IAW DISCUSSION PAPERS

iaw@iaw.edu | www.iaw.edu

IAW Diskussionspapiere | Nr. 110 Oktober 2014 | No. 110 October 2014

Offshoring and Outsourcing Potentials of Jobs

Evidence from German Micro-Level Data

Tobias Brändle
Andreas Koch

Institut für Angewandte Wirtschaftsforschung e.V.
Ob dem Himmelreich 1 | 72074 Tübingen | Germany
Tel.: +49 7071 98960 | Fax: +49 7071 989699

ISSN: 1617-5654

IAW-Diskussionspapiere

Das Institut für Angewandte Wirtschaftsforschung (IAW) an der Universität Tübingen ist ein unabhängiges Forschungsinstitut, das am 17. Juli 1957 auf Initiative von Professor Dr. Hans Peter gegründet wurde. Es hat die Aufgabe, Forschungsergebnisse aus dem Gebiet der Wirtschafts- und Sozialwissenschaften auf Fragen der Wirtschaft anzuwenden. Die Tätigkeit des Instituts konzentriert sich auf empirische Wirtschaftsforschung und Politikberatung.

Dieses IAW-Diskussionspapier können Sie auch von der IAW-Website als pdf-Datei herunterladen:

http://www.iaw.edu/index.php/IAW-Diskussionspapiere

ISSN 1617-5654

Weitere Publikationen des IAW:

- IAW News (erscheinen 4x jährlich)
- IAW Impulse
- IAW Forschungsberichte

Möchten Sie regelmäßig eine unserer Publikationen erhalten? Dann wenden Sie sich bitte an uns:

IAW e.V. Tübingen, Ob dem Himmelreich 1, 72074 Tübingen,
Telefon +49 7071 98 96-0
Fax +49 7071 98 96-99
E-Mail: iaw@iaw.edu

Aktuelle Informationen finden Sie auch im Internet unter:

http://www.iaw.edu

Für den Inhalt der Beiträge in den IAW-Diskussionspapieren sind allein die Autorinnen und Autoren verantwortlich. Die Beiträge stellen nicht notwendigerweise die Meinung des IAW dar.

Offshoring and Outsourcing Potentials

Evidence from German Micro-Level Data[1]

Tobias Brändle[2] and Andreas Koch[3]

IAW Tübingen

October 30, 2014

Abstract

This paper analyses the potentials of jobs to be offshored or outsourced. We use four waves of the BIBB/BAuA Survey on Qualification and Working Conditions in Germany and employ a large set of potential determinants of offshoring and outsourcing derived from the literature. Applying the data-driven method of principal component analysis, we provide two indicators that measure both the offshoring potentials (cross-country geographical relocation) and the outsourcing potentials (organisational relocation) at the level of jobs, occupations, tasks, or industries. Our results show significant variation in the determinants of both dimensions. In addition to the direct contribution, our paper provides two indicators that can be used to further investigate the economic effects of job offshorability.

JEL-Classification: D23, F16, J24, O33

Keywords: Outsourcing, International Trade, Offshoring, Trade in Tasks

---

[1] This paper is part of the research project 'Trade in tasks – potentials for internationalization and their effects on the wage structure and composition of employment', funded by the German Research Foundation (DFG) (BO 2793/3-1). We use data from the waves 1991, 1998, 2006 and 2012 of the BIBB/BAuA Employment Survey of the Working Population on Qualification and Working Conditions in Germany provided by the Research Data Centre of the Federal Institute for Vocational Education and Training (BIBB). We thank our colleagues Bernhard Boockmann, Carina Dengler, Peter Eppinger, Wilhelm Kohler, and Katja Neugebauer, as well as the participants of the PhD Summer Workshop at University Hohenheim, the ETSG Conference, the SEEK workshop at ZEW Mannheim, the Brown Bag Seminar at University of Tübingen, the FIW-Seminar in International Economics at WIIW Wien, the Annual Conference of the Verein für Socialpolitik in Duesseldorf, the MIUR-PRIN Workshop in Milano, and two anonymous referees for useful comments. Jane Dreyer, Patrick Maier, Elitza Milenkova, Miriam Morlock, Matthias Seckler, and Lisa Tarzia are gratefully acknowledged for excellent research assistance. All errors remain ours alone.

[2] Corresponding author; Institute for Applied Economic Research, Tübingen, Germany (www.iaw.edu); Phone: +49 7071 9896 16; Mail: tobias.braendle@iaw.edu.

[3] Institute for Applied Economic Research, Tübingen, Germany.

1 Introduction

In recent years outsourcing processes, both on the national and on the international levels, have not only been growing quantitatively, but they have also been undergoing profound qualitative changes. The technological advancements with regard to information and communication technology, declining costs of transportation, and thus a contraction of physical and cultural distances (*global village scenario, death of distance*) have led to substantial growth in the national and international trade of goods and services, both within and between firms (see, for instance, Hijzen, 2006; Merino and Rodriguez, 2007). Simultaneously, production processes are observed to be more and more differentiated and fragmented, continuously promoting a "new type" of trade: The relocation of intermediate inputs, i.e. a shift from the relocation of entire plants, production stages or jobs towards the relocation of particular and fine-grained components of these jobs, frequently referred to as "tasks", i.e. certain components of occupations (cf. Autor, 2013). A large number of studies has analysed offshoring and outsourcing and its effects on the labour market.[4]

In the context of this discussion, only a few studies have engaged in measuring the *potentials* of jobs to be outsourced or offshored and analysing the factual outcomes of such potentials.[5] However, measuring relocation potentials is difficult, as it does not represent an economic activity per se, but just a "risk". Empirical work on offshoring potential is usually based on general characteristics of industries (e.g. labour intensities) or jobs (e.g. skill levels). Finer methodologies drawing on the characteristics of jobs themselves have only recently been introduced. The question of "how many jobs can be offshored" (Blinder, 2006) remains relevant and has, to our understanding, not been finally answered. A recent article by Blinder and Krueger (2013) summarises the attempts and methods to answer this question for the U.S.

As not all jobs are conceived to be equally offshoreable, there is an intensive discussion about which job characteristics might influence a firm's decision to shift this activity to another firm and/or country or not. According to the view promoted in the present paper, this decision has two dimensions which have to be accounted for: First, various considerations at the firm level have an impact on the decision whether to provide the respective good (or intermediate input) inside the firm's boundaries or to purchase it on the market ("make-or-buy decision") – denominated as the outsourcing potential in the following. Second, a choice has to be made whether to make or buy the good on the home market or abroad – entitled as the offshoring potential. Both decisions are based on often similar – but not identical – job characteristics. When analysing the offshoring potential of jobs, the outsourcing potential has therefore to be accounted, otherwise the results could not be identified, but suffer from an omitted variable bias.

Hence, in line with the new empirical approaches in the trade in tasks literature, we analyse the characteristics of jobs themselves as important determinants of offshoring and outsourcing potential (see, e.g. Becker and Muendler, 2012).[6] However, potential differences in the determinants of

---

[4] See Crinò (2009), Mankiw and Swagel (2006) or Wagner (2011) for recent overviews.

[5] A recent example analysing the link between offshoring and offshoring potential is the working paper by Hogrefe (2013). He analyses the effect of offshoring on relative labour demand measured as the share of routine tasks in occupations in German manufacturing industries. The dependent variable can also be used as a proxy for how easily jobs can be offshored in the future.

[6] This view is based on examples using single job characteristics, such as communication intensities and interactivity requirements (Blinder, 2006; Leamer and Storper, 2001), routineness of tasks (Autor et al., 2003; Spitz-Oener, 2006), or the standardization of goods (Costinot et al., 2011).

offshoring and outsourcing have not been comprehensively considered in the literature so far. A *comprehensive* empirical classification of the determinants of how easily jobs can be offshored and outsourced is therefore missing. The main contribution of the present paper is to complement existing research by developing and testing more general measures and by allowing for a differentiation between factors affecting offshoring and outsourcing potentials of occupational activities.

We base our measurement on a bundle of characteristics of jobs (e.g. working conditions, tools, attributes of professional activities), which have been identified in the literature so far to have an impact on one or both outcomes. Using rich representative individual-level data of German employees, we can derive condensed individual-, occupation-, task-, or industry-specific indicators, by using a large number of job characteristics, and by applying principal component analysis (PCA). Such a data-driven method to describe the potentials of a job to be relocated complements the existing literature also by differentiating between the two dimensions of offshoring and outsourcing potential.

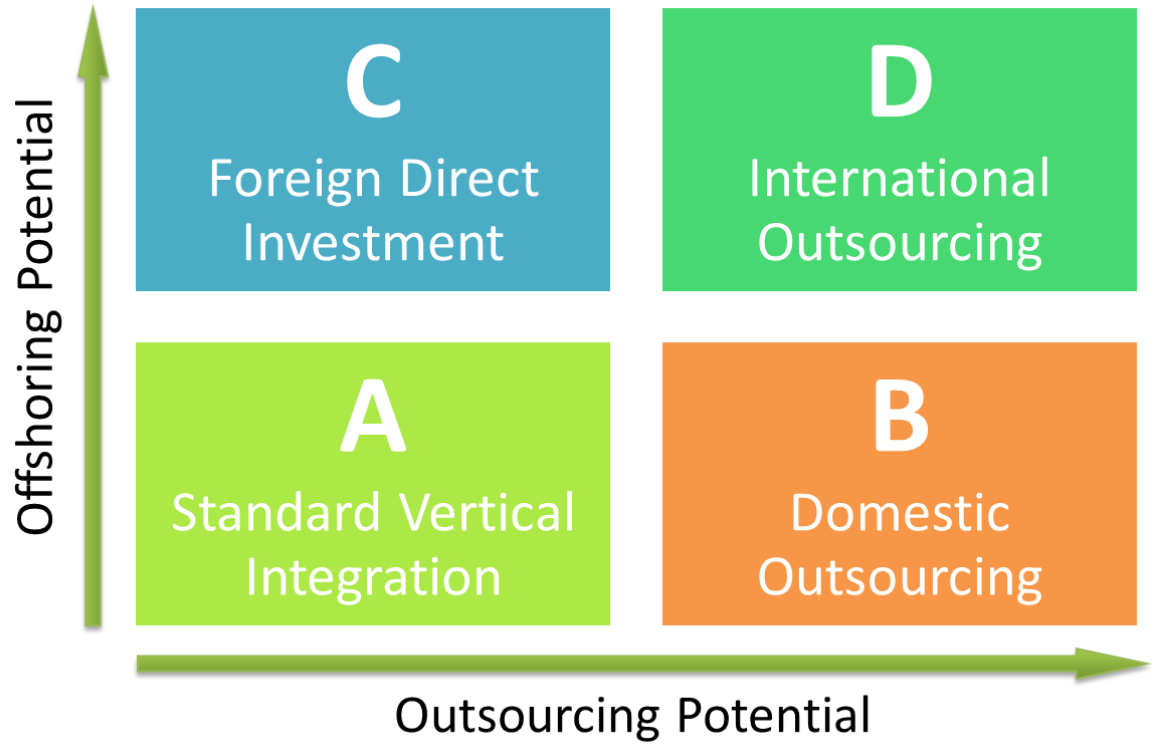
The paper proceeds as follows: In Section 2, we lay out the characteristics of jobs which potentially determine their probability to be organisationally or geographically relocated based on a review of existing studies. Section 3 introduces the data and the construction of variables, particularly focusing on the characteristics which possibly determine the offshoring and outsourcing potentials of jobs. The description of the methodology underlying the construction of two indicators represents the content of Section 4, whereas Section 5 includes a descriptive overview of the resulting indicators on various levels of aggregation as well as a comparison with other indicators from the existing literature and an analysis of potential individual and aggregate drivers of offshorability and outsourcability. Section 6 concludes.

2 Literature Review

2.1 Operationalising Offshoring

The literature on offshoring (and, more specifically, on trade in tasks) has so far addressed offshoring decisions as one-dimensional processes (see, for instance, Blinder and Krueger, 2013; Lo Turco and Maggioni, 2012): Firms either perform a job within their company and country, or they offshore. However, the determinants of (solely) organisationally relocating (i.e. outsourcing) a specific activity might differ from the factors affecting the decision of whether to geographically relocate an activity, i.e. to perform it in the home country or abroad. In our approach, we therefore address these two dimensions of the relocation of economic activities: First, the feasibility of organisationally relocating activities, i.e. whether to "make or buy", designated here as the *outsourcing potential*. Second, the potential of spatially relocating activities across international borders, designated as *offshoring potential* (see Figure 2.1, cf. also Antras and Helpman, 2004; Federico, 2012).

