which is based on a PCA using only the most recent BIBB surveys of 2006 and 2012. This index includes questions on routines and codifiability of tasks in addition to those contained in Ω_A.[18] Using only data from 2006 and 2012 allows for better comparability of the survey questions over time and for exploiting more detailed responses for some questions. However, it comes at the cost of using less data to construct the index, resulting in less than 30 observations for some smaller industries.

Table 2.2: Overview of alternative measures of offshoring potential

Ω_A	Main measure, including: interactivity, proximity, writing, legal (negative), ICT (positive), weighted by PCA, 1999-2012
$\Omega_{2006-12}$	Including: interactivity, proximity, writing, legal (negative), ICT, codifiability, routines (positive), weighted by PCA, 2006-2012
non-routine (BEM, lenient) interactive (BEM, lenient)	Share of tools used by a person that indicate non-routine or interactive activities as classified by Becker et al. (2013, BEM, their lenient definition)
	Share of tasks that fall into the respective category of the classification by Spitz-Oener (2006, S-O):
routine manual (S-O)	e.g. tasks such as 'running or equipping a machine' with many routines and a manual component.
routine cognitive (S-O)	e.g. calculating, book-keeping, measuring.
non-routine analytical (S-O)	e.g. researching, analyzing, designing.
non-routine interactive (S-O)	e.g. negotiating, coordinating, buying, advising customers.
non-routine manual (S-O)	e.g. repairing houses, vehicles or machinery, serving or accommodating.
$\Omega_{Blinder}$	Includes only the index introduced by Blinder (2009) as a measure for offshoring potential.

Second, I use the tool-based measures of interactivity and routines proposed by Becker et al. (2013, their lenient definitions), which are computed for the 1999 wave of the BIBB data.[19] This method exploits a set of

[17]Restricting the computation to employees in service occupations results in a similar ranking of industries. However, it seems to be more prone to outliers due to the small numbers of observations in some industries. I therefore prefer the aggregation based on the entire BIBB sample.

[18]The alternative measure is computed as

$$\begin{aligned}\Omega_{2006-12} = &- 0.7159 \text{ proximity} - 0.3526 \text{ interactive} + 0.474 \text{ ICT} \\ &- 0.0175 \text{ writing} - 0.308 \text{ legal} + 0.1326 \text{ routines} + 0.1604 \text{ codifiability}.\end{aligned}$$

[19]Unfortunately, these questions are not asked in similar detail in the surveys of 2006 or 2012.

questions on the tools used at work and is based on the authors' judgement as to whether these tools indicate non-routine or interactive activities.

The third alternative employs the classification of all tasks into five categories: non-routine interactive, non-routine analytic, non-routine cognitive, routine manual, and routine cognitive. This approach was first proposed by Spitz-Oener (2006) and has been applied to the offshoring context by Hogrefe (2013).

Finally, in one variant I rely exclusively on the measure of physical proximity $\Omega_{Blinder}$ that is based on Blinder's (2009) ranking of occupations. This specification essentially amounts to giving a weight of one to proximity and zero to all other components of $\Omega_{2006-12}$.

For all of these measures, industry-level averages are computed over the employees surveyed in the BIBB data. The resulting indicators reflect the task composition of the typical employee in each industry over the time period 1999-2012. They will be used in regression analysis below to measure the offshoring potential Ω.

3 Descriptive evidence

This section outlines the evolution of services offshoring over the period 2001-2012 referring to aggregate data and then describes the micro-dataset on German firms that is subsequently used for in-depth analyses.

3.1 Developments in aggregate services trade

From 1980 to 2012, nominal services trade worldwide has increased approximately by a factor of ten to twelve and it has increased almost threefold since 2001. The share of services trade in world GDP rose by 25-31%, reaching 5.6-6.0 percentage points in 2012. This rise is comparable to the share of goods trade, which increased by one third over the same period, reaching 25% of world GDP in 2012.[20] This development is mirrored by the fact that the share of services trade in overall trade (in goods plus services) increased over the 1980s and has since fluctuated between 18% and 20%. The sole exception constitutes the crisis year 2009, where the share of services in trade was higher due to the 'crisis resilience' of services relative to the particularly severe drop in goods trade (Borchert and Mattoo, 2009).

Over the entire period observed, Germany has been the world's second largest importer of services (after the U.S.) and the third largest exporter of commercial services (after the U.S. and the U.K.). Still, the relative importance of services trade in Germany appears rather small. In 2001, services imports amount to merely 7.5% of GDP, while services exports make up only 4.5% of domestic production. Both shares rise over the period 2001-2012. However, while exports catch up enormously and constitute 7.4% of GDP by 2012 (an increase of 66%), services imports rise by less than one percentage point, corresponding to only 11% nominal growth. These observations indicate that the importance of services trade is growing, but less rapidly than innovations in communications technology might suggest. Also, growth in German services imports, which I interpret as services offshoring in this study, is much smaller than on the export side.[21]

This finding hints to the reason why a public debate on services offshoring is almost entirely absent in Germany. It also begs the question of what is preventing firms from exploiting obvious international factor price differences to their benefit. This puzzle motivates the search for determinants of and barriers to services offshoring conducted in this paper.

3.2 Services offshoring by German firms

Drawing on the combined micro-dataset introduced in Section 2, the magnitudes and recent trends described above can be broadly confirmed at the firm level for 2001-2012, though the SITS data do not lend themselves readily to compute the aggregate balance of payments for services (see Biewen et al., 2013).

Two overlapping samples are used for the subsequent descriptive statistics and the regression analysis below. The first sample, which I call the *full sample*, comprises all firms from SITS that report positive services imports in the categories of interest, irrespective of whether information on firms balance sheets etc. from USTAN is available or not. The second, *combined sample* consists of the overlap of SITS and USTAN, including

[20] These numbers derive from commercial services trade flows (excluding government services) from the WTO statistics database (see `http://stat.wto.org/Home/WSDBHome.aspx`) and current GDP from the Worldbank's WDI. Aggregate trade flows based on imports or exports differ due to large measurement error and reporting inconsistencies, in particular in the early years.

[21] For comparison: In the US, the corresponding growth rates are higher in the long run, and they are of similar magnitude for services exports and imports.

only firms for which the relevant firm characteristics are observed.[22]

Table A.4 documents the evolution of the full sample over the period from 2001 to 2012. It includes 1,640,086 observations corresponding to 73,219 firms with positive imports of 39 different types of 'other commercial services' from 245 countries (see Biewen et al., 2013, for a list). The number of observations has increased steadily over the observed time period (except for a small decline in 2009), while the number of firms fluctuates around 26,000 per year. This finding indicates that the number of service import transactions per firm has risen, which can also be observed in the monthly data.

On average, around 3,000 (or 12%) of these services importing firms are also represented in USTAN, as shown in Table A.5. Conversely, the share of USTAN firms that report positive services imports lies in the range between 9 and 12.5%. The combined sample of services importing firms in USTAN includes 6,437 firms and 349,718 observations overall. Note that the share of services importing firms shows a negative trend, while the share of services exporters rises from 2.4 to 3.8% from 2001 to 2012. USTAN firms account for approximately 24% of total services imports by German firms in 2006, as recorded in SITS. The average value of services imports is increasing over time, but much less steeply than the average export value. Hence, firm-level trends at both the extensive and the intensive margin of services trade mirror the relative development observed in aggregate data: the average German firm has become more oriented towards exporting rather than importing services over the recent past.

To get a better idea of the micro-structure of services trade, I look at services trade across service types and sectors in the year 2006, the middle of my panel. As mentioned in the previous section, service trade flows are differentiated by the type of service provided in SITS. Dividing these service types into broad categories (as detailed in Table A.1), the patterns of Table A.7 emerge. In the cross-section in 2006, other business services are imported by the largest number of firms, followed by transport and insurance services. The largest value of cross-border services transactions captured in the data accrues to transport services, which are not examined further, followed by insurance and other business services. Exports show a similar ranking.