Figure 2.1 Organisational and Spatial Dimensions of Job Offshoring



Source: Own Drawing.

The four cells displayed in Figure 2.1 are not mutually exclusive, but the categorisation allows drawing conclusions on firm strategies regarding the relocation of activities on different organisational and spatial levels:

- Cell A refers to activities which are vertically integrated and produced in-house (*make*) in the home country, e.g. because they are subject to high transaction costs or other international trade barriers. Therefore, the probability of organisational and spatial relocation is low. Examples are highly specialised technical workers, e.g. setters of customised machines.
- Activities classified in cell B are characterised by a high potential for organisational relocation (*buy*), but similarly to cell A, barriers to offshoring are significant. These activities are likely to

be outsourced on the national or even on the regional level. Examples are providers of personal services such as catering or cleaning.

- In contrast, activities allocated to field C are likely to be vertically integrated; however, barriers to offshoring pertaining to these activities are low. Therefore, they are prone to be relocated spatially within the firm via foreign direct investment (FDI). Examples for such activities are tasks requiring highly specific and sensitive knowledge, which is, however, ubiquitously available, for instance firm-specific IT-functions.
- Finally, field D covers activities with both high organisational and spatial relocation potentials. These activities are most likely to be subject to international outsourcing. These comprise, for example, standardised IT activities or customer services for routine processes available around the globe.

In addition to traditional (one-dimensional) concepts of offshoring, this two-dimensional perception of organisational and geographical relocation of activities allows us to fully capture determinants that potentially affect only one of the two dimensions, or both. We are thus able to address whether such determinants really influence offshoring, outsourcing, or both. It also facilitates distinguishing between determinants that affect the home country labour demand or wages directly (spatial relocation), and determinants that only have indirect effects (organisational relocation). Such a distinction has rarely been addressed in the literature so far; a recent exception can be found in Federico (2012), who analyses the choice of firms between integration and outsourcing, in the home country or abroad. Akcomak et al. (2011) follow a different approach. They distinguish between outsourcing as a firm-level decision and offshoring as a country-level decision, each with (completely) different determinants.

In the following, our concept will be described in more detail, with respect to the question which factors and characteristics of activities might have an impact on their offshoring and outsourcing potentials.

2.2 Determinants of Job Offshorability and Outsourcability

A sound empirical assessment of offshoring and outsourcing potentials of tasks, jobs, or economic activities first and foremost requires an adequate operationalisation of the relevant job characteristics. Based on existing economic literature, this section identifies possible determinants of offshoring and outsourcing potentials of jobs and activities. In our view, however, this literature can be supplemented in two regards: First, the majority of studies do not distinguish between factors determining the outsourcing potentials of jobs, and factors determining their offshoring potential (see Section 2.1). Second, the majority of the available studies is restricted with respect to the number of factors and builds on limited sets of potential determinants.

Based on similar data as used in the present paper (see Section 3), Spitz-Oener (2006) examines the changes in job contents and tasks due to technological development. She introduces a classification of tasks into five categories: ‘non-routine analytic’, ‘non-routine interactive’, ‘routine cognitive’, ‘routine manual’, and ‘non-routine-manual’. Thus, she classifies tasks according to categories of routines, interaction, and blue-collar/white-collar activities. Using the same dataset, Becker et al. (2013) establish a link to internationalisation, adding ‘interactive’ and ‘non-interactive’ tasks to the already mentioned ‘routine’ and ‘non-routine’ tasks. Non-routine tasks are defined as the ones that cannot be simply repeated, while interactive tasks require interaction within the workforce, with clients or collaborators. Becker et al. (2013) find that offshoring is accompanied by significant shifts to non-routine and interactive tasks in the home country.

Although the concrete allocation of professions, activities or job tasks to the above (or similar) categories is frequently based on theoretically motivated, but rather subjective and somewhat arbitrary assignments, three main factors are concordantly seen to be of particular relevance with regard to offshoring and outsourcing potentials (see Table 2.1): (A) Characteristics of complexity and knowledge requirements, (B) measures of interaction and context and (C) information and communication technologies. The table also summarises the expectations concerning the directions of impact of the respective job characteristics on the offshoring and outsourcing potential of these jobs, which will be further substantiated in the next paragraphs.

Table 2.1 Theoretical Predictions regarding the Determinants of Job Offshoring and Outsourcing Potentials

Job Characteristics	Outsourcing Potential	Offshoring Potential
A) Measures of Complexity / Knowledge Requirements		
Codifiability and Routines	++	+
Complexity	--	-
B) Measures of Interaction and Context		
Interactivity	-	--
Locational ties	-	--
Cultural linkages (e.g. language, law)	-	--
Complementary tasks	--	--
C) Information and Communication Technologies		
Use of ICT	+	++

Note: ++/-- indicate unambiguously positive/negative predictions; +/- indicate possible positive/negative predictions of a certain job characteristic on offshoring and outsourcing potential. Own compilation.

A) Measures of Complexity / Knowledge Requirements

In the context of the theory of the firm and the transaction cost approach (cf. Antras 2003; Barba Navaretti and Venables, 2004; Coase, 1937; Ethier, 1986; Grossman and Hart, 1986; Hart and Moore, 1990), both offshoring and outsourcing potentials of goods or services increase with their standardisation or codifiability. They decrease with their complexity and with the requirements to specific types or allocations of knowledge, as codifiable products or activities can be more easily covered by contracts than complex and customised goods (cf. also Leamer and Storper, 2001). The term *codifiability* thereby refers directly to whether it is possible to describe a certain activity in a way that it can be performed by another company, either located in the home country or abroad. Thus, our hypothesis is that outsourcing potential is positively correlated with codifiability. Of course, this holds also for offshoring potential, as long as the geographical relocation also involves organisational relocation.

Costinot et al. (2011) empirically confirm that non-standardised activities are usually traded inside the firm, whereas standardised tasks can also be purchased from independent providers. This paper is one of the few examples differentiating between general outsourcability (which, in the view of the authors, mainly depends on the potential for standardisation) and offshorability (referring to international trade barriers). The main determinant of whether a certain job can be performed by a different company is the existence of a market for the respective task performed by the job. Hence, it is initially irrelevant for the outsourcing potential whether this activity is offshoreable.

Quite similarly, routines and complexity of jobs are important predictors of offshoring and outsourcing potentials of activities. Costinot et al. (2011) assume that complex (non-routine) tasks may cause frictions in the production process that cannot be resolved ex ante. As adaptation costs occurring ex post are lower when an activity is provided internally, multinational firms choose vertical integration for complex non-routine tasks. Their empirical examination on the sectoral level confirms this hypothesis by showing high correlations between shares of complex tasks and intra-firm trade. In a similar manner, Oldenski (2009) finds high (negative) correlations between relocation and the complexity of tasks. Departing from the *Dictionary of Occupational Titles* (DOT),[7] Autor et al. (2003) theoretically and empirically confirm that "routine tasks" (i.e. limited and well-defined sets of cognitive and manual activities) can more easily be substituted by "computer capital", whereas "non-routine tasks" (i.e. "problem-solving and complex communication activities"), are rather being complemented or supported than substituted by computer capital (see also below). Based on the above mentioned considerations, we assume that routines have a positive impact on both offshoring and outsourcing potential of jobs. Complexity, on the other hand, is supposed to have a contrary effect.

B) Measures of Interaction and Context

High demands for interaction and context, e.g. face-to-face communication with customers or requirements to cultural proximity (e.g. skills in languages or law) are believed to reduce offshorability. Using data from the U.S., Bardhan and Kroll (2003) identify several characteristics that are common to internationally tradable jobs: These jobs do not require personal contact, they have high information requirements, working processes are linked to the internet, or jobs are characterised by low social networking requirements. In line with these findings, van Welsum and Reif (2005) find evidence that, for a sample of OECD countries, outsourcing potentials crucially depend on social contact and the use of computers.

Based on judgments conducted by theoretical considerations and contingent empirical observations (but not on a thorough empirical investigation), Blinder (2009) categorises occupations according to their likeliness of being offshored. The main argument used by Blinder (2009) for his assignment of offshorability is whether a job or a profession requires a specific work location (and, therefore, cannot be easily relocated) or intense interaction. In a later paper, Blinder and Krueger (2013) test their measure against professional coding according to a range of job characteristics, and against direct questioning of households.

Important underlying factors of the locational ties outlined by Blinder (2006, 2009) can be based on specific requirements of jobs which can be substantial impediments to relocation. For instance, if a job requires a profound knowledge of written German or of the specific German legislation, these requirements might prevent the job being offshored – but it might not necessarily inhibit it to be relocated organisationally within the home country (e.g. to a specialised lawyer).

Whereas the above approaches are based on the characteristics of single tasks or jobs, other scholars emphasise that jobs must be conceived as bundles of tasks (Autor and Handel, 2013). Some

[7] The DOT has been followed by the *Occupational Information Network* (O*NET, cf. www.onetonline.org) since the late 1990s, which is now used by most U.S. studies. In Europe and Germany, the *International Standard Classification of Occupations* (ISCO, most recent version from 2008, cf. http://www.ilo.org/public/english/bureau/stat/isco/index.htm) is more common.

combinations of tasks frequently appear together – they are thus complementary to each other and as such might be more efficiently performed by one worker than by two or more. These 'task portfolios' (complementary tasks) might limit the division of labour and increase the unbundling costs from outsourcing a specific job (cf. Görlich, 2010; Lanz et al., 2011).

Jensen and Kletzer (2010) base their index of offshorability on so-called "occupational requirements": They assume that, for instance, activities involving intensely modern information and communication techniques are characterised by high offshoring potentials (see also Autor et al., 2003; as well as Bardhan and Kroll, 2003). These techniques are, to a certain degree, standardised, or at least codifiable, and the physical distance between supplier and customer is only of minor importance.

Generally spoken, increasing needs to interact personally are supposed to be a barrier to offshorability, whereas the impact on the outsourcing potential is not that clear-cut. If, for instance, interaction requires high levels of trust, outsourcing is less probable; however, trust must not always be confined to intra-firm cooperation. Cultural linkages might similarly hinder offshorability of an economic activity, but might have no influence on organisational dislocation on the national level, as, for instance, the cultural background of firms or people does not differ in many respects in the home country.

C) Information and Communication Technologies

Last but not least, ICT has recently been frequently and intensely discussed as a determinant of the relocation of economic activities. However, hypotheses are somewhat ambiguous and they share some expectations with both the discussion on routines / complexity and interaction outlined above (see also, for instance, Jensen and Kletzer, 2010; Bardhan and Kroll, 2003).

While from the perspective of standard users and simple adopters of ICT, these techniques may foster the standardisation and codification of many relevant processes in the economy. They might thus make jobs and tasks more tradable across both firms and countries. The extreme facilitation and the intensification (both quantitatively and qualitatively) of communication between individuals across long distances might be another promoter of (international) trade.

On the other hand, the development of new technologies of information and communication frequently requires an intensive and often personal interaction which could be a barrier to organisational and/or geographical relocation of the activities. However, as most workers are rather "simple" adopters and users of ICT, we suppose that an increasing utilisation of these technologies in the workplace has a positive effect on the potentials of jobs to be relocated.

3 Data and Measurement

3.1 The Data

Our research is based on four cross-sections (namely the waves 1991, 1998, 2006 and 2012) of the BIBB/BAuA Employment Survey of the Working Population on Qualification and Working Conditions in Germany provided by the Research Data Centre of the Federal Institute for Vocational Education and Training (BIBB Survey).[8] The purpose of this representative employee survey is to describe employees and their jobs in a wide range of perspectives, e.g. to demonstrate trends and features of a changing work environment and to enable its empirical quantification. In total, the data include six cross-sections (the first dating from 1979 and the most recent from 2011/12) based on personal and telephone interviews, each covering up to 30,000 individuals.[9]

The different cross-sections of the survey contain a variety of information on individual employees and their jobs. They cover basic information such as education, age, or wages as well as data on current and past employment, mobility, and working conditions, which are especially valuable for our research question. With regard to tasks, the data contain several variables describing in detail the assignment, the content and the attributes of the tasks an employee performs at the workplace. Concerning job characteristics, which are believed to be relevant for the offshoring and outsourcing potential of jobs, there is plenty of information in the data, which will be described in more detail below.

In the BIBB Survey, the definition of variables regarding individual characteristics, occupations and tasks is not fully consistent across the waves which restricts the comparability of the data and requires special consideration (cf. Becker and Muendler, 2012; Rohrbach-Schmidt and Tiemann, 2013). For the subsequent analyses, we therefore use data from the latest four available waves of the BIBB Survey, namely from 1991, 1998, 2006, and 2012.[10] Moreover, we restrict our sample to workers aged 15 to 65 years and drop public servants, retirees, unemployed and self-employed individuals, as well as marginal employees, from the sample. These groups are of minor relevance for our analysis.[11]

3.2 Identifying and Constructing Job Characteristics

The first step of our empirical analysis is to operationalise characteristics that potentially determine the offshoring and outsourcing potential of jobs (see section 2.2, and particularly Table 2.1). Instead of relying on classifying job tasks, we make use of the fact that the BIBB Survey contains direct information on job characteristics that have been used in the economics literature to determine the

---

[8] The surveys are carried out by the German Federal Institute for Vocational Training (BIBB), the Research Institute of the Federal Employment Service (IAB), the Federal Institute for Occupational Safety and Health (BAuA) and the Federal Ministry of Education and Research. For detailed information on the survey, see www.bibb.de.

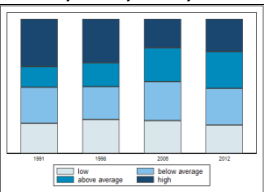
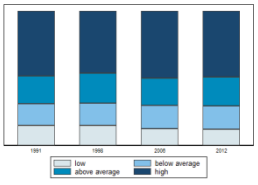
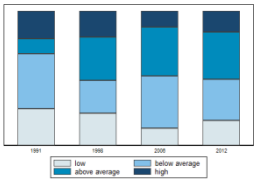
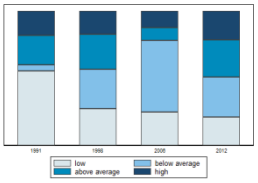
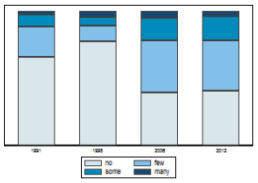
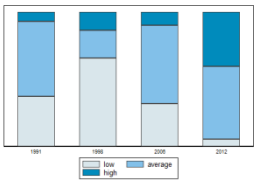
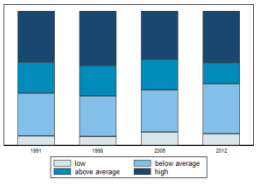
[9] Several other studies have used the data in this context, e.g. Spitz-Oener (2006). However only a few studies use a longer time period: some partial inconsistency over time restricts the comparability of the data and requires special consideration (cf. Becker and Muendler, 2012; Görlich, 2010).

[10] Furthermore, it can be argued that trade in tasks is a relatively new (in terms of decades) phenomenon; that the German unification has changed the work environment in Germany; and that we want to use the most recent data available without losing too much information due to inconsistencies.

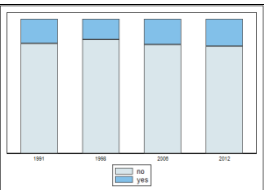
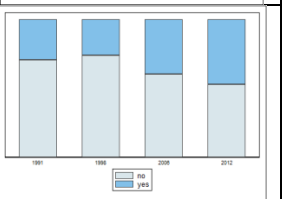
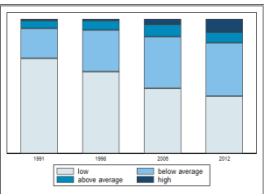
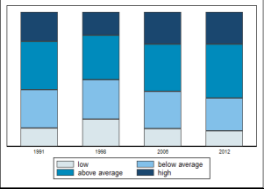
[11] And they are not consistently surveyed in the data.

offshoring potential of a job.[12] A large number of the variables in question can be directly extracted from the data, although in most cases, we have to smooth inconsistencies over time, and in some cases, we take several single variables to create an indicator that reflects one characteristic. Some job characteristics, however, are not directly available or they are only available in some waves; for these job attributes, we have thus relied on methodologies established elsewhere, e.g. the computation of an index on locational ties based on occupations by Blinder (2009), and, respectively for Germany, Schrader and Laaser (2009).

Table 3.1 Operationalisation of Job Characteristics

Characteristic	Underlying question / information in survey	Development*, 1991, 1998, 2006, 2012
Codifiability (COD)	Every step of the execution of tasks / activities is stipulated in detail (never, seldom, often, and always).	
Routines (ROU)	The operational cycles of work are exactly and constantly repeating (never, seldom, often, and always).	
Multitasking (SUM)	Sum of different tasks performed, relative the average number of tasks performed in that year.	
Complementarity (COM)	Number of complementary tasks performed, relative to all tasks performed.	
Information and Communication Technologies (ICT)	Daily work involves working with computers or other ICT devices (no, few, some, many).	
Interactivity (INT)	Daily work involves direct contact with clients or patients; daily work involves convincing others; daily works involves negotiating agreements (number of items marked).	
Locational Ties (LOC)	Defined on the basis of 3-digit professions according to Blinder (2006) and Schrader and Laaser (2009), respectively.	

[12] Also, Rohrbach-Schmidt and Tiemann (2013) suggest to directly measuring job requirements and job conditions, when analysing routinisation.

Cultural Linkage: Law (LAW)	Daily work requires specific knowledge of law and justice (yes or no).	
Cultural Linkage: Writing Skills (WRI)	Daily work requires specific knowledge of writing skills (yes or no)	
Cultural Linkage: Languages (LAN)	Daily work requires skills in one or more foreign languages (never, seldom, often, and always).	
New Scopes (NEW)	Daily work involves addressing new and / or unforeseen problems and challenges or testing new procedures or processes (never, seldom, often, and always).	

** Bars for 1991, 1998, 2006 and 2012 (left to right), respectively. Darker areas denote higher intensities / larger values of the variables.*[13] *Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.*

Table 3.1 contains a detailed description of the information underlying the variables used in our empirical analysis. In the second column, we explain the underlying meaning of the items in the BIBB Survey in more detail. Table A2 in the Appendix further outlines which exact items are used in each wave alongside the computational procedures we have used to generate the job characteristics.[14] In the third column of Table 3.1, we graphically present descriptive statistics regarding the realisations of our variables and their development over time. Darker areas denote higher intensities or larger values of the variables.

With regard to the values of the variables and their development over time, the graphs show several facts consistent with the theoretical expectations. On the one hand, if offshoring and outsourcing takes place and easily offshoreable jobs are offshored first, one would expect job characteristics to shift to characteristics linked to lower potentials of offshoring and outsourcing. This would, e.g., be displayed in a declining share of routines over time. On the other hand, there are, of course, other mechanisms shaping the job environment, which can thwart this development. For example, the rise of ICT is going to affect more and more jobs, such that the share of jobs in which daily work involves working with computers is likely to rise, although these jobs can be more easily offshored. Moreover,

---

[13] For flag variables (LAW, ICT) "yes" is light blue and "no" is white. For categorical variables (COD, ROU, NEW, LAN, PRE) "always" is dark blue, "often" is blue, and "seldom" is light blue and "never" is white. Regarding interactivity (INT), blue indicates at least two items marked, light blue indicates one item marked and white indicates no item marked. The indicator for locational ties (LOC) follows the Schrader and Laaser (2009: 28) classification: Dark blue occupations are easily offshorable, blue occupations are offshorable, light blue occupations are hardly offshorable, and white occupations are not offshorable at all. The indicator of physical working conditions (UND) measures the relative frequency of the above mentioned items occurring: Dark blue: Almost all occur; blue: The majority occurs; light blue: Some occur; white: None occur.

[14] For example, in many cases, standardisation of the variables across the waves has been performed. More detailed information and Stata programmes are available upon request.

changing work environments or a change in workplace culture affects peoples' own perception of jobs. A clerical job, for example, might be seen as less mechanical today, as most of the routine tasks have been offshored or are performed by computers. However, the remaining tasks could also be seen as more routine relative to other jobs, because there are now more non-routine analytical jobs at the workplace.

In fact, most of the descriptive statistics illustrated in Table 3.1 show ambiguous changes over time. Codifiability and routines increase only slightly over time, with around two thirds (half) of the jobs involving routine (codifiable) tasks often or always. We see, however, increases in the shares of jobs that have to multi-task and also perform relatively many complementary tasks. Clear positive trends can be observed in the share of jobs that need cultural linkages via writing and language skills. The latter may also indicate that a growing share of jobs involves contact with offshored jobs.

Table 3.2 Correlation between Characteristics

	COD	ROU	SUM	COM	ICT	INT	LOC	LAW	WRI	LAN	NEW
COD	1										
ROU	0.4434*	1									
SUM	-0.1222*	-0.1352*	1								
COM	-0.1830*	-0.1931*	0.4949*	1							
ICT	-0.1158*	-0.1235*	0.1848*	0.2910*	1						
INT	-0.1193*	-0.1388*	0.3250*	0.3441*	0.2213*	1					
LOC	0.0194*	0.0546*	- 0.0011	-0.1270*	-0.3376*	0.0081	1				
LAW	-0.0732*	-0.0889*	0.1960*	0.2457*	0.1244*	0.1920*	-0.0051	1			
WRI	-0.1149*	-0.1084*	0.1481*	0.2906*	0.2771*	0.2358*	-0.1334*	0.2354*	1		
LAN	-0.0828*	-0.1211*	0.1494*	0.1906*	0.2698*	0.2242*	-0.1029*	0.0731*	0.2404*	1	
NEW	-0.1118*	-0.2204*	0.3557*	0.3079*	0.2754*	0.3639*	-0.1228*	0.1774*	0.2124*	0.2234*	1

*Note: * indicate significant correlation at the one percent level. Shaded areas indicate correlation coefficients of > 0.3.*

Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.

Of course, as discussed in detail before, it can be argued that a number of variables identified in the literature to determine the offshoring potentials of a job are very similar or measure similar job characteristics. Including more job characteristics, however, induces a decreasing level of additional variation and an increasing probability of multiple correlations. We want to restrict the set of variables to those items identifying distinct dimensions of offshoring and outsourcing potential. As a first step, Table 3.2 reveals that there is of course correlation between nearly all of our characteristics, displayed by the significance of the correlation coefficients. We use a threshold of a correlation coefficient of more than 0.3 to define strong correlation between two variables, which is a rather conservative value. It can be seen that for most correlations this threshold is not reached. Some variables, however, measure similar, but not the same job characteristics: Routineness and codifiability are very much linked, as are job complementarity and the sum of tasks performed. Still, based on theoretical concepts laid out in Section 2, we keep these variables in the analysis.

3.3 Aggregation of the Data and Further Control Variables

Apart from the outlined job and workplace characteristics, the BIBB Survey contains further valuable information which we use for our analysis. First, there are different variables allowing us to generate aggregates of the two indicators of offshoring, e.g. occupation, sector affiliation and performed tasks etc. (see Section 5). Second, we can use individual and household information to test whether and how the offshorability and outsourcability indicators are linked to observable characteristics (see Section 6). These are outlined in Table A1 in the Appendix.

For further use of the information on job offshorability in other datasets, we aggregate our indicators on different levels: the fine grained KldB1988 3–digit level on job classifications[15] can be merged with employer- and employee-level data from the Federal Employment Agency;[16] the NACE 2-digit level of industries, which is a standard aggregation level in large number of studies in international economics. Furthermore, we can also use information on the location of the employee's workplace (German State), or the task groups performed by individual workers.

4 Method and Implementation

4.1 Overview: Objectives of the Analysis

The main objective of our paper is to empirically generate indicators of offshoring and outsourcing potential of German jobs. These indicators are calculated on the individual level and they can be aggregated, inter alia, on the levels of professions, sectors of economic activity, or task groups. We obtain the indicators from the data described above in a transparent and both theory- and data-driven way. In order to compute the indicators, we use various job characteristics that are supposed to have an impact on the offshoring and outsourcing potentials of jobs (see Tables 2.1 and 3.1).