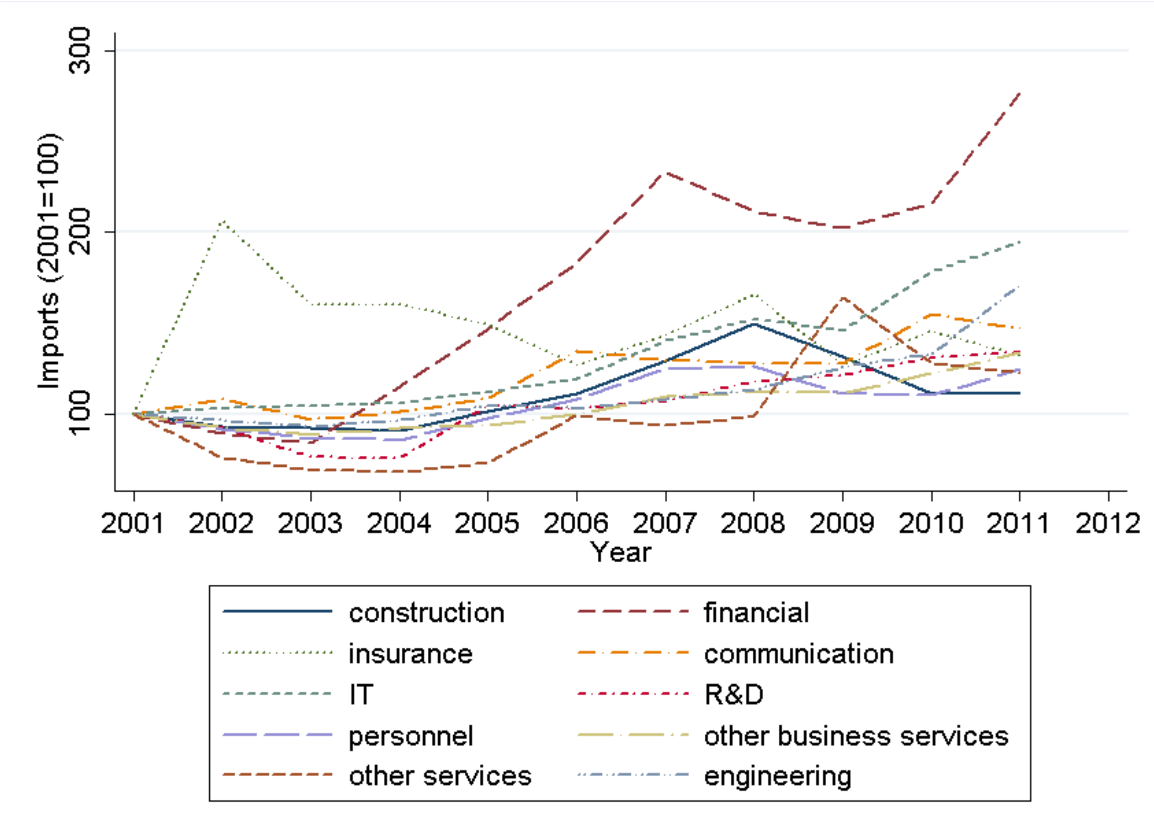
The relative growth of other commercial services imports by category is illustrated in Figure 3.1. The highest, quite spectacular growth rate over the period 2001-2011 is observed in financial services (above 8% per annum), followed by IT and communication services. Offshoring values in most categories exhibit yearly growth rates of around 4% (in nominal terms). Also, the financial crisis is visible in almost all categories in 2009 and obviously hit financial services the hardest, which have however recovered by 2011. Only imports in the residual category of 'Other services' increased significantly in 2009. Hence the proclaimed 'resilience' of services trade in the recent crisis (Borchert and Mattoo, 2009) cannot be confirmed for all services imports in Germany. The decline was, however, smaller than in goods trade for most services.

The cross-sectoral pattern in the USTAN dataset is illustrated in Table A.8 for the year 2006. An interesting picture emerges, revealing that the share of firms that conduct services offshoring is highest in manufacturing. More than one fifth of the observed manufacturing firms import services, while this share amounts to approximately 7-8% in all other non-primary sectors, including the services sector. Even more surprisingly, the share of services exporters is also highest in manufacturing. One reason for this pattern may lie in the structure of the USTAN dataset.

Finally, Table A.6 provides summary statistics for all variables used in my regression analyses for both

[22]Two comments are in order. First, the 'full' sample does not correspond to all available data in SITS due to the selection of service categories outlined in Section 2.1. Second, MiDi does not enter in the definition of my samples since MiDi data are perfectly matched to SITS via identical firm IDs: This allows for perfect identification of all multinational enterprises (defined by the MiDi reporting threshold) in SITS; if a firm does not show up in MiDi, it is thus coded as a non-multinational.

Figure 3.1: The evolution of services offshoring by service category



samples. The average values of the observed services imports are very similar, suggesting no large, systematic differences between the two samples. Still, USTAN firms are known to be larger and more likely to be located in Western Germany than the representative firm (Stöss, 2001), so there will likely be some significant differences in the firm characteristics, which are unobserved for SITS-only firms. For this reason, I conduct the regression analysis below for both samples, where possible, to establish robustness.

4 Firm-level gravity model for services

This section sketches a one-sided firm-level gravity model of services trade to motivate the empirical analysis. It takes the simple theory of services offshoring by Head et al. (2009) to the firm level and adds the task composition of industries, determining their offshoring potential, as an important factor influencing services imports. Note that this theory is not derived formally, but merely outlined to provide some guidance for the specification of my empirical model.

A generic gravity model

The basic premise of the model is that firms can buy a service directly from abroad, i.e. they can fill a position with a service worker from a foreign country instead of employing one in the domestic economy. This assumption differs markedly from traditional trade theory, in which labor can only be traded indirectly, embodied in goods. In contrast, in this model, services can be delivered directly to a foreign country, e.g. through modern communication technologies or via (temporary) physical presence of a foreign worker.[23] As mentioned in the introduction, this setup reflects the core idea of 'trade in tasks' (Grossman and Rossi-Hansberg, 2008) even more explicitly than in the case of trade in intermediate goods. Services offshoring means that the task itself is traded across the border, whereas material offshoring involves indirect imports of tasks embodied in intermediate goods.

If firm i chooses source country j for the purchase of service S of type s by minimizing the cost of delivery, we can derive a gravity-type equation for services trade by assuming a specific functional form for the cross-country distribution of productivity, similar to Eaton and Kortum (2002). Bilateral services imports will then depend on characteristics of the importer (such as labor demand) as well as wages and productivity of the source country (this is shown in Head et al., 2009).

In a frictionless world, where services can be delivered internationally at zero cost (and undiminished quality), firms will always buy each service from the lowest cost location. However, if delivering a service costs an additional τ units per unit of the service, these costs will affect the firm's decision. We obtain a generic gravity equation

$$S_{ijs} = f(\mathbf{X}_i, \mathbf{Y}_j, \tau_{ij}), \tag{2}$$

where $\mathbf{X}_i$ and $\mathbf{Y}_j$ collect relevant characteristics of the importing firm and the exporting country. I assume a multiplicative form of equation (2) and estimate it in log-linear form, which is the standard approach in the empirical literature on goods trade and has been adopted by researchers analyzing services trade (cf. Head and Mayer, 2014).

Empirical implementation

The empirical implementation of the gravity model (2) proceeds in three steps, identifying the effects of different variables on services offshoring: (i) source country characteristics and bilateral trade cost variables, (ii) firm characteristics, and (iii) task characteristics varying at the industry level. I add a time index t for each year, since my data has a panel structure, and an index k for each industry, which nests the firm index i because I do not observe multi-product firms. Due to the high dimensionality of the data, large sets of fixed effects are

[23] The former is captured by GATS mode 1 and the latter refers to GATS mode 4 in the data.

used to control for both observed and unobserved heterogeneity across service types, countries, industries, and firms.

My first specification provides micro-level evidence on macroeconomic determinants of services offshoring. It seeks to explain services imports S, defined as imports of services of type s by firm i in sector k from country j in the year t by the following empirical model:

$$\ln S_{ijkst} = \alpha + \boldsymbol{\gamma}\mathbf{T}_{jt} + \beta_i\delta_i + \beta_{st}\delta_{st} + \boldsymbol{\mu}\mathbf{MR}_{jt} + \varepsilon_{ijkst}\,. \tag{3}$$

The vector $\mathbf{T}_{jt}$, includes the source-country specifics and bilateral 'gravity' variables of interest: source country GDP and GDP per capita, as well as the following trade cost proxies: logged distance from Berlin, time zone difference, a set of dummies for a common border, language, colonial past, or origin of the legal system and a dummy indicating a Free Trade Agreement (FTA) that includes provisions for services.[24]

To identify the effect of components of $\mathbf{T}_{jt}$ from unobserved multilateral resistance (Anderson and van Wincoop, 2003), I control for trade costs between the source country and Germany relative to all other countries, as proposed by Baier and Bergstrand (2009). These proxies for multilateral resistance are summarized in the vector $\mathbf{MR}_{jt}$. The preferred specification further includes fixed effects for each firm (δ_i) and time-varying service type effects (δ_{st}). Among other things, they control for the average effect of the firm characteristics discussed below, as well as the task composition, the sectoral pattern of comparative advantage, macroeconomic shocks, and type-specific supply shocks. Model (3) is preferably estimated for the entire SITS sample, since it does not require availability of firm characteristics from USTAN provided that firm dummies capture this heterogeneity well.[25]