Our two indicators have the following form:

$$outsourcing\ potential_i = \sum_{j=1}^{n} weight_{1j} \cdot job\ characteristic_{ij}$$

$$offshoring\ potential_i = \sum_{j=1}^{n} weight_{2j} \cdot job\ characteristic_{ij}.$$

We compute each indicator for every individual i based on its individual- and job-specific characteristics j as defined in Table 3.1. The realisations of each of the n workplace characteristics is weighted and then summed up to form two indicators, one for the outsourcing dimension and one for the offshoring dimension.

The assignment of weights is usually based on the use of simple or subjective weights, it has been restricted to one or very few characteristics, or it has been limited to only one dimension of

[15] The KldB 88 ("Klassifizierung der Berufe") is a classification of professions quite common in German datasets and literature. Contrary to the International Standard Classification of Occupations (ISCO), it is based on the actual type of professional activity, and not on skill levels.

[16] For example the LIAB dataset from the IAB (www.fdz.iab.de).

offshorability.[17] We therefore complement the literature on these three margins. Based on hypotheses derived from the economic literature, especially on "trade in tasks", we choose a set of specific characteristics (with their theoretical weight displayed in Table 2.1). Instead of assigning the same (standardised) weight to each characteristic, we test the underlying theory on the basis of the data. We use a multivariate method, namely principal component analysis (PCA), to obtain variance-maximising weights that have been computed in a maximally transparent way, i.e. non-arbitrary and data-driven.[18]

4.2 Principal component analysis (PCA)

Principal component analysis is a multivariate method that allows for the reduction of potentially multicollinear information, in our case a large number of possibly correlated job characteristics. It reduces the number of dimensions, while at the same time regains maximally explained variance. This method helps to reduce a large number of potentially correlated or even collinear variables in an analysis by producing a series of uncorrelated linear combinations of these, which contain a maximal share of the variance in the data (cf. Rabe-Hesketh and Everitt, 2007, Ch. 14 for more detailed information). Each linear combination (principal component) maximises the explained variance that is left in the data, i.e. the second principal component maximises the variance that is uncorrelated to the first principal component, and so forth. All principal components together contain the same information as the original variables as they are linear transformations of those variables, but with strongly decreasing information content. For our estimation we use the first or second components, depending on which best fits to the theoretical hypotheses.[19] It is possible to interpret PCA as a fixed effects factor analysis with homoscedastic residuals:

$$y_{ij} = a_i' b_j + e_{ij}, i = 1, \dots, n \; j = 1{,}2$$

where y_{ij} are the elements of the matrix y, a_i (scores) and b_j (loadings) are f-vectors of parameters, and e_{ij} are independent homoscedastic residuals. In our case the scores i represent the job characteristics. The loadings b_j represent the weights assigned to each indicator j, with $j = 1{,}2$. For more information on these properties and for other characterisations of PCA, see Jackson (2003) and Jolliffe (2002).

4.3 Identification of Indicators of Outsourcing and Offshoring Potentials

As mentioned above, the results of a PCA may depend on the selection of variables included in the model. For our analysis, a large number of job characteristics are available in our data, facing a trade-off between consistency over time and additional explained variation in certain waves. We have

---

[17] Blinder (2009), for instance, uses locational ties as the only job characteristic defining a one-dimensional offshorability index (and implicitly assigns a weight of one to this characteristic).

[18] In a related paper, Heyman and Tingvall (2012) use PCA to structure a large number of institutional characteristics into three indicators which to analyse their effect on offshoring. In fact, other authors have already used this technique: Autor et al. (2003) use a PCA as an alternative computation method, Goos et al. (2009) use it, and Autor and Dorn (2009) use it in an early draft.

[19] It is an open question whether or not to rotate the components after the PCA. When relying on a fixed or desired number of components, the application of an orthogonal varimax rotation could lead to an easier interpretation of the components. However, some of the desired optimality properties of the PCA components are lost (cf. Kaiser, 1958). The rotation would maintain the property that the number of rotated components in sum maximises the explained variance, the rotated components are still uncorrelated, and the loadings of the characteristics are allocated differently on the two components in such a way that they have a clearer, i.e. more distinct interpretation from one another. We have performed both estimates, with arguably some qualitative difference between the two methods.

decided to use as many variables as we can consistently construct over the last four waves of the data. Furthermore, we have chosen a set of variables that covers all facets of the theory-implied findings from the literature (cf. Table 2.1). Against this background, Table 4.1 shows the results from a PCA based on the sample of the last four waves of the BIBB Survey and using the characteristics described in Section 3.2. Specifications based on alternative selections of variables (available upon request) yield largely similar results.

Table 4.1 PCA Estimates

	Outsourcability		Offshorability	
Characteristic	Comp1	Comp2	Comp1	Comp2
Codifiability	-0.28	**0.66**	-0.27	**0.61**
Routines	**-0.31**	**0.62**	-0.29	**0.58**
Number of Tasks	**0.42**	0.26		
Complementarity	**0.46**	0.17	**0.43**	0.02
ICT Use	**0.32**	0.12	**0.40**	**0.31**
Interactivity	**0.40**	0.22	**0.36**	0.00
Locational Ties			-0.21	**-0.36**
Law Knowledge			0.27	0.02
Writing Skills			**0.38**	0.19
Language Skills			**0.33**	0.17
New Scopes	**0.42**	0.15		

Note: Coefficients larger than 0.3 are marked bold. Green coefficients are in line with theoretical considerations, red coefficients are opposed to theoretical coefficients. Eigenvalues are > 1. The Kaiser-Meyer-Olkin measures and squared multiple correlations of variables are well behaved and available upon request.
Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.

Table 4.1 summarises the results for the first two components from two separate PCAs, one using all characteristics that should influence mainly the outsourcability of a job, and one where the characteristics influencing the offshorability of a job are included. For easier interpretation, "strong" coefficients, i.e. loadings > 0.3 are marked bold and "correct" ("incorrect") coefficients, i.e. in line with the theoretical hypotheses are marked green (red).

For outsourcability, we can conclude that codifiability and routineness should have a strong positive impact, which is present in component 2. For the other characteristics, component two has no or little explanatory power. For component 1 we get inconclusive results, where ICT loads correctly, and all other characteristics load "incorrectly". We could, however, interpret component 1 as containing characteristics that prevent a job from being outsourceable.

For offshorability we have, at first sight, again the strange result that most coefficients except ICT are loading "incorrectly". However, this is not a problem when interpreting the indicator oppositely: Component 1 encompasses loadings that define "barriers to offshorability". Component 2, however,

can be interpreted correctly as an indicator of offshorability that contains the "main" characteristics: Routineness and codifiability, locational ties, and interactivity.[20]

The final indicators can then be calculated as the respective weighted sum of all job characteristics for each individual i, using the weights from the first two components' loadings from a PCA. This provides for potentially individual-specific offshoring measures that enclose information from a large number of job characteristics.

5 Empirical Illustration and Tests

To give an overview of the quality of the calculated indicators with regard to their potential use in further analyses, we present three types of plausibility checks: First, we present empirical results for the aggregation of the indicators at different levels, namely professions, tasks, and industry sectors (Section 5.1). In a second check, we compare our indicators to similar measures used in the literature (Section 5.2). Finally, we present an estimation which reveals to which individual, household and firm characteristics the indicators are linked (Section 5.3).

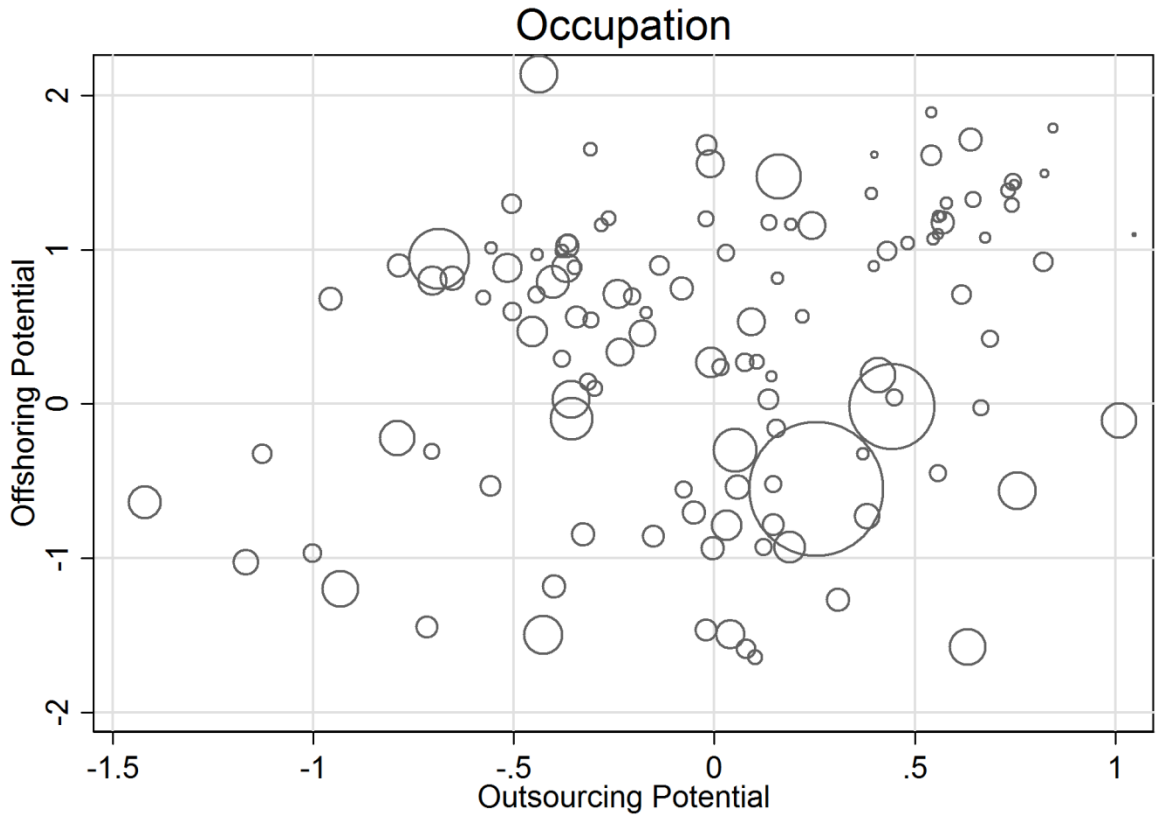
5.1 Offshoring Potentials in Different Occupations, Industries, and Tasks

In this section, we present the results for different aggregation levels, including occupations, task groups, and industries in order to convey an idea of possible usage of the generated offshoring indicators. The variation in the data originates from each group having, on average, different job characteristics, which makes the group more or less easily outsourceable or offshoreable.

Figure 5.1 shows the distribution of 3-digit KldB occupations, weighted by the number of employees, across their offshoring and outsourcing potential. Outsourcing potential is embodied on the x-axis, offshoring potential on the y-axis. In accordance with Figure 2.1, it reveals that many occupations may be classified as either domestically integrated (quadrant A) or offshorable (quadrant D). They display below or above average loading for both indices of offshoring and outsourcing potential, respectively. However, a significant number of occupations can be sorted in contrast to the one-dimensional view of offshoring: they are rather prone to be outsourced domestically (B), or the opposite is true: they may rather be kept inside the firm's boundaries, but shifted to a foreign location (C).

[20] Very similar qualitative results are obtained when using the varimax rotation, when performing a meta-analysis over different specifications of the PCA, and when estimating the PCA separately on every wave. The loading matrices of these robustness checks may be obtained from the authors upon request. We are aware of the fact that locational ties and ICT are important factors influencing the offshoring potential of jobs. Therefore, "wrong" loadings of these important characteristics seem unfortunate. In the robustness checks we can, however, show that our overall findings are not significantly affected by these two variables (as they are based on a total number of ten characteristics).

Figure 5.1 Distribution of Occupations across the Offshoring and Outsourcing Potential Matrix

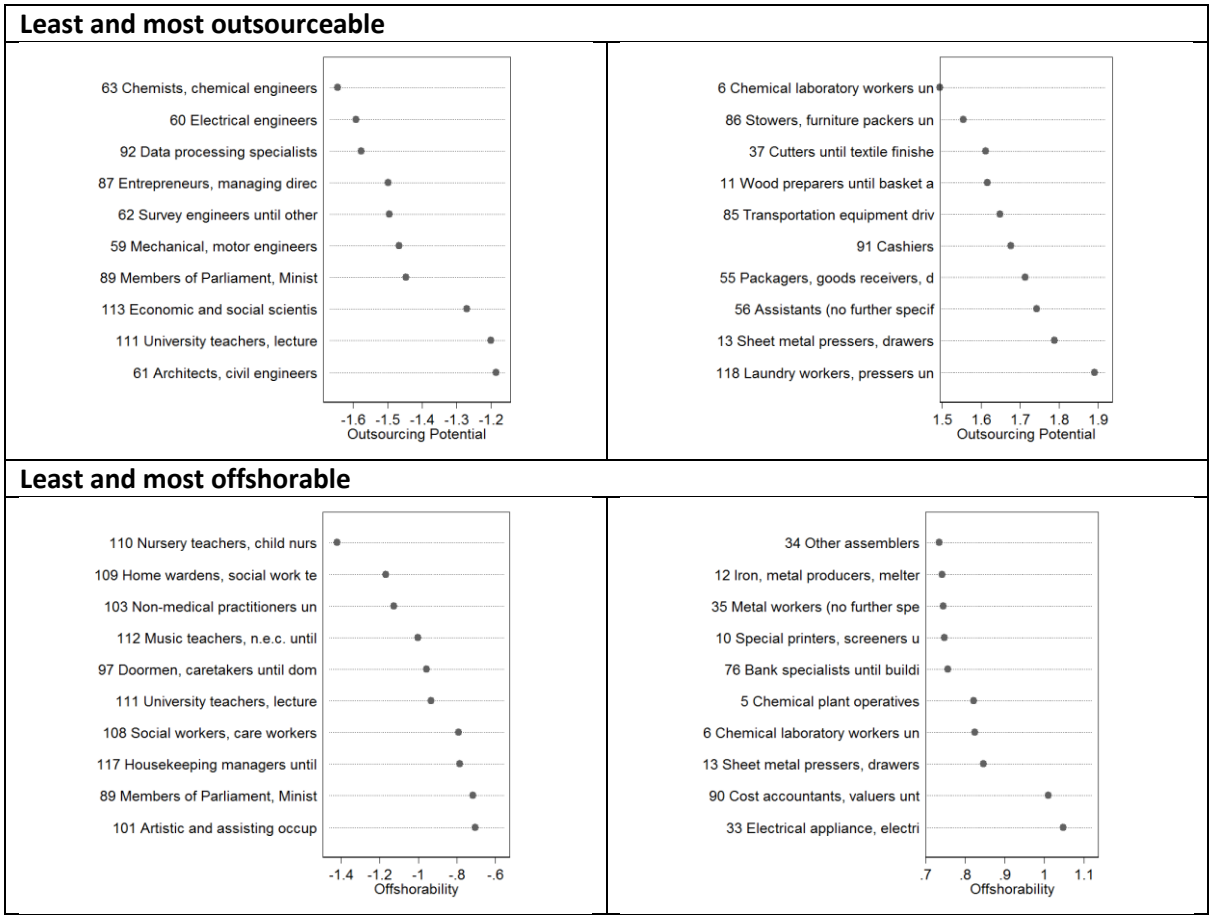


Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.

Figure 5.2 displays the mean loadings of the occupations which are particularly susceptible or reluctant to offshoring or outsourcing. Although some occupations might be somewhat unexpected, there are no obvious odd occupations. Laundry workers are the most prone, chemical engineers are the least prone to be outsourced. This suggests that firms might want to keep upstream occupations inside the company. Regarding offshoring potentials, the most offshoreable occupations are manufacturing or low-skill routine service jobs, while the least offshoreable occupations are interactive service jobs, such as nurses or housekeepers.

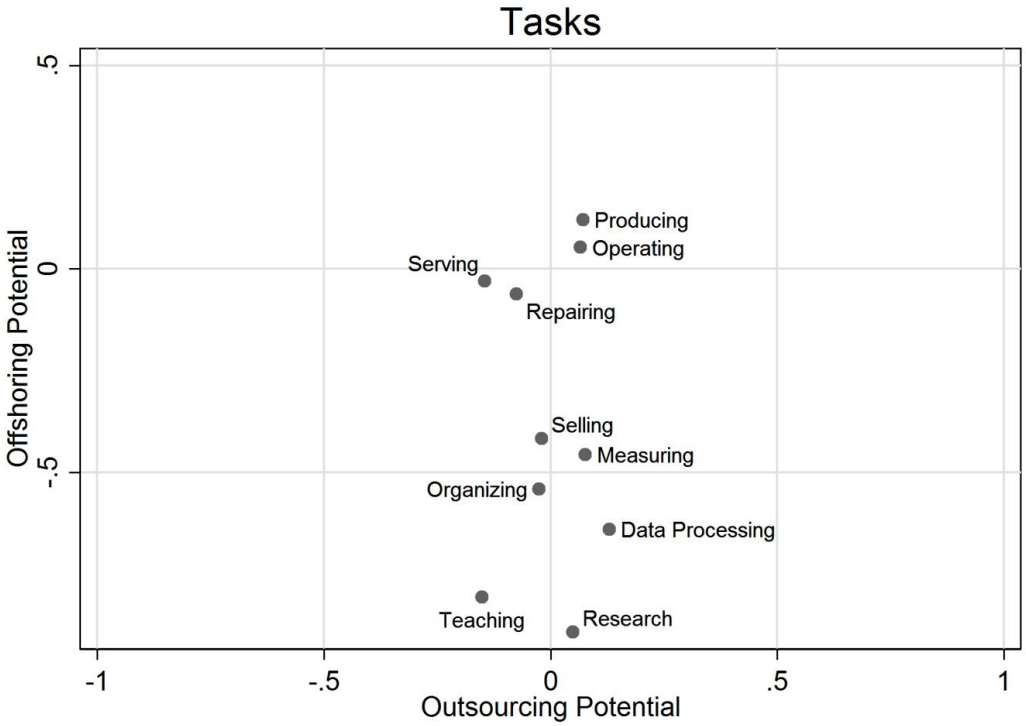
With respect to tasks, Figure 5.3 presents the results for the two indicators aggregated on the task level. We have used ten task categories that are consistently available for all waves (cf. Rohrbach-Schmidt and Tiemann, 2013). The results show that manual and production tasks are more easily offshoreable, whereas service tasks are more resistant to be relocated. Data processing is the most outsourceable task, while teaching and serving are the least outsourceable ones. The picture is quite heterogeneous between service tasks: Whereas knowledge intensive activities such as research and data processing seem to be characterized by low values of offshoring potential, other service activities of a rather interactive nature such as repairing or serving indicate quite high levels of offshoring potential. Compared to Figure 5.1, there is much less variation between groups on the outsourcing dimension, suggesting that outsourcing potential varies also within tasks, while offshoring potential varies more between tasks. The results, however, should be interpreted with care, as the vast majority of workers in the survey are not confined to one single task, but declare to perform several tasks. An analysis of main tasks, however, would be constrained to fewer waves of the BIBB data.

Figure 5.2 Potentials of Outsourcing and Offshoring by Occupational Groups



Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.

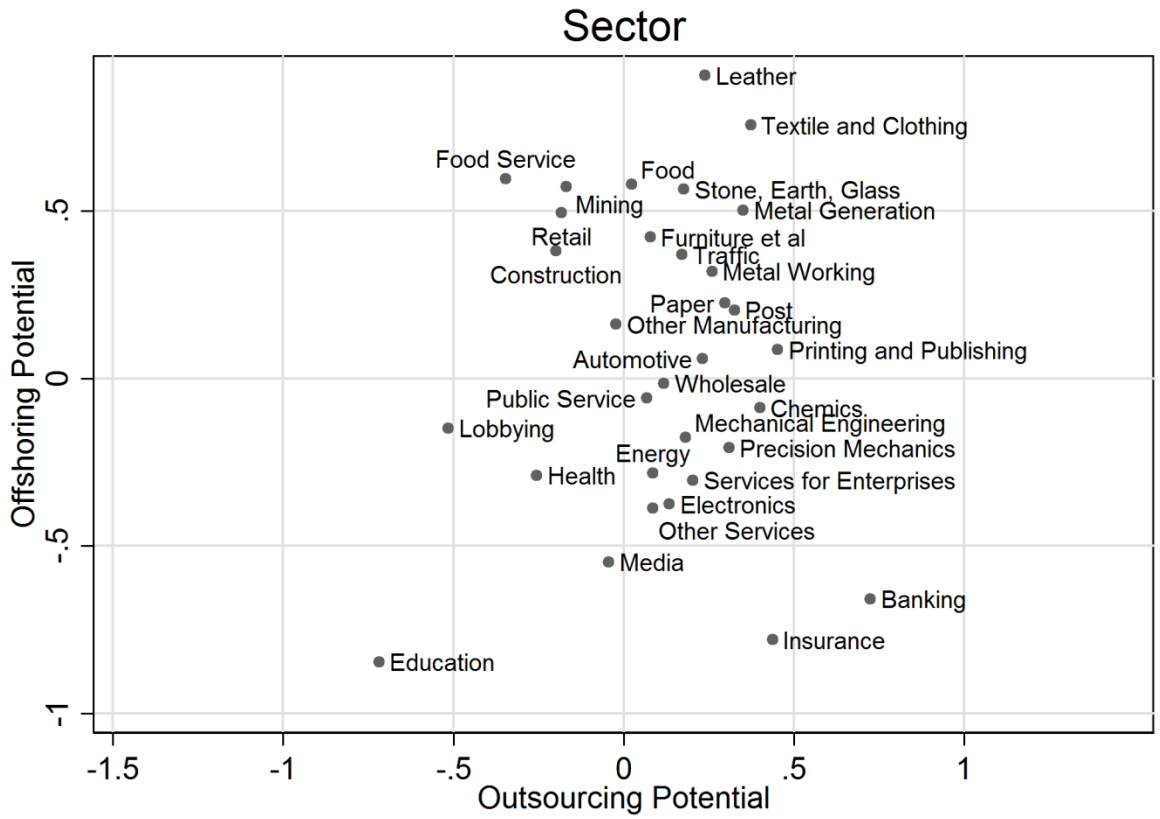
Figure 5.3 Potentials of Outsourcing and Offshoring by Task Groups



Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.

Finally, Figure 5.4 displays aggregate results with regard to different industries in the economy. The pattern matches the observations above in such a way that a large number of service industries are located either in the lower or in the left segment of the scatterplot (A), whereas the bulk of manufacturing activities is located in its upper right quadrant (D). The most offshoreable sectors are the leather and textile industries, while education, insurance and banking are least offshoreable. Banking and insurance are, however, more easily outsourceable, while education is most likely to be performed in-house.

Figure 5.4 Outsourcing Potential and International Tradability by Sectors of Economic Activity



Source: BIBB Survey, waves 1991, 1998, 2006, 2012; own calculations.

All in all, the results show that the indicators seem to capture the anecdotal and publicly available information on outsourcing and offshoring potential quite well. It also shows some similar patterns compared to other articles on the topic (Blinder, 2009; Spitz-Oener, 2006; Becker et al., 2013).[21] Also, the results show that the indicators allow for a significant amount of variation between offshoring and outsourcing potential. However, especially important for using the indicators in scientific research is the question how they perform relative to other measures in the literature.

[21] Of course, this is naturally the case, because we encompass the existing measures into our computations.

5.2 Comparison with other Indicators of Offshoring Potentials

Several papers from the literature on the labour market effects of international trade analyse the offshoring potentials of jobs, professions, or industries. For the following analyses, we chose three contributions from which either use similar indices to ours or which contain a similar basis for calculating such indices. As, to the best of our knowledge, there is no empirical paper that would allow for calculating simultaneously both an index on offshoring potentials and on outsourcing potentials, we restrict the analysis to the respective single external indicator (mostly on offshoring) contained in the contributions and compare them to our own indicators on offshoring and outsourcing potentials.

First, we revert to Blinder's (2009) index of offshorability. This index is available on the level of occupations (using 291 concrete occupational titles) and it has been transformed to the German classification of occupations by Schrader and Laaser (2009). Blinder's index is based on a subjective analysis of job characteristics and it mainly captures the attribute of locational ties, i.e. whether a job has to be performed at a specific location and cannot be transferred to another location abroad.