The second model examines the role of firm heterogeneity for services offshoring explicitly. Its most demanding specification reads

$$\ln S_{ijkst} = \alpha + \boldsymbol{\xi}\mathbf{X}_{ikt} + \beta_i\delta_i + \beta_{jt}\delta_{jt} + \beta_{kt}\delta_{kt} + \beta_{st}\delta_{st} + \varepsilon_{ijkst}\,, \tag{4}$$

where I am interested in the role of the firm characteristics collected in the vector $\mathbf{X}_{ikt}$: the natural logarithm of total factor productivity (TFP), capital intensity, equity, and asset tangibility (defined as the share of tangible assets over tangible plus intangible assets), as well as the firm's age, and dummies indicating if the firm is a goods exporter or a services exporter, or if it owns an affiliate in the source country. I also control for differences in size (turnover brackets) and legal form with sets of dummies. In addition to the time-varying service type effects δ_{st}, (4) also features time-varying country effects δ_{jt}, which now control for the elements of $\boldsymbol{\tau}$ as well as multilateral resistance and unobserved source country effects. Since firm characteristics vary over time and within industries, their impact on services offshoring can be identified from a specification including firm dummies δ_i and time-varying industry fixed effects δ_{kt}. Naturally, model (4) can only be tested on the (smaller) combined sample for which firm characteristics from USTAN are available.

The literature on trade in tasks posits that there are fundamental differences in the international tradability of tasks. As discussed above, several task characteristics affect their tradability and hence the scope for offshoring. To capture this idea, I explicitly account for the offshoring potential Ω_k in the gravity equation for

[24] Summary statistics of all variables in both samples are prvided in Table A.6.

[25] To verify comparability of the two samples, (3) is also estimated for the combined sample, including firm characteristics. This yields similar results, which are available from the author upon request.

services. Ω_k reflects the industry-specific task composition, which is fundamentally determined by production and offshoring technologies. For instance, firms in the health and education sector need to deliver most of their services personally, by virtue of their economic activities, while firms in the IT sector are more intensive in programming and similar tasks, which can be delivered from distance at a similar level of quality. These differences are reflected in the industry rankings shown in Table A.3. Since task characteristics are important factors determining the offshoring potential, they should be accounted for in the gravity equation for services. To examine whether the task composition is indeed a relevant determinant of offshoring and to test how it relates to services imports, I augment the previous specification with the term Ω_k capturing the industry-specific offshoring potential:[26]

$$\ln S_{ijkst} = \alpha + \boldsymbol{\omega}\Omega_k + \boldsymbol{\xi}\mathbf{X}_{ikt} + \boldsymbol{\iota}\mathbf{I}_{kt} + \beta_{jt}\delta_{jt} + \beta_{st}\delta_{st} + \varepsilon_{ijkst}. \tag{5}$$

Since my measures of Ω_k do not vary over time or within industries, the corresponding dummies are dropped from the regression and replaced by observable industry characteristics $\mathbf{I}_{kt}$, namely labor costs, the input structure (capital intensity), and the asset structure (tangible assets over total assets). The model (5) is estimated by OLS both for the full sample (without firm controls $\mathbf{X}_{ikt}$) and for the combined sample.

I further examine how the effect of Ω_k varies over time using a variant of (5), which includes interaction terms for the offshoring potential measure with year dummies $\omega_t\Omega_k \times \delta_t \,\forall t$ and which controls for sector-specific effects δ_k.

In another modification, the dependent variable $\ln S$ is replaced with the logged growth rate of services trade $\Delta S_t \equiv \ln S_t - \ln S_{t-1}$. Due to the strongly unbalanced nature of the firm-service type-country panel, growth rates are analyzed for different aggregations at the level of the (i) firm and (ii) firm-service type combinations.

The last variant of model (5) scrutinizes which firms can exploit existing opportunities for services offshoring better in sectors characterized by high offshoring potential. International trade theory and numerous empirical studies suggest that more productive firms can overcome trade barriers and bear fixed costs more easily. To examine how this advantage varies with sectoral task characteristics, I interact firm-level TFP with Ω_k.

[26]The definition of Ω as a sector characteristic is, of course, driven by the availability of data. In principle, there certainly exists some relevant variation in Ω within industries that one would preferably like to capture. Nevertheless, due to the technological nature of the task composition, a large part of the variation in Ω will arguable be across sectors and can be meaningfully exploited, which is confirmed by the results shown in Section 5.

5 Results

In this section, the gravity model is estimated to identify the drivers of services offshoring at the country, sector, and firm level. It first considers an extended set of the classical gravity covariates specific to the source-country or the bilateral trading relationship. In the second part, determinants of services offshoring at the firm level are examined. Third, I investigate in more detail how the industry-specific task composition determines offshoring behavior.

5.1 Macroeconomic determinants

Table 5.1 develops the model in equation (3) by successively adding additional control variables. Most results are qualitatively similar across these variations.[27] In all specifications, the productive capacity of the source country, approximated by GDP, increases imports, and so does GDP per capita. The latter may proxy the productivity or skill abundance of the source country, which should foster imports of the commercial services that I examine in this study. However, if GDP per capita captures average wages, this would suggest a negative impact on trade. For German firms, the former effect seems to dominate; they tend to offshore more services to richer countries.

Physical distance exerts a negative impact on services imports at the firm level, too, but the estimated elasticity of around -0.2 is much smaller than studies using aggregate trade flows between many countries suggest.[28] Also, Breinlich and Criscuolo (2011) find a much stronger effect using UK firm data. Interestingly, my micro-level results confirm the net positive effect of time zone differences on services imports found by Head et al. (2009). This effect is small but robust across specifications, for which I suggest three alternative explanations. First, this finding may reflect what Head et al. (2009) call the 'continuity effect': as time zone differences get larger, services can be delivered around the clock from different locations. This positive effect seems to dominate the adverse effect that time zone differences have on the cost of communicating during business hours. Second, the positive effect of time zone differences in combination with a negative effect of distance may be due to a non-linear effect of distance, but I do not find systematic evidence supporting this explanation in further regressions. Third, the fact that there is less South-North trade than East-West trade in services might explain my finding. Conditional on distance, German firms import less from African countries that are in the same time zone compared to North America or Asia for other reasons not captured well by the gravity model, such as productive capacity specific to the service sector.

The positive effects of common official language, origin of the legal system, currency, and colonial link are in line with expectations. More surprisingly, sharing a border or an FTA that includes provisions for services does not seem to increase German firms' services imports, after controlling for all other trade cost proxies. The coefficients on these two variables even turn out negative, which seems counterintuitive at first. The explanation for the first finding may be similar as in the case of time zone differences.[29] The services FTA dummy may be a very crude proxy of political barriers to services trade and it seems to be more relevant for exports, but a negative role seems implausible nevertheless. I suspect a collinearity issue, which leads the FTA dummy to pick up the effect of some other common feature of FTA partner countries, such as high wages. Finally, German

[27] There are only two exceptions: identification of a positive language effect hinges on controlling for time-varying service type-effects and the positive effect of a common legal origin is only visible after controlling for multilateral resistance.

[28] Kimura and Lee (2006) report elasticities between -0.6 and -0.7, and they are even below -1.2 in Head et al. (2009).

[29] In the case of Austria and Switzerland, the only two countries sharing an official language with Germany, a part of the border effect also may be attributed to the language dummy.

firms also tend to trade more services with landlocked countries, which deviates from standard results in the goods trade literature, where remoteness and inferior accessibility are typically found to decrease trade. This different finding may be rationalized by the intangible nature of services trade, which does not typically enter or exit a country through a port, except in case of the presence of natural persons (GATS mode 4).