Second, we relate to Spitz-Oener's (2006) paper on the changing educational demands of jobs, where she also provides an assignment of job tasks to different types of activities (see Spitz-Oener, 2006, p. 243). Thereby, she distinguishes five types of activities, i.e. (i) non-routine analytic, (ii) non-routine interactive, (iii) routine cognitive, (iv) routine manual, and (v) non-routine manual. These types of activities can be linked, according to our literature review (cf. Section 2), to different degrees of offshorability. For the correlation analysis presented in Table 5.1, similarly to Hogrefe (2013), all tasks classified as routine manual or as routine cognitive have been classified as more offshorable (+1), whereas non-routine analytic tasks are classified as less offshoreable (-1); tasks classified as non-routine interactive and non-routine manual have been classified as ambiguous (0). Based on these assignments, indices of offshorability according to Spitz-Oener's (2006) classification have been calculated for the (various) tasks performed by the respective individual.[22]

Similarly to Spitz-Oener (2006) (and also based on the BIBB-Survey), Becker et al. (2013, p. 94f) classify tasks involved in an occupation into non-routine and interactive. Therefore, they use information from the survey on the tools used in the workplace[23] and they assign two indicators to each of the tools (i.e. whether the respective tool implies a non-routine or an interactive task). For the below calculations, we apply these assignments and calculate individual indices based on Becker's et al. (2013) propositions assuming that both non-routine and interactive tools imply decreasing degrees of offshorability of jobs (according to the extant literature).

Table 5.1 shows the correlation coefficients of our indices with the external indices on the level of professions (Tables A3 and A4 in the Appendix contain the correlation coefficients on the levels of industry sectors and individuals, respectively).

[22] Thereby, all tasks are weighted equally.

[23] The spectrum of these tools ranges from hand tools to machinery and diagnostic devices to computers and means of transport.

Table 5.1 Correlations between Indicators of Offshoring and Outsourcing Potentials and External Indicators (Level of Occupations)

	OFFSHORING	OUTSOURCING	Spitz-Oener	Becker et al.	Blinder
OFFSHORING	1.0000				
OUTSOURCING	0.2472	1.0000			
Spitz-Oener (2006)	0.5425	0.6991	1.0000		
Becker et al. (2013)	-0.5079	-0.5838	-0.6403	1.0000	
Blinder (2009)	-0.8107	0.1368	-0.2763	0.2340	1.0000

Source: Own calculations based on the BIBB Survey, waves 1991, 1998, 2006 and 2012.

Altogether, the correlations between our index of offshoring potentials and the external indices are quite high (each above 0.5). Particularly Blinder's (2009) index, which is also used as a proxy for locational ties in the present paper, shows a very close association with our index of offshoring potentials. On the other hand, the correlation with our measure of outsourcing potentials is quite low (0.14), as there is no link between an organisational relocation of a job and its (geographical) locational ties. The other external indices are more equally linked to both offshoring and outsourcing potentials, as both of them are based on measures (routines, interactivity) that can be used for both offshoring and outsourcing. Together with the equally high correlation coefficients on the level of industries (see Appendix), these results can be taken as an indication for the plausibility of our indicators.

5.3 Determinants of Offshorability and Outsourcability

In this section we analyse which observable characteristics in the data are correlated with the two indicators of offshorability and outsourcability. This allows us to get an insight into what types of individuals, sectors, and occupations are most affected by the potential to being offshored or outsourced. Therefore, we estimate a simple linear model:

$$y_{it} = \alpha_i + \gamma \boldsymbol{X}_{it} + \delta T_t + \varepsilon_{it} ,$$

where y_{it} either embodies an indicator of offshorability or outsourcability of individual i at time t.[24] We estimate the coefficient vector γ of individual level characteristics $\boldsymbol{X}_{it}$ as well as industry and occupation dummies and year dummies T_t using ordinary least squares. In this representation, we assume that the two dimensions of offshoring and outsourcing potentials can be explained independently from each other.[25] The coefficients of the independent variables can be interpreted as the marginal effects on one dimension conditioning that the other dimension does not change. An

[24] Variation over time is restricted to changes in observable characteristics in the baseline model. We have also used yearly PCA estimates, where we ran each PCA separately for each wave, allowing for different weights in each cross-section of the data.

[25] If one is interested in the determinants of combined outsourcing *and* offshoring potential, i.e. international outsourcing (category D in Figure 2.1), a joint indicator could be generated by e.g. adding up or multiplying. Theoretically, the relationship between the two dimensions can be negative if firms sort themselves according to specific productivities (Antras and Helpman, 2004). However, the empirical literature has found similar characteristics which affect both dimensions in the same direction, e.g. routines in Becker et al. (2013) for offshoring and Costinot et al. (2011) for outsourcing.

important benefit from directly using the BIBB Survey data is that the variables of interest do not represent aggregate indicators, but individual attributes. However, we cannot control for unobserved heterogeneity on the individual level, because of the cross-sectional nature of the data.

Table 5.1 presents the results from the OLS regression (summary statistics of all used variables are shown in Table A1 in the Appendix). Three models each present the results for outsourcing potential (1-3) and offshoring potential (4-6), and we subsequently add control variables. Specifications (1) and (4) only contain controls for firm size, industry, region, year and broad occupational groups. Specifications (2) and (5) add a number of individual and household attributes, while specifications (3) and (6) also include detailed occupational fixed effects.

First, it can be seen from the yearly dummy variables that outsourcing potential is lower in later time periods, while offshoring potential is higher in 2006 and 2012, but lower in 1998, compared to 1991. However, when adding control variables, outsourcing potential rises in 1998, and then falls.

Next, it seems to be the case that employees in larger firms have a lower outsourcing potential, but a higher offshoring potential. Hence, small firms tend to do certain tasks in-house, while large firms outsource them. Contrariwise, large firms employ individuals that may be offshored more easily.

The industry patterns show that (relative to public administration as a baseline category) most sectors have less outsourceable employees except in retail, transport and communications, and household services. However, the latter two are not significant after adding further control variables. Especially manufacturing industries employ individuals with less outsourceable jobs, indicating that they may have already outsourced most of the non-core tasks. Offshorability is relatively low in agriculture, construction, retail, hospitals and education, and in the cleaning sector. These are jobs that need to be performed in the home country. A high degree of offshorability is observed in wholesale, transport and communications (driven by the latter), and in services for businesses. Distinguishing occupations into service and manufacturing jobs, manufacturing jobs seem to be more outsourceable and offshoreable than service jobs in the service sectors, while service jobs in manufacturing are the least offshoreable jobs.

Table 5.1 Determinants of Outsourcing and Offshoring Potentials

Variable	Outsourcing Potential			Offshoring Potential		
	(1)	(2)	(3)	(4)	(5)	(6)
Year Dummy Variables (Baseline: 1991)						
1998	-0.0372**	0.7195***	0.6570***	-0.0405***	-0.0355	-0.0627***
	(0.0149)	(0.0290)	(0.0268)	(0.0103)	(0.0224)	(0.0212)
2006	-0.1158***	-0.0345**	-0.0306**	0.2565***	0.2152***	0.2202***
	(0.0148)	(0.0150)	(0.0141)	(0.0114)	(0.0125)	(0.0118)
2012	-0.5821***	-0.5682***	-0.5412***	0.4061***	0.3868***	0.3981***
	(0.0155)	(0.0164)	(0.0156)	(0.0114)	(0.0133)	(0.0126)
Firm Size in Employees (Baseline: < 10 Employees)						
10-49 Employees	-0.1305***	-0.0011	-0.0010	0.1290***	0.1607***	0.1027***
	(0.0157)	(0.0144)	(0.0139)	(0.0120)	(0.0120)	(0.0114)
50-99 Employees	-0.1412***	0.0286	0.0248	0.2415***	0.2831***	0.1720***
	(0.0204)	(0.0184)	(0.0176)	(0.0150)	(0.0149)	(0.0143)
100-499 Employees	-0.2591***	-0.0366**	-0.0384**	0.2997***	0.3454***	0.1764***
	(0.0176)	(0.0161)	(0.0155)	(0.0130)	(0.0131)	(0.0126)
500-999 Employees	-0.3999***	-0.1227***	-0.1120***	0.3679***	0.4189***	0.2259***
	(0.0249)	(0.0226)	(0.0215)	(0.0181)	(0.0180)	(0.0173)
> 1000 Employees	-0.5819***	-0.2071***	-0.1662***	0.3331***	0.3986***	0.2086***
	(0.0203)	(0.0187)	(0.0179)	(0.0146)	(0.0149)	(0.0144)
Industry (Baseline: Public Administration)						
Agriculture, Energy, Mining	-0.2186***	-0.2009***	-0.1010*	-0.2907***	-0.3049***	-0.0979**
	(0.0673)	(0.0602)	(0.0560)	(0.0499)	(0.0495)	(0.0476)
Basic production	-0.2900***	-0.3342***	-0.2144***	0.0640	0.0294	0.0356
	(0.0653)	(0.0584)	(0.0538)	(0.0482)	(0.0477)	(0.0458)
Steel, Electrical Eng., Precision	-0.3671***	-0.3348***	-0.1947***	-0.0709	-0.0817*	0.0332
	(0.0613)	(0.0551)	(0.0509)	(0.0459)	(0.0455)	(0.0436)
Steel forming, products and tools	-0.7701***	-0.6444***	-0.3003***	-0.0765	-0.0822*	0.0469
	(0.0663)	(0.0593)	(0.0548)	(0.0488)	(0.0483)	(0.0463)
Consumer Goods	-0.0864	-0.1945***	-0.1383**	0.0959*	0.0414	0.0299
	(0.0665)	(0.0597)	(0.0563)	(0.0494)	(0.0489)	(0.0480)
Food and Luxury	-0.1309*	-0.2180***	-0.1522***	-0.1844***	-0.2302***	-0.0743
	(0.0675)	(0.0604)	(0.0563)	(0.0496)	(0.0492)	(0.0475)
Construction	-0.2686***	-0.2549***	-0.1809***	-0.3100***	-0.3118***	-0.1345***
	(0.0651)	(0.0586)	(0.0550)	(0.0485)	(0.0481)	(0.0471)
Wholesale	-0.0393	-0.1058***	-0.2140***	0.1559***	0.1579***	0.1424***
	(0.0409)	(0.0374)	(0.0356)	(0.0298)	(0.0294)	(0.0284)
Retail	0.4897***	0.2208***	0.1863***	-0.1759***	-0.2471***	-0.0753***
	(0.0271)	(0.0248)	(0.0278)	(0.0211)	(0.0209)	(0.0221)
Transport and Comm.	0.4295***	0.3773***	0.0154	0.1277***	0.1248***	0.0833***
	(0.0335)	(0.0310)	(0.0308)	(0.0245)	(0.0243)	(0.0252)
Economic Services	-0.3474***	-0.2124***	-0.1552***	0.2917***	0.2903***	0.1375***
	(0.0269)	(0.0241)	(0.0252)	(0.0203)	(0.0200)	(0.0203)
Household Services	0.2910***	0.1618***	-0.0530	-0.2521***	-0.3135***	-0.0014
	(0.0347)	(0.0313)	(0.0361)	(0.0253)	(0.0253)	(0.0287)
Hospitals and Education	-0.3377***	-0.2214***	-0.1636***	-0.5021***	-0.5157***	-0.0531**
	(0.0249)	(0.0226)	(0.0262)	(0.0195)	(0.0192)	(0.0216)
Cleaning and Organisations	-0.5082***	-0.3351***	-0.3030***	-0.5243***	-0.4897***	-0.2009***
	(0.0427)	(0.0376)	(0.0369)	(0.0342)	(0.0335)	(0.0307)
Service Jobs in Service	-0.0637***	-0.1613***	-0.6838***	0.1315***	0.0603***	0.7864***
	(0.0236)	(0.0207)	(0.2101)	(0.0165)	(0.0166)	(0.1603)
Manufacturing Jobs	0.6600***	0.6094***	0.2153***	0.2451***	0.2494***	0.1574***
	(0.0604)	(0.0541)	(0.0497)	(0.0447)	(0.0444)	(0.0428)
Service Jobs in Manufacturing	-0.4798***	-0.3882***	-0.1868***	-0.0460**	-0.015	-0.0720***
	(0.0299)	(0.0261)	(0.0268)	(0.0209)	(0.0207)	(0.0214)

Sex		0.3280***	0.4590***		0.2046***	0.1060***
		(0.0123)	(0.0125)		(0.0097)	(0.0099)
Age		-0.0481***	-0.0452***		-0.0082***	-0.0144***
		(0.0035)	(0.0033)		(0.0028)	(0.0026)
Age Squared/100		0.0664***	0.0627***		0.0027	0.0103***
		(0.0041)	(0.0039)		(0.0033)	(0.0031)
German Born		-0.3930***	-0.2518***		-0.1449***	-0.1567***
		(0.0225)	(0.0208)		(0.0182)	(0.0173)
Foreign Nationality		0.1947***	0.1460***		0.1128***	0.1379***
		(0.0319)	(0.0298)		(0.0250)	(0.0238)
Education and Qualification (Baseline: Only Middle School)						
Middle School and Vocational Training		-0.6064***	-0.3791***		-0.0277**	-0.0585***
		(0.0151)	(0.0146)		(0.0112)	(0.0111)
Only Highschool		-0.8349***	-0.4481***		0.0361	-0.0496*
		(0.0434)	(0.0398)		(0.0300)	(0.0287)
Highscool and Vocational Training		-1.2229***	-0.7501***		0.0984***	-0.0251
		(0.0251)	(0.0248)		(0.0204)	(0.0200)
College Degree		-1.5436***	-0.8964***		-0.2303***	-0.2216***
		(0.0206)	(0.0211)		(0.0165)	(0.0166)
University Degree		-1.9860***	-1.1735***		-0.2750***	-0.2936***
		(0.0203)	(0.0227)		(0.0161)	(0.0180)
Tenure (Baseline: 1 Year or less)						
2-4 Years Tenure		-0.0422**	-0.0356**		0.0260*	0.0280**
		(0.0178)	(0.0165)		(0.0142)	(0.0133)
5-10 Years Tenure		-0.0802***	-0.0645***		0.0545***	0.0478***
		(0.0170)	(0.0159)		(0.0136)	(0.0127)
More than 10 Years		-0.2082***	-0.1533***		0.0814***	0.0592***
		(0.0172)	(0.0161)		(0.0137)	(0.0130)
Working Time		-0.0190***	-0.0164***		-0.0011**	-0.0003
		(0.0006)	(0.0005)		(0.0005)	(0.0004)
Household Size (Baseline: 1 Person)						
2 Persons		-0.0512***	-0.0315***		-0.0363***	-0.0381***
		(0.0122)	(0.0114)		(0.0097)	(0.0092)
3 Persons		-0.0191	0.0119		-0.0514***	-0.0472***
		(0.0181)	(0.0169)		(0.0145)	(0.0137)
4 or more Persons		-0.1113***	-0.0863***		-0.1304***	-0.1273***
		(0.0220)	(0.0205)		(0.0174)	(0.0163)
Children Present		-0.0804***	-0.0850***		-0.0539***	-0.0518***
		(0.0124)	(0.0116)		(0.0098)	(0.0093)
Partner Works		-0.0041	-0.0170		0.0091	0.0148
		(0.0163)	(0.0150)		(0.0128)	(0.0121)
16 German State Dummy Variables	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
99 Occupation Dummy Variables	No	No	Yes***	No	No	Yes***
Constant	0.3888***	2.8780***	2.6377***	-0.3063***	0.1624**	-0.1203
	(0.0446)	(0.0838)	(0.1872)	(0.0313)	(0.0679)	(0.1372)
No. Of Obs.	75276	75276	75276	75276	75276	75276
F-Statistic	235.32	568.01	381.79	230.71	191.56	168.85
R^2 between Occupations			0.68			0.52
R^2 within Occupations			0.14			0.06
R^2 Overall	0.1	0.28	0.38	0.11	0.13	0.24

*Note: Robust standard errors in parentheses: * p<0.10, ** p<0.05, *** p<0.01;*

Source: BIBB Survey, waves 1991, 1998, 2006 and 2012, own calculations.

The results for individual and household characteristics indicate that female employees and employees with foreign nationality work in more outsourceable and offshoreable jobs. Moreover, there is a negative effect of workers' age for both offshorability and outsourcability. Concerning education and qualification, there is a strong negative correlation between having higher school degrees and working in an outsourceable job, but a less strong correlation between education and offshorability. In fact, only a college or university degree reduces the offshorability of a job, while employees without a vocational degree might work in less offshoreable jobs than employees with a vocational degree. Tenure is negatively associated with job outsourcability, while jobs with long tenure are more easily offshoreable. Working time (in terms of weekly hours) has only a weak correlation with offshorability, while longer working hours reduce the outsourcability of a job. Finally, employees in larger households have jobs less susceptible to be outsourced or offshored. A working partner is not correlated with higher or lower offshorability.

Most of the results hold when we include a large number of occupational dummy variables, i.e. fixed effects. Including these has a huge explanatory power, as occupations share a lot of job characteristics, which means that variation in the indicators of outsourcing and offshoring potentials occurs rather between than within occupations. This can be seen from the respective R^2s of an occupation-fixed effects regression. The between R^2 is about five to eight times larger than the within R^2. The overall R^2 of our estimation models seem of reasonable magnitude.

Compared with other studies that try to explain outsourcing or offshoring potential with microeconomic characteristics, e.g. Blinder and Krueger (2013), we find similar results. This may, however, not be the case for all variables, mainly because we use an aggregated index rather than single job characteristics. Also, results distinguishing between outsourcing and offshoring potential have not been provided by the literature yet.

6 Conclusions

In this paper we empirically develop two indicators measuring the potentials of jobs to relocated organisationally (outsourcing) and/or geographically across boarders (offshoring). Our implementations are based on the four latest waves of the BIBB/BAuA Survey on Qualifications and Working Conditions in Germany, an employee-level dataset containing comprehensive information on the characteristics of individuals and their respective jobs and tasks. So far, the empirical evidence on trade in tasks has focused on grouping certain tasks according to their offshoring potential. While the literature has precisely modelled the effects of falling offshoring costs and rising intra-firm division of labour, there has been, until now, a substantial degree of imprecision in analysing offshoring as a one-dimensional decision. Contrary to this, the decision to outsource a certain activity might be driven by factors other than the decision of whether or not to perform these activities abroad or domestically.

The basic assumption of our contribution is that the potentials of a job to be relocated depend on certain characteristics of that job. Based on a review of the literature on the outsourcing and offshoring potentials of jobs, several of these characteristics are outlined and discussed. These characteristics are then identified and operationalised in our data. By the means of a principal components analysis, a mathematical procedure that uses an orthogonal transformation to reduce the set of possibly correlated determinants into a smaller set of linearly uncorrelated components,

two indicators (i.e. components) are computed – one of them is interpreted as the potential of a job to be relocated organisationally (outsourcing potential), the other one as the potential of a job to be relocated geographically across boarders (potential to be traded internationally, i.e. offshored).

To confirm the viability and plausibility of the new indices, several empirical illustrations and tests of the indicators are performed. We start from graphical visualisations of the indices at the aggregate levels of professions, tasks, and sectors of economic activity. These show, inter alia, that many manufacturing or low-skill routine service jobs are among the most susceptible professions to be offshored, whereas laundry workers, packagers or cashiers are most prone to be outsourced. Secondly, we compare our measures to other computable or already computed measures of relocation potentials, which use either similar data or similar hypotheses. It turns out that the results of our indices are quite connatural to these other measures and are thus plausible. Last but not least, we link our employee-level indices to several relevant characteristics of these same employees and analyse which employee-level attributes determine whether an employee's job is outsourceable or offshoreable. It turns out, for instance, that employees in larger firms are less prone to be outsourced than in small firms (maybe because most outsourceable jobs already have been *de facto* outsourced in larger firms), whereas they are more susceptible to be offshored (maybe because of different job characteristics in larger firms).

Although our computed indices are not completely unambiguous[26], the bottom line is that these new measures, which have been generated in a data-driven, transparent and documented way, show viable and plausible results that are consistent with the extant literature. Therefore, if these indices are used in further analyses, e.g. in studies relating them to actual offshoring or outsourcing, they can provide valuable additional insights into the processes shaping and determining the (international) division of labour.

[26] Which might have several causes starting from inherent problems of the survey data, continuing with the threat of arbitrariness of the principal components analysis and probably not ending up with our manipulations of the data in order to get consistent measures over a large time span.

7 References

Akcomak, S.; Borghans, L. and B. ter Weel (2011): Measuring and Interpreting Trends in the Division of Labour in the Netherlands, in: *De Economist* 159 (4), 435-482.

Antonczyk, D.; Fitzenberger, B. and U. Leuschner (2009): Can a Task-Based Approach Explain the Recent Changes in the German Wage Structure, in: *Journal of Economics and Statistics (Jahrbücher für Nationalökonomie und Statistik) 229 (2+3), 214-238.*

Antras, P. (2003): Firms, Contracts, and Trade Structure, in*: Quarterly Journal of Economics* 118 (4), 1375-1418.

Antras, P. and E. Helpman (2004): Global Sourcing, in: *Journal of Political Economy* 112 (3), 552-580.

Autor, D.H. (2013): The "Task Approach" to Labor Markets: An Overview, in: *Journal for Labour Market Research* 46 (3), 185-199.

Autor, D.H. and D. Dorn (2009): This Job is "Getting Old": Measuring Changes in Job Opportunities Using Occupational Age Structure, in: *American Economic Review* 99 (2), 45-51.

Autor, D.H. and M. Handel (2013): Putting Tasks to the Test: Human Capital, Job Tasks and Wages, in: Journal of Labor Economics 31 (2), 59-96.

Autor, D.H.; Levy, F. and R.J. Murnane (2003): The Skill Content of Recent Technological Change: An Empirical Exploration, in: *Quarterly Journal of Economics*118 (4), 1279-1333.

Baldwin, R. (2006): Globalisation: The Great Unbundling(s), Graduate Institute of International Studies, Geneva, Economic Council of Finland, Helsinki.

Barba-Navaretti, G. and A. Venables (2004): *Multinational Firms in the World Economy*, Princeton University Press.

Bardhan, A.D. and C.A. Kroll (2003): The New Wave of Outsourcing, Research Report, Fisher Center for Real Estate and Urban Economics, University of California, Berkeley.

Becker, S.O. and M.A. Muendler (2012): Trade in Tasks: A Preliminary Exploration with German Data, EFIGE Working Paper No. 45.

Becker, S. O. ; Ekholm, K. and M.A. Muendler (2013): Offshoring and the Onshore Composition of Tasks and Skills, in: *Journal of International Economics*90 (1), 91-106.

Blinder, A.S. (2006): Offshoring: The Next Industrial Revolution?, in: *Foreign Affairs* 85 (2).

Blinder, A.S. (2009): How Many US Jobs Might be Offshorable?, in: *World Economics* 10 (2), 41-78.

Blinder, A.S. and A.B. Krueger (2013): Alternative Measures of Offshorability: A Survey Approach, in: Journal of Labor Economics 31 (2), 97-128.

Coase, R. (1937): The Nature of the Firm, in: *Economica 16 (4)*386-405.

Costinot, A. ; Oldenski, L. and J. Rauch (2011): Adaption and the Boundary of Multinational Firms, in: *Review of Economics and Statistics* 93 (1), 298-308.

Crinò, R. (2009): Offshoring, Multinationals and Labour Market: A Review of the Empirical Literature, in: *Journal of Economic Surveys* 23 (2), 197-249.

Ethier, W.J. (1986): The Multinational Firm, in: *Quarterly Journal of Economics* 101 (1), 805-833.

Federico, S. (2012): Headquarter Intensity and the Choice between Outsourcing versus Integration at Home or Abroad, in: *Industrial and Corporate Change* 21 (6), 1337-1358.

Goos, M.; Manning, A. and A. Salomons (2009): Recent Changes in the European Employment Structure: The Roles of Technology and Globalization, Open Access Publications from Katholieke Universiteit Leuven.

Görlich, D. (2010): Complementary Tasks and the Limits to the Division of Labour, Working Paper No. 1670, Kiel Institute for the World Economy.

Görlich, D. and D. Snower (2010): Wage Inequality and the Changing Organization of Work, Working Paper No. 1588, Kiel Institute for the World Economy.

Grossman, G.M. and O. Hart (1986): The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, in: *Journal of Political Economy* 94 (4), 691-719.

Hart, O. and J. Moore (1990): Property Rights and the Nature of the Firm, in: *Journal of Political Economy* 98 (6), 1119-1158.