Table 5.1: Macroeconomic determinants of services offshoring

	(1)	(2)	(3)	(4)	(5)	(6)
ln GDP	0.116***	0.0972***	0.185***	0.181***	0.184***	0.181***
	(0.00479)	(0.00669)	(0.00658)	(0.00953)	(0.00658)	(0.00953)
ln GDP per capita	0.0802***	0.0501***	0.0917***	0.0587***	0.0915***	0.0586***
	(0.00602)	(0.00567)	(0.00538)	(0.00568)	(0.00539)	(0.00567)
ln distance	-0.162***	-0.173***	-0.190***	-0.213***	-0.190***	-0.213***
	(0.0100)	(0.0106)	(0.00755)	(0.00757)	(0.00753)	(0.00754)
time zone difference	0.0169***	0.0132***	0.0174***	0.0163***	0.0174***	0.0164***
	(0.00262)	(0.00265)	(0.00236)	(0.00241)	(0.00235)	(0.00241)
border	-0.163***	-0.191***	-0.135***	-0.195***	-0.134***	-0.195***
	(0.0136)	(0.0176)	(0.0129)	(0.0162)	(0.0128)	(0.0162)
language	-0.0149	0.0167	0.0417***	0.0824***	0.0412**	0.0822***
	(0.0161)	(0.0182)	(0.0162)	(0.0177)	(0.0162)	(0.0177)
legal origin	-0.0374***	0.0659***	-0.00572	0.0966***	-0.00465	0.0969***
	(0.0137)	(0.0167)	(0.0135)	(0.0153)	(0.0135)	(0.0153)
currency	0.138***	0.150***	0.113***	0.120***	0.113***	0.119***
	(0.00970)	(0.0102)	(0.00965)	(0.0102)	(0.00965)	(0.0102)
colony	0.233***	0.286***	0.243***	0.309***	0.242***	0.308***
	(0.0269)	(0.0278)	(0.0216)	(0.0227)	(0.0215)	(0.0227)
services FTA	-0.144***	-0.0882***	-0.140***	-0.0643***	-0.140***	-0.0635***
	(0.0129)	(0.0137)	(0.0123)	(0.0130)	(0.0123)	(0.0131)
landlocked	0.115***	0.117***	0.175***	0.202***	0.174***	0.202***
	(0.0175)	(0.0174)	(0.0134)	(0.0136)	(0.0134)	(0.0136)
service type & year effects	yes	yes	yes	yes	nested	nested
service type × year effects	no	no	no	no	yes	yes
firm effects	no	no	yes	yes	yes	yes
multilateral resistance proxies	no	yes	no	yes	no	yes
R^2	0.088	0.090	0.090			
R^2 (within firm)				0.092	0.092	0.094
Observations	1,611,450	1,607,325	1,611,450	1,607,325	1,611,450	1,607,325
Firms	72,748	72,705	72,748	72,705	72,748	72,705

Dependent variable: ln services imports: ln S_{ijkst}.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Overall, these findings are comparable to those obtained from macro-level gravity equations for services and other firm-level studies. However, the explanatory power of my micro-level gravity equation is relatively low since it considers imports at the level of the country, firm, and 39 service types. The preferred model explains only close to 10% of the variation in services imports. For comparison, Head et al. (2009) report a much higher R^2 of 80%. This difference indicates that aggregate services trade flows mask substantial unexplained heterogeneity. In the next step, we thus turn to studying firm-level determinants of services offshoring.

5.2 Firm characteristics

Table 5.2 shows the results of estimating (4), which confirm that firm heterogeneity is an important feature of services offshoring. In the pooled cross-section (columns 1-2), more productive firms in terms of TFP import more services.[30] This finding is in line with previous firm-level evidence on services trade (see, e.g. Breinlich and Criscuolo, 2011) and may reflect either selection of the best firms into offshoring or productivity improvements due to offshoring or both. Size dummies also show the expected pattern: larger firms trade more. This size premium amounts to around 50% for the largest firms (with a turnover above 500 million €) compared to the smallest ones (below 5 million €).[31]

Table 5.2: Firm-level determinants of services offshoring

	(1)	(2)	(3)	(4)	(5)
ln TFP	0.0879**	0.0877**	0.0433	0.0315	0.0221
	(0.0378)	(0.0375)	(0.0431)	(0.0407)	(0.0356)
ln capital intensity	-0.0263	-0.0289*	-0.000412	0.00489	-0.000112
	(0.0176)	(0.0173)	(0.0183)	(0.0171)	(0.0167)
ln equity	0.126***	0.130***	0.00224	0.00178	0.00452
	(0.0228)	(0.0231)	(0.0168)	(0.0167)	(0.0147)
ln asset tangibility	-0.102**	-0.104**	-0.0282	-0.0356	-0.0407
	(0.0452)	(0.0458)	(0.0383)	(0.0362)	(0.0343)
age	-0.000776	-0.000712	0.00888**	-0.170	0.261
	(0.000487)	(0.000476)	(0.00379)	(34.32)	(17.41)
goods exporter dummy	0.00740	0.0206	0.0154	0.0126	0.00612
	(0.0486)	(0.0478)	(0.0224)	(0.0219)	(0.0201)
services exporter dummy	0.203***	0.194***	0.0712**	0.0688**	0.0582**
	(0.0413)	(0.0381)	(0.0296)	(0.0273)	(0.0250)
foreign affiliate dummy	0.623***	0.607***	0.549***	0.538***	0.533***
	(0.0658)	(0.0671)	(0.0497)	(0.0499)	(0.0530)
size and legal form dummies	yes	yes	yes	yes	yes
sector effects	yes	nested	nested	nested	nested
service type, country, and year effects	yes	nested	yes	nested	nested
sector × year effects	no	yes	no	no	yes
service type × year effects	no	yes	no	yes	yes
country × year effects	no	yes	no	yes	yes
firm effects	no	no	yes	yes	yes
R^2	0.189	0.204			
R^2 (within firm)			0.132	0.143	0.144
Observations	349,718	349,718	349,718	349,718	349,718
Number of firms	6,437	6,437	6,437	6,437	6,437

Dependent variable: ln services imports: $\ln S_{ijkst}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Capital intensity of German firms is not a significant driver of services offshoring and correlates weakly

[30] Similar results obtain if TFP is substituted with labor productivity in terms of value added over labor costs.

[31] Size dummies, as well as indicators of the legal form of the firm, are jointly (but not always individually) significant in each specification. Their coefficients are not reported in the regression tables to save space.

negatively (if at all) with the value of services imported. This finding contrasts with the results found in research on goods trade and may be due to the fact that a higher skill (or *human* capital) intensity increases the total wage bill of the firm, which is used as the denominator of capital intensity. If firms with a more skilled workforce offshore more (relatively unskilled) tasks, the effect of capital intensity should indeed be negative. A larger measure of asset tangibility (i.e. tangible assets over tangible plus intangible assets) may indicate less innovative firms (with relatively less intangible assets) or better access to finance due to more collateralizable assets. Asset tangibility is negatively related to services offshoring in the cross-section, indicating that innovative firms import more services. There might however also be a positive effect of financial health as equity enters with a positive sign. Neither the age of the firm nor its status as a goods exporter seem to explain the amount of services imports.

Other international activities, captured by dummies for being a services exporter or owning a foreign affiliate in the source country, do increase services offshoring significantly. These are also the only firm characteristics that remain significant after controlling for all firm-specific effects that are constant over time in columns 3-5 of Table 5.2. The preferred specification in column 5 identifies the impact of $\mathbf{X}$ within the firm, whereby controlling for any time-varying country-, sector-, and service type-specifics. Results from this specification suggest that firms import approximately 6% more (than non-exporters) if they also export services in the respective year. This finding suggests substantial complementarities of both activities at the firm level. Owning a foreign affiliate even increases imports by more than 50%, which points to the great importance of intra-firm trade for services offshoring.[32]

5.3 Industry-level task composition

How does services offshoring depend on the tradability of tasks? To answer this question, I estimate the model (5), which examines whether firms in industries characterized by a high share of offshorable tasks, i.e. a high offshoring potential, import more or less services. Table 5.3 reports the results for different variants of specification (5) using the preferred measure for offshoring potential Ω_A. Results are shown both for the full sample (columns 1-4), which has the advantage of exploiting all available observations, and the combined sample (columns 5-8), which allows for controlling firm characteristics in addition, but is likely to be selective.

In all specifications, I estimate a highly significant negative value of $\hat{\omega}$, the coefficient on the offshoring potential. The regressions reveal that German firms offshore more services in industries where the potential for offshoring, as observed by the typical tasks of its workforce, is low. This finding indicates that, on the one hand, industries that use few offshorable tasks domestically already source more services from abroad. On the other hand, firms in industries with a high offshoring potential offshore relatively little, but they have those tasks done domestically instead. Put differently, if the tasks performed by the typical employee in an industry are *highly* offshorable, firms in this industry are observed to import *less* services.

The negative correlation is found already in the simplest specification, controlling only for one-dimensional effects in the full, pooled sample. It appears even stronger after controlling for sectoral differences in labor costs, the input structure (capital intensity) and asset structure (share of tangible assets) as well as time-varying country- and service type-effects (see column 4 of Table 5.3). As expected, higher labor costs, the opportunity costs of offshoring, are strongly associated with more services offshoring, although measurement error in this variable is presumably large (see Section 2). Restricting the regression to the combined sample and controlling for the full set of firm-specifics results in estimates $\hat{\omega}$ of a similar magnitude.

[32]While I cannot identify intra-firm trade explicitly in my dataset, this feature warrants more attention in future research.

Table 5.3: The role of offshoring potential for services

sample	full				combined			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ω_A	-0.120***	-0.426***	-0.120***	-0.433***	-0.222**	-0.385***	-0.214**	-0.371***
	(0.0403)	(0.0491)	(0.0402)	(0.0496)	(0.0981)	(0.118)	(0.0976)	(0.117)
ln sectoral labor costs		0.969***		0.980***		0.466***		0.454***
		(0.102)		(0.104)		(0.148)		(0.147)
ln sectoral capital intensity		-0.0383		-0.0462		-0.0648		-0.0643
		(0.0334)		(0.0348)		(0.0483)		(0.0486)
ln sectoral asset tangibility		-0.102*		-0.108		-0.126		-0.158
		(0.0597)		(0.0664)		(0.232)		(0.246)
firm controls	no	no	no	no	yes	yes	yes	yes
country, service type, and year effects	yes	yes	nested	nested	yes	yes	nested	nested
country × year and service type × year effects	no	no	yes	yes	no	no	yes	yes
R^2	0.094	0.092	0.100	0.100	0.176	0.181	0.187	0.192
Observations	1,640,086	1,262,879	1,640,086	1,262,879	349,718	324,275	349,718	324,275

Dependent variable: ln services imports: $\ln S_{ijkst}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Note that these estimations cannot establish a causal effect of the task composition on services offshoring since realized offshoring itself also affects the task composition, leading to a simultaneity problem. Despite this caveat, the model (5) allows for a meaningful interpretation of $\hat{\omega}$. Instead of a causal effect, it rather aims at describing the long-run relationship between services imports and the offshoring potential in terms of the task composition. I conjecture that in the long run, the industry-level task composition is fundamentally determined by production and offshoring technologies. To the extent that no revolutionary innovations in information and communication technologies took place over the observed time span, my results capture this long-run effect. Also, it seems hard to imagine that any single firm can affect the industry-wide task composition, which is also computed over a long time frame from another dataset. To give an idea of the quantitative importance of the link between services imports and the task composition, I use the estimate from the preferred specification in column 8 of Table 5.3. It implies that a one standard deviation higher offshoring potential (in the sectoral cross-section) is associated with 17% less services offshoring.

Alternative measures of offshoring potential

To test the robustness of my findings, I examine a number of alternative indicators measuring the overall offshoring potential of industries or aspects thereof, which are substituted for Ω_A in equation (5). Table A.9 summarizes the estimation results for each alternative measure in the simplest and in the most demanding specifications, corresponding to columns 1 and 8 of Table 5.3, respectively.

The first index $\Omega_{2006-12}$ is computed in a similar way as the baseline measure and contains also measures of routineness and codifiability, but it uses only BIBB data from the years 2006 and 2012. While it does not enter significantly in the simple specification, $\Omega_{2006-12}$ has a highly significant negative effect after controlling for sectoral labor costs (not shown), which remains weakly significant in the preferred specification featuring firm characteristics.

Second, I measure the intensity of non-routine and interactive tasks by sector based on the tools used at work, as proposed by Becker et al. (2013).[33] Both variables show a strong positive and significant correlation with services offshoring in the full sample, which substantiates my previous result. If non-routine and interactive tasks are harder to offshore, those are also the sectors with a lower offshoring potential, where we observe more services offshoring. Interestingly, if I control for sectoral and firm-level variables, the effect of the non-routine category vanishes, whereas the intensity in interactive tasks appears even more important. These findings suggest that interactivity is a more important determinant of offshoring potential than routineness.

Similar results arise for sectoral intensities in the tasks classified by Spitz-Oener (2006). There, regardless of the sample or specification, I find a strong negative coefficient for the routine manual category, which includes the types of tasks that one would assume to be easily offshorable. Large and highly significant positive coefficients are estimated for the non-routine interactive and non-routine manual categories in the preferred specification. The results show that sectors intensive in non-routine interactive tasks source the largest volume of services from abroad. Again, interaction seems to be crucial, as the intensity in non-routine analytic tasks, which are similar otherwise, shows no significant correlation with services offshoring.

Finally, using only the information contained in the Blinder (2009) index $\Omega_{Blinder}$ does not yield any significant correlation. This points towards the advantage of the compound measure Ω_A in which proximity obtains a high weight, but which also takes into account the multiple other dimensions of offshoring potential.

These findings in general substantiate the main result established above: Less services offshoring takes place in sectors that employ more offshorable tasks in the domestic country.

Implications and potential explanations

This result has a number of interesting implications and may have competing explanations. First, I have shown that the task-based approach bears some relevance for explaining services offshoring. Measuring the offshoring potential from individual data and combining them to a compound indicator as in Brändle and Koch (2014) helps to understand which industries import more services as opposed to performing or buying them domestically.

A second implication is that there seemingly continue to exist substantial (unobserved) barriers that prevent services offshoring. These barriers vary across sectors and appear to be highest in those sectors where we observe a high offshoring potential in Germany. If a task is truly offshorable, i.e. it can be just as well delivered from abroad, then it should be moved to the lowest cost location if the costs are not too high. As long as Germany is not the most efficient country in the world to execute this task, we should not observe it to be done in Germany at all. This leads to the conclusion that offshoring is prevented by large barriers that I do not observe in the data, such as the explicit and implicit costs of relocation, institutional commitments, or complementarities between offshorable and non-offshorable tasks (Görlich, 2010). These barriers make it too costly to offshore the respective activities.

The third, rather speculative conclusion would be that the major part of the so-called ‘second wave of offshoring’ is yet to come, at least in Germany. My results may indicate a sizeable untapped potential for services offshoring, which has not yet been exploited. This view is strongly connected to the second implication, and both together raise the question: What are the unobserved barriers, are they going to fall in the future, and which firms can overcome these barriers?

Fourth, the observed pattern might alternatively be interpreted as a long-run equilibrium relationship, in

[33] The reported results use the lenient definition of Becker et al. (2013), but they also hold for the strict definition.

which non-offshorable tasks are conducted domestically and there are two types of tasks that can be delivered internationally. One set of tradable tasks, in which Germany has a comparative advantage, is also done in the domestic economy. The other set of tradable tasks has already been offshored and is imported from abroad. Then, more offshoring should be observed in sectors with a higher offshoring potential if the domestic, tradable tasks are complementary to the imported ones. This conclusion would contradict the third, competing explanation for the observed pattern.

To shed light on these competing hypotheses, I subsequently conduct deeper analyses of the link between offshoring potential and observed services offshoring. If the observed relationship is not an equilibrium outcome, we should observe it changing over time. In particular, if the observed correlation is an out-of-equilibrium situation, growth in services offshoring should be higher in those industries where the potential remains high. Furthermore, if large barriers continue to prevent the international relocation of tasks that would be feasible and profitable to offshore in the absence of barriers, we should observe that the most productive firms perform better at exploiting these offshoring potentials. The second deeper analysis exploits firm heterogeneity within sectors to test this hypothesis.

The effect of offshoring potential over time

In order to examine the dynamic features of services offshoring, I conduct two types of analyses. First, the effect of offshoring potential is allowed to vary over time in the pooled cross-section by interacting it with year dummies. Second, I look at the growth rates of offshoring on the left hand side of equation (5) to study the offshoring dynamics.[34]

The results from interactions of Ω_A with year dummies are summarized in Figure 5.1. It shows the coefficient estimates of these interaction terms $\omega_{t\ell}$ from four different specifications $\ell = 1, 2, 3, 4$ for each year $t = 2001, \ldots, 2012$.[35] This illustration provides at least indicative evidence that the effect of the sectoral task composition changes over time, as the coefficients on the interaction terms show an increasing tendency. They are significantly negative across all specifications in 2002 and remain so until 2009 in some cases, while they are close to zero for the years 2010-2012.

An alternative approach to study the dynamics is to examine the growth rates of services offshoring over time, defined as: $\Delta S_t \equiv \ln S_t - \ln S_{t-1}$. If firms in sectors with a high share of offshorable tasks exploit this offshoring potential over time, the growth rates of services imports should be higher in those sectors.

Computing growth rates poses a challenge, since the definition of growth rates at the firm-service type-source country level results in restricting the sample to the relatively small subset of firms that source the same service from the same country in two or more consecutive years.[36] I therefore aggregate the services trade flows and examine growth rates (i) at the firm level ΔS_{it}, and (ii) at the service type-firm level ΔS_{ist}.

Results at the firm level indicate that the growth rates of services offshoring are indeed significantly higher in sectors with higher offshoring potential, as the results in Table 5.4 show. However, estimations at the service type-firm level provide much weaker evidence of this effect, which remains insignificant in the preferred specifications (see Table A.11) after controlling for other differences across sectors and firms.

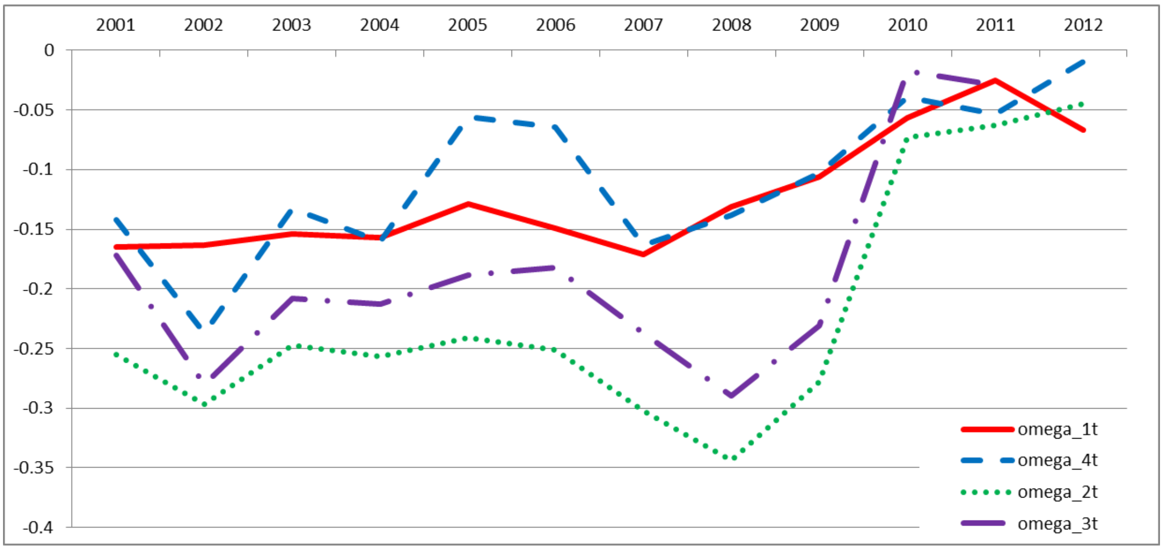
These findings rather favor the hypothesis that the negative link between offshoring potential and services imports is an out-of-equilibrium situation, as it becomes weaker over time and services offshoring seems to

[34]Note that this analysis neglects potential changes in the composition of the workforce and the tasks that it executes over time. Unfortunately, I cannot construct a time-varying measure of offshoring potential due to data constraints.

[35]The corresponding regression results are shown in Table A.10.

[36]Results from such a specification remain inconclusive.

Figure 5.1: The effect of offshoring potential over time



Notes: $\omega_{\ell t}$ is the coefficient on the interaction term of Ω_A and year dummies in four different specifications $\ell = 1, 2, 3, 4$. Specifications and regression results are shown in Table A.10.
ω_{1t} and ω_{2t} are significantly negative for each year in 2001 to 2009 (at least at 5% significance level with the exception of ω_2 in 2005 and 2006, where it is only significant at 10%). ω_{4t} is significantly negative in 2002, 2008, and 2009, while ω_{4t} is only significantly negative in 2002 (at 5%).

grow faster in those industries that host many tradable tasks. This development may be due to decreasing barriers to services trade or due to an adjustment towards an equilibrium in the presence of unchanged trade barriers.

Which firms exploit the offshoring potential?

We have seen above that larger and more productive firms tend to be more intensively engaged in services offshoring, while the average firm offshores less in sectors with a high offshoring potential. This begs the question whether different firms exploit offshoring potentials differently. On the one hand, one might expect against the backdrop of most of the recent offshoring literature (e.g. Antràs and Helpman, 2004; Kohler and Smolka, 2014) that more productive firms overcome barriers to offshoring more easily and are hence better able to exploit the existing potentials. One the other hand, the theory of trade in tasks with heterogeneous firms by Egger et al. (2013) does not suggest any difference across firms in the subset of tasks that are offshored. Still, also in such a model, productivity may have a differential effect across industries that use different subsets of tasks. To test this conjecture, we plug an interaction term of Ω_A with $\ln$ TFP into the model (5).

The results shown in Table 5.5 show no evidence of a differential effect of Ω_A for more or less productive firms. However, if the sample is split into manufacturing and service sector firms (and all other firms), a positive interaction effect is found only for the service sector firms (see column 3). There, more productive firms seem to be more able to exploit the offshoring potential. The reason may be that their higher productivity allows them to overcome the costs associated with services offshoring more easily. This advantage makes a difference if the potential is high, but it does not come to bear in industries with a low offshoring potential because there most tasks are inherently non-offshorable. However, it remains unclear, why the effect is muted in the manufacturing sector.

Table 5.4: Offshoring growth at the firm level

sample	full		combined	
	(1)	(2)	(3)	(4)
Ω_A	0.0420***	0.0213**	0.0414*	0.0525*
	(0.00615)	(0.00856)	(0.0223)	(0.0290)
firm controls	no	no	yes	yes
sector controls	no	yes	no	yes
year dummies	yes	yes	yes	yes
R^2	0.001	0.002	0.004	0.005
Observations	174,279	133,246	22,853	21,329

Dependent variable: growth in firm-level services imports $\Delta S_{it} \equiv \ln S_{it} - \ln S_{i,t-1}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.5: Interaction between offshoring potential and ln TFP

sample	combined	manufacturing	services
	(1)	(2)	(3)
$\Omega_A \times$ ln TFP	0.119	-0.0953	0.841***
	(0.111)	(0.188)	(0.234)
firm controls	yes	yes	yes
sector effects	yes	yes	yes
service type, country, and year effects	yes	yes	yes
R^2	0.189	0.206	0.237
Observations	349,718	261,639	43,673

Dependent variable: ln services imports: $\ln S_{ijkst}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusions

In this paper, I have exploited a newly combined dataset covering the universe of German firms' services trade to analyze their offshoring behavior over the period 2001-2012. Using a firm-level gravity model for trade in tasks, I have studied determinants of services offshoring at the level of source countries, firms, and tasks.

My analysis of macroeconomic determinants generally confirms that services trade follows gravity patterns, as German firms import more services from larger and richer countries. While offshoring decreases with distance, it seems to increase with time zone differences (as found by Head et al., 2009), presumably due to the advantage of delivering a service continuously around the clock. In contrast to standard results for goods trade, German firms import less services from direct neighbors but more from landlocked countries.

Regressions at the micro level confirm that larger and more productive firms offshore more services. The results point towards substantial complementarity between services exports and imports, which is surprising since many services cannot be stored or processed to be re-exported. Also, intra-firm services trade seems to be important, since ownership of a foreign affiliate in the source country is associated with more than 50% larger services imports.

To capture the offshoring potential inherent in the set of tasks used by an industry, I construct a compound indicator from several characteristics of the tasks conducted by its workforce. My results reveal that the task composition is an important factor explaining services offshoring. German firms in industries that employ less offshorable tasks domestically import significantly more services from abroad. This result is supported by a number of alternative measures of the offshoring potential.

It is also compatible with other recent findings. Capturing offshoring in a several different ways in German linked employer-employee data, Brändle (2014) finds a negative association between the offshoring potential of the workforce and actual offshoring. In a similar vein, Boockmann (2014) shows that workers in highly offshorable occupations tend to have relatively more stable jobs. All of these findings indicate that German employees in offshorable industries and occupations have not been subject to a huge wave of offshoring in the past decades. Together, these results rationalize the absence of a public debate on services offshoring in Germany.

While employees can be cheerful, this result also points towards the existence of a sizeable potential for services offshoring, which German firms do not fully exploit, presumably due to substantial remaining trade barriers. Potentially, if those barriers fall, the big wave of services offshoring lies still ahead for Germany.

I find some evidence that supports this view. First, the negative relationship between the offshoring potential and the level of services offshoring declines over time and offshoring growth is higher in industries with greater potentials. Second, in the service sector, more productive firms, which are more likely to overcome existing barriers, exploit the offshoring potential more effectively.

This paper indicates several interesting directions for future research. First, the role of firm heterogeneity in services offshoring remains to be fully understood, in particular regarding complementarities with services exports and FDI. The combined firm dataset used in this study provides a good point of departure for such deeper analyses. Second, an examination of the remaining barriers to offshoring is beyond the scope of this study. They need to be understood more profoundly, which requires further work. Finally, it remains a challenge for future research to identify the causal effect of (changes in) the task composition on subsequent offshoring.

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A Appendix

Table A.1: List of Services

Aggregate service category	Service types
Travel	17
Transport	13-16, 20, 80-82, 210, 215-217, 220, 225, 226, 233, 234, 240, 244, 260, 270, 271, 300, 319, 320, 330, 340, 360-362, 370, 560
Insurance	400, 401, 410, 420, 440-445, 450, 451, 460
Financial services	533
Communication	518, 591
Construction	561, 570, 580
Engineering	512
Computer/information services	513
R&D	502, 511
Other business services	516, 519, 523, 530, 531, 540
Personnel services	514, 517, 521
Other services	501, 503, 507, 510, 534, 562, 594, 595

The table groups all service types into broad categories for the descriptive analysis in Section 3. For details on the service types, see the documentation by Biewen et al. (2013).

Table A.2: List of Industries

Industry name	NACE Rev. 1.1 industry codes
Agriculture, forestry, and fishing	01, 02, 05
Mining and quarrying	10, 11, 12, 13
Other mining and quarrying	14
Manufacture of food products, beverages and tobacco	15, 16
Manufacture of textils, wearing apparel, dressing and dyeing of fur	17, 18
Manufacture of leather and leather products	19
Manufacture of wood and wood products, except furniture	20
Manufacture of pulp, paper and paper products	21
Publishing, printing and reproduction of recorded media	22
Manufacture of coke, refined petroleum products, chemicals, rubber and plastic	23, 24, 25
Manufacture of other non-metalic mineral products	26
Manufacture of basic metals	27
Manufacture of fabricated metal products, except machinery and equipment	28
Manufacture of machinery and equipment n.e.c.	29
Manufacture of office machinery and computers	30
Manufacture of electrical machinery and apperatus n.e.c.	31
Manufacture of radio, television and communication equipment and apparatus	32
Manufacture of medical, precision and optical instruments, watches and clocks	33
Manufacture of motor vehicles, trailers and semi-trailers	34
Manufacture of other transport equipment	35
Manufacture of furniture, manufacturing n.e.c.	36
Recycling	37
Electricity, gas and water supply	40, 41
Construction	45
Sale, maintenance and repair of motor vehicles and motorcycles; Retail sale of fuel	50
Wholesale trade and commision trade, except of motor vehicles and motorcylces	51
Retail trade, except of motor vehicles and motorcycles; Repair of household goods	52
Hotels and restaurants	55
Transport and auxiliary activities	60, 61, 62, 63
Post and telecommunications	64
Financial intermediation, except insurance and pension funding	65
Insurance and pension funding, except compulsory social security	66
Real estate activities, renting of machinery and equipment	70, 71
Computer and related activities	72
Research and development	73
Other business activities	74
Public administration, defence and compulsory social security	75
Education	80
Health, social work and veterinary activities	85
Sewage and refuse disposal, sanitation and similar activities	90
Activities of membership organizations n.e.c.	91
Recreational, cultural and sporting activities	92
Other service activities	93
Private households with employed persons	95
Extra-territorial organizations and bodies	99

Table A.3: Ranking of industries with highest and lowest offshoring potential

Top ten industries (highest offshoring potential Ω_A)			
rank	industry name	Ω_A	N
1	Computer and related activities	1.075	786
2	Insurance and pension funding, except compulsory social security	0.6886	810
3	Manufacture of machinery and equipment n.e.c.	0.6758	2001
4	Manufacture of coke, refined petroleum products, chemicals, rubber and plastic	0.6741	1895
5	Publishing, printing and reproduction of recorded media	0.6662	795
6	Manufacture of pulp, paper and paper products	0.6638	255
7	Manufacture of other transport equipment	0.6615	240
8	Manufacture of fabricated metal products, except machinery and equipment	0.6424	207
9	Financial intermediation, except insurance and pension funding	0.6069	1677
10	Manufacture of radio, television and communication equipment and apparatus	0.5737	493

Bottom ten industries (lowest offshoring potential Ω_A)			
rank	industry name	Ω_A	N
40	Manufacture of office machinery and computers	-0.2005	269
41	Retail trade, except of motor vehicles and motorcycles; Repair of household goods	-0.2377	4559
42	Construction	-0.3669	3296
43	Agriculture, forestry, and fishing	-0.3680	750
44	Activities of membership organizations n.e.c.	-0.3797	547
45	Research and development	-0.4368	1319
46	Private households with employed persons	-0.6806	161
47	Health, social work and veterinary activities	-0.8297	6889
48	Education	-0.8436	1932
49	Hotels and Restaurants	-0.8836	1108

The table lists the ten industries with the highest and lowest offshoring potential, respectively, according to the main measure Ω_A. The last column lists the number of observations in the BIBB data from which the indicator was computed.

Table A.4: Evolution of full SITS sample

year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
services imports (bn €)	86.32	104.87	91.11	92.84	96.66	98.03	107.75	116.13	111.42	118.34	122.41	129.41
services exports (bn €)	60.50	91.29	82.65	82.26	87.73	93.76	106.59	119.05	116.78	124.23	124.71	132.96
firms	23,471	26,638	26,601	25,512	24,816	25,693	26,966	27,534	26,155	26,341	26,522	25,972
observations	138,120	160,012	168,083	165,666	171,033	176,486	182,050	189,117	184,363	188,317	195,023	196,958

Table A.5: Services traders in USTAN sample

year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
share of firms importing services	11.1%	12.0%	12.5%	12.3%	11.7%	11.9%	11.5%	11.0%	10.2%	9.4%	9.0%	9.3%
services imports per firm (1,000 €)	726	748	625	672	710	736	756	795	755	861	835	960
share of firms exporting goods	2.4%	2.5%	2.6%	2.8%	3.0%	3.3%	3.5%	3.6%	3.6%	3.5%	3.6%	3.8%
services exports per firm (1,000 €)	474	562	499	577	657	712	721	743	764	857	851	933
share of firms exporting goods	23.9%	22.5%	23.8%	25.5%	26.4%	27.0%	26.4%	26.7%	26.8%	27.1%	27.4%	27.3%
export sales (goods) per firm (1,000 €)	2,169	1,605	1,673	1,809	1,855	1,793	1,823	1,851	1,651	2,342	2,760	3,053
turnover per firm (million €)	3,349	3,404	3,201	3,471	3,363	2,238	2,118	2,137	1,861	2,387	2,759	3,096
firms	30,475	26,922	25,289	24,626	24,201	25,225	26,584	28,010	29,037	29,871	28,881	24,072
observations	73,134	69,982	69,669	67,965	66,932	71,801	74,395	77,211	76,054	77,873	77,550	70,157

Table A.6: Summary statistics

sample	full			combined		
	mean	sd	N	mean	sd	N
ln services offshoring (ln S)	4.103	1.878	1,640,086	4.143	1.945	349,718
ln TFP				2.125	1.004	349,718
age				62.9	49.72	
ln equity				11.48	2.588	
ln capital intensity				-0.7116	1.309	
ln asset tangibility				-0.1728	0.4896	
goods exporter dummy				0.7177	0.4501	
services exporter dummy				0.628	0.4833	
foreign affiliate dummy				0.08056	0.2722	
size class dummies				5.502	1.613	
legal form dummies				2.128	1.224	
ln sectoral capital intensity	-0.1299	0.8799	1,548,777	-0.2819	0.7242	349,718
ln sectoral asset tangibility	-0.1392	0.2139		-0.1162	0.1315	
ln sectoral labor costs	10.92	0.2181	1,353,355	10.89	0.1937	324,275
ln GDP	27.13	1.658	1,617,796	26.98	1.643	344,315
ln GDP per capita	10.03	1.084		9.861	1.17	
ln distance	7.25	1.28	1,628,175	7.394	1.284	347,266
time zone difference	2.31	3.168		2.454	3.157	
border	0.3508	0.4772		0.3172	0.4654	
language	0.1841	0.3876		0.1621	0.3686	
legal origin	0.173	0.3783		0.1639	0.3702	
currency	0.3263	0.4689		0.3063	0.4609	
colony	0.02227	0.1476		0.02132	0.1445	
landlocked	0.1945	0.3958		0.1782	0.3826	
services FTA	0.5582	0.4966	1,635,434	0.5221	0.4995	348,874
MR ln distance	0.06689	0.041	1,608,530	0.06965	0.03738	342,072
MR common border	0.0005642	0.0005689		0.0005747	0.000555	
MR common language	0.0007425	0.0008109		0.0007042	0.0008144	
MR colony	0.0004948	0.0006873		0.0004375	0.0006388	
MR common colonizer	0.0000233	0.0000752		0.0000279	0.000081	
Ω_A	0.4231	0.3365	1,640,086	0.4924	0.2776	349,718
$\Omega_{2006-12}$	0.4755	0.3287	1,639,945	0.524	0.2562	349,713
$\Omega_{Blinder}$	0.4675	0.1137		0.4583	0.09021	
non-routine analytic (S-O)	0.7148	0.09762		0.6928	0.08802	
non-routine interactive (S-O)	0.829	0.05915		0.8009	0.04793	
non-routine manual (S-O)	0.3718	0.1229		0.428	0.08432	
routine cognitive (S-O)	0.9383	0.04754		0.9392	0.04104	
routine manual (S-O)	0.6569	0.1363		0.725	0.0812	
non-routine (BEM, lenient)	0.6994	0.09695	1,539,082	0.6521	0.07631	336,591
interactive (BEM, lenient)	0.2937	0.06686		0.2833	0.05917	

This table provides summary statistics of all variables used in regression analysis for the full (SITS) sample and the combined (SITS-USTAN) sample, as defined in Section 3.2. Descriptions of all variables and data sources are provided in Section 2.1.

Table A.7: Services imports and exports by service category in 2006

service category	number of importers	share of all service trading firms	services imports (million €)	services exports (million €)	services imports by firm (1,000 €)	services exports by firm (1,000 €)
travel	3,185	8.2%	6,726	410	2,112	129
transport	6,858	17.7%	40,790	43,950	5,948	6,409
construction	2,587	6.7%	5,555	9,573	2,147	3,700
financial	2,415	6.2%	4,541	6,704	1,880	2,776
insurance	2,088	5.4%	27,743	26,752	13,287	12,812
communication	1,104	2.8%	4,949	3,567	4,483	3,231
IT	4,328	11.2%	7,178	7,890	1,658	1,823
R&D	3,190	8.2%	9,258	9,994	2,902	3,133
personnel	6,761	17.4%	4,515	2,687	668	397
other business services	14,911	38.4%	21,141	14,818	1,418	994
engineering	5,195	13.4%	5,334	7,040	1,027	1,355
other services	3,783	9.8%	7,818	4,738	2,067	1,253

Table A.8: Services imports and exports by broad sector in 2006

sector	observations	firms	share of firms importing services	services imports per firm (1,000 €)	share of firms exporting services	services exports per firm (1,000 €)	share of firms exporting goods	export sales (goods) per firm (1,000 €)	turnover per firm (million €)
Primary	996	684	2.6%	233	1.0%	93	4.4%	353	156
Manufacturing	40,314	8,823	20.4%	469	5.2%	377	49.2%	2,225	3,092
Construction	1,426	838	7.4%	272	3.5%	886	15.0%	69	259
Wholesale/Retail	12,052	8,128	6.8%	265	1.4%	190	25.3%	158	374
Services	16,148	6,244	8.4%	1,894	3.4%	2,091	4.3%	482	1,643
Utilities/Public	865	589	8.1%	478	2.0%	136	3.1%	68	3,465
Total	71,801	18,473	11.9%	3,611	3.3%	3,773	27.0%	3,354	8,989

Table A.9: Alternative measures of offshoring potential

measure	main: Ω_A		alternative: $\Omega_{2006-12}$		Becker et al. (2013)		Spitz-Oener (2006)		Blinder (2009)	
sample	full (1)	combined (2)	full (3)	combined (4)	full (5)	combined (6)	full (7)	combined (8)	full (9)	combined (10)
Ω_A	-0.120***	-0.371***								
	(0.0403)	(0.117)								
$\Omega_{2006-12}$			-0.0260	-0.297*						
			(0.0387)	(0.171)						
non-routine (BEM, lenient)					0.556***	-0.377				
					(0.195)	(0.343)				
interactive (BEM, lenient)					0.709***	2.326***				
					(0.203)	(0.509)				
non-routine analytic (S-O)							-0.0510	-1.344*		
							(0.393)	(0.786)		
non-routine interactive (S-O)							0.652	2.258***		
							(0.443)	(0.572)		
non-routine manual (S-O)							0.189	1.238***		
							(0.293)	(0.448)		
routine cognitive (S-O)							0.0652	-0.472		
							(0.613)	(1.020)		
routine manual (S-O)							-1.014**	-1.610**		
							(0.439)	(0.628)		
$\Omega_{Blinder}$									-0.00934	0.870*
									(0.127)	(0.499)
firm and sector controls	no	yes	no	yes	no	yes	no	yes	no	yes
country, service type, and year effects	yes	nested	yes	nested	yes	nested	yes	nested	yes	nested
country-year and service type-year effects	no	yes	no	yes	no	yes	no	yes	no	yes
R^2	0.094	0.192	0.094	0.191	0.097	0.195	0.098	0.194	0.094	0.191
Observations	1,640,086	324,275	1,639,945	324,275	1,539,082	312,703	1,639,945	324,275	1,639,945	324,275

Dependent variable: ln services imports: $\ln S_{ijkst}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.10: Effect of offshoring potential over time

sample	full		combined	
	(1)	(2)	(3)	(4)
$\Omega_A \times \delta_{2001}$	-0.165***	-0.255**	-0.172	-0.142
	(0.0441)	(0.111)	(0.140)	(0.135)
$\Omega_A \times \delta_{2002}$	-0.163***	-0.297***	-0.280**	-0.237**
	(0.0504)	(0.0967)	(0.127)	(0.113)
$\Omega_A \times \delta_{2003}$	-0.154***	-0.247**	-0.208	-0.133
	(0.0507)	(0.106)	(0.128)	(0.121)
$\Omega_A \times \delta_{2004}$	-0.157***	-0.257***	-0.213*	-0.160
	(0.0495)	(0.0995)	(0.124)	(0.115)
$\Omega_A \times \delta_{2005}$	-0.129**	-0.241*	-0.188	-0.0558
	(0.0529)	(0.137)	(0.159)	(0.112)
$\Omega_A \times \delta_{2006}$	-0.149***	-0.251*	-0.182	-0.0646
	(0.0518)	(0.137)	(0.136)	(0.116)
$\Omega_A \times \delta_{2007}$	-0.171***	-0.302**	-0.237*	-0.163
	(0.0473)	(0.127)	(0.126)	(0.109)
$\Omega_A \times \delta_{2008}$	-0.131***	-0.344***	-0.290**	-0.138
	(0.0443)	(0.115)	(0.116)	(0.112)
$\Omega_A \times \delta_{2009}$	-0.106**	-0.278**	-0.231**	-0.103
	(0.0458)	(0.113)	(0.109)	(0.116)
$\Omega_A \times \delta_{2010}$	-0.0565	-0.0727	-0.0175	-0.0392
	(0.0490)	(0.162)	(0.0608)	(0.113)
$\Omega_A \times \delta_{2011}$	-0.0254	-0.0626	-0.0287	-0.0531
	(0.0480)	(0.158)	(0.0458)	(0.111)
$\Omega_A \times \delta_{2012}$[a]	-0.0664	-0.0450		-0.00958
	(0.0484)	(0.164)		(0.109)
firm controls	no	yes	yes	yes
country, service type and year effects	yes	yes	yes	yes
sector effects	no	no	yes	nested
firm effects	no	no	no	yes
R^2	0.094	0.176	0.189	
R^2 (within firm)				0.132
Observations	1,640,086	349,718	349,718	349,718
Number of firms	73,219	6,437	6,437	6,437

Dependent variable: ln services imports: $\ln S_{ijkst}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
[a] Due to Stata's automatic choice of base category, no coefficient is estimated for the interaction term with δ_{2012} in column 3.

Table A.11: Offshoring growth at firm-service type level

sample	full				combined			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ω_A	0.0201***	0.00563	0.0196***	0.00586	0.0167	0.0343	0.0148	0.0324
	(0.00591)	(0.00799)	(0.00591)	(0.00804)	(0.0167)	(0.0219)	(0.0166)	(0.0218)
firm controls	no	no	no	no	yes	yes	yes	yes
sector controls	no	yes	no	yes	no	yes	no	yes
year and service type dummies	yes	yes	nested	nested	yes	yes	nested	nested
service type $\times$ year dummies	no	no	yes	yes	no	no	yes	yes
R^2	0.002	0.002	0.004	0.004	0.004	0.004	0.011	0.012
Observations	325,745	259,386	325,745	259,386	58,350	54,802	58,350	54,802

Dependent variable: growth in firm-service type-level services imports $\Delta S_{ist} \equiv \ln S_{ist} - \ln S_{is,t-1}$.
Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, *p<0.10.

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