Heyman, F. and P.G. Tingvall (2012): The Dynamics of Offshoring and Institutions, Working Paper No. 919, Research Institute of Industrial Economics.

Hijzen, A. (2006): International Outsourcing, Technological Change, and Wage Inequality, in: *Review of International Economics* 15 (1), 188-205.

Hogrefe, Jan (2013): Offshoring and Relative Labor Demand from a Task Perspective, *ZEW Discussion Paper No. 13-067*.

Jackson, J.E. (2003): *A User's Guide to Principal Components*. New York: Wiley.

Jensen, J.B. and L.G. Kletzer (2010): Measuring Tradable Services and the Task Content of Offshorable Services Jobs, in: Abraham, K.; Harper, M. and J. Spletzer (eds.): *Labor in the New Economy*, University of Chicago Press, 309-335.

Jolliffe, I.T. (2002): *Principal Component Analysis*. 2nd ed. New York: Springer.

Kaiser, H.F. (1958): The Varimax Criterion for Analytic Rotation in Factor Analysis, in: *Psychometrika*23 (3), 187-200.

Lanz, R. ; Miroudot, S. and H.K. Nordås (2011): Trade in Tasks. OECD Trade Policy Working Paper No. 117. Paris: OECD.

Leamer, E. and M. Storper (2001): The Economic Geography of the Internet Age, NBER Working Paper No. 8450.

Lo Turco, A. and D. Maggioni (2012): Offshoring to High and Low Income Countries and the Labor Demand. Evidence from Italian Firms, in: *Review of International Economics* 20 (3), 636-653.

Mankiw, N. and P. Swagel (2006): The Politics and Economics of Offshore Outsourcing, in: *Journal of Monetary Economics*, 53 (5), 1027-1056.

Merino, F. and D.R. Rodríguez (2007): Business Services Outsourcing by manufacturing Firms, in: *Industrial and Corporate Change* 16 (6), 1147-1173.

Oldenski, L. (2009): Export Versus FDI: A Task-Based Framework for Comparing Manufacturing and Services, *mimeo*.

Rabe-Hesketh, S. and B.S. Everitt (2007): *A Handbook of Statistical Analyses Using Stata*. 4th ed. Boca Raton, FL: Chapman & Hall/CRC.

Rohrbach-Schmidt, D. and M. Tiemann (2013): Changes in Workplace Tasks in Germany – Evaluating Skill and Task Measures, in: *Journal for Labour Market Research* 46 (3), 215-237.

Schrader, K. adn C. Laaser (2009): Globalisierung in der Wirtschaftskrise: Wie sicher sind die Jobs in Deutschland?, Kieler Diskussionsbeiträge No.465, Kiel Institute for the World Economy.

Spitz-Oener, A. (2006): Technical Change, Job Tasks, and Rising Educational Demands: Looking outside the Wage Structure, in: *Journal of Labor Economics* 24 (2), 235-270.

Wagner, J. (2011): Offshoring and firm performance: Self-selection, effects on performance, or both?, in: *Review of World Economics* 147 (2), 217-247.

Welsum, D. van and X. Reif (2005): Potential Offshoring: Evidence from Selected OECD Countries, in: *Brookings Trade Forum 1*, OECD, 164-194.

8 Appendix

Table A1 Overview of Individual, Household, and Firm Characteristics

Variable	Obs	Mean	Std. Dev.	Min	Max
Wage Class					
<500	63,672	0.05	0.21	0	1
500-1000	63,672	0.13	0.33	0	1
1000-1500	63,672	0.20	0.40	0	1
1500-2000	63,672	0.20	0.40	0	1
2000-2500	63,672	0.15	0.36	0	1
2500-3000	63,672	0.10	0.30	0	1
3000-3500	63,672	0.06	0.24	0	1
3500-4000	63,672	0.04	0.20	0	1
<4000	63,672	0.08	0.27	0	1
Sex	72,845	0.46	0.50	0	1
Age	72,845	41.18	10.89	18.00	65.00
German Born	72,845	0.93	0.25	0	1
Foreign Nationality	72,845	0.03	0.18	0	1
Education and Qualification					
Only Middle School	72,845	0.16	0.37	0	1
Middle School and Vocational Training	72,845	0.56	0.50	0	1
Only Highschool	72,845	0.02	0.14	0	1
Highscool and Vocational Training	72,845	0.05	0.22	0	1
College Degree	72,845	0.10	0.30	0	1
University Degree	72,845	0.11	0.31	0	1
Tenure	72,845	11.70	9.87	0	51.00
Experience	72,845	21.55	11.69	0	53.00
Working Time	72,845	51.48	21.19	10.00	80.00
Type of Worker					
Blue Collar Worker	72,845	0.31	0.46	0	1
White Collar Worker	72,845	0.69	0.46	0	1
Household Size					
1	72,845	0.41	0.49	0	1
2	72,845	0.35	0.48	0	1
3	72,845	0.15	0.35	0	1
4 and more	72,845	0.10	0.30	0	1
Children Present	72,845	0.52	0.50	0	1
Partner Works	72,845	0.13	0.33	0	1
16 German States (Länder) Dummy Variables					
Firm Size in Employees					
< 10	72,845	0.18	0.38	0	1
10-49 E	72,845	0.27	0.45	0	1
50-99	72,845	0.12	0.32	0	1
100-499	72,845	0.22	0.41	0	1
500-999	72,845	0.07	0.25	0	1
< 1000	72,845	0.15	0.35	0	1
Year Dummy Variables for 1998, 2006, 2012					
15 Industry Dummy Variables					
Service Worker	72,845	0.64	0.48	0	1
Manufacturing Worker	72,845	0.43	0.50	0	1
Service Worker in Manufacturing	72,845	0.14	0.34	0	1

Source: BIBB Survey, waves 1991, 1998, 2006, 2012, own calculations.

Table A2 Computation of Job Characteristics across Waves

Variable	1991	1998	2006	2012	Procedures of Data Treatment
Codifiability (COD)	V184: How often does it happen in your job that you are given highly specific regulations on how to perform your work? *Answers may be given on a scale from 1 (practically always) to 5 (practically never)*	V265 (F22402): How often does it happen in your job that you are given highly specific regulations on how to perform your work? *Answers may be given on a scale from 1 (often) to 3 (never)*	f411_02: How often does it happen in your job that you are given highly specific regulations on how to perform your work? *Answers may be given on a scale from 1 (often) to 3 (never)*	F411_02: How often does it happen in your job that you are given highly specific regulations on how to perform your work? *Answers may be given on a scale from 1 (often) to 3 (never)*	Consistent coding of scales: 5-point scale from 1991 and 1998 transformed into 4-point scale to match 2006 and 2012
Routines (ROU)	V185: How often does it happen in your job that you have to repeat the same step in every detail? *Answers may be given on a scale from 1 (practically always) to 5 (practically never)*	V266 (F22403): How often does it happen in your job that you have to repeat the same step in every detail? *Answers may be given on a scale from 1 (often) to 3 (never)*	f411_03: How often does it happen in your job that you have to repeat the same step in every detail? *Answers may be given on a scale from 1 (often) to 3 (never)*	F411_03: How often does it happen in your job that you have to repeat the same step in every detail? *Answers may be given on a scale from 1 (often) to 3 (never)*	Consistent coding of scales: 5-point scale from 1991 and 1998 transformed into 4-point scale to match 2006 and 2012
Complexity (SUM)	Please tell me which of these activities apply to your work *(yes/no)* V38 machines/system setting, adjusting, adapting, programing V39 machines/system operating, controlling, loading V40 machines/system repairing, Servicing V41 driving V42 houses/ apartments /art repairing restoring, renewing V43 growing, harvesting plants / breed, fostering animals V44 resource attracting, dismantling, promoting V45 producing, molding, processing substances, preparing earth V46 building, demolishing, installing, assembling buildings / facilities / equipment V47 host, serve, accommodate V48 Clean, ironing, purify V49 remove waste, dispose V50 pack, load, ship, deliver V51 Sort, store, display, archive V52 analyze, research, experiment, test, measure, plan V53 construct, design, draw, create art V54 buy, sell, collect, arrange, advise clients, advertise	I will now give you some selected activities. Please indicate how often these occur in your work *(Often, Rarely, Never)* V189 forming, teaching V190 Other advising, informing V191 measuring, testing, quality control V192 monitoring, control of machines/equipment, technical processes V193 Repairing V194 Shopping, procurement, Selling V195 organizing, planning (beyond the immediate preparation of your own work) V196 Advertising, Communication/PR, marketing, acquiring V197 Collecting / analyzing information, investigating V198 Negotiating V199 developing, researching V200 manufacturing, producing goods V201 serving/attending/caring for people	Please tell me how often these activities occur in your work, whether they occur *(often, sometimes or never).* F303: Manufacturing, producing goods and commodities F304: Measuring, testing, quality control F305: Monitoring, control of machines, plants, technical processes F306: Repairing, refurbishing F307: Purchasing, procuring, selling F308: Transporting, storing, shipping F309: Advertising, marketing, public relations F310: Organizing, planning and preparing work processes. Here we are not talking about your own work processes. F311: Developing, researching, constructing F312: Training, instructing, teaching, educating F313: Gathering information, investigating, documenting F314: Providing advice and information F315: Entertaining, accommodating, preparing food F316: Nursing, caring, healing	Please tell me how often these activities occur in your work, whether they occur *(often, sometimes or never)* F303: Manufacturing, producing goods and commodities F304: Measuring, testing, quality control F305: Monitoring, control of machines, plants, technical processes F306: Repairing, refurbishing F307: Purchasing, procuring, selling F308: Transporting, storing, shipping F309: Advertising, marketing, public relations F310: Organizing, planning and preparing work processes. Here we are not talking about your own work processes. F311: Developing, researching, constructing F312: Training, instructing, teaching, educating F313: Gathering information, investigating, documenting F314: Providing advice and information F315: Entertaining, accommodating, preparing food F316: Nursing, caring, healing F317: Protecting, guarding, patrolling,	Sum of tasks done by individual relative to average number of tasks done in that Year. Recoded as a 4-point scale

	V55 typing, correspondence, form work V56 calculate, compute, book V57 computer services, programing V58 Secure, guard V59 apply, interpret, notarize laws/regulations V60 educate, teach, train, help, advise V61 groom, care for, handle medication/cosmetics, hairdressing V62 publish, maintain, submit, design V63 HR, manage, monitor, evaluate V64 decision making, coordinating, organize, planning V65 other activities		F317: Protecting, guarding, patrolling, directing traffic F318: Working with computers F319a: Cleaning, removing waste, recycling	directing traffic F318: Working with computers F320: Cleaning, removing waste, recycling	
Complementarity (COM)	Subset of task/activity questions used for complexity variable	Subset of task/activity questions used for Complexity variable	Subset of task/activity questions used for Complexity variable	Subset of task/activity questions used for Complexity variable	Coding of similar tasks according to Görlich/Snower (2010) and Spitz-Oener (2006). 4-point scale based on number times individuals do a specific combination of tasks based on their total number of tasks (from the following: Operating, Repairing, Data Processing, Measuring, Researching, Producing, Selling, Serving, Teaching, Organizing)
Information and Communication Technologies (ICT)	Do you work with the following computer- or program-controlled machines/systems? *(yes/no)* v140: computers, computer systems/terminals, screens, process computers v141: program-controlled medical devices Which computerized office machines and data processing equipment do you use? v160: Personal Computer v161: Electronic Data Processing (EDP) system v162: visual display terminals v163: typewriters v164: teletext device v166: CAD graphics system	V53 (F106D): Do you often at your main professional activity, possibly secondary activity, work with computers and data processing equipment? V54 (F106D30): If you look at this list, what are they? Please give me the reference. Do they include objects that you work with frequently? V55 (F106D31): PC/terminal with a connection to an internal network (also host computer) V56 (F106D32): PC/terminal with connection to an external network: internet, e-mail v57 (F106D33): A portable computer (laptop, notebook) V59 (F106D35): computer for the control of machines/equipment V60 (F106D36): Other types of computers or computer equipment	f320: If working with computers: In the following, we are interested in which way do you work with computers. Are you exclusively a computer user, or does your work with computers include more than just using them? f324: What percentage of your time in your work do you spend, on average, working on a computer? f1001_02: In the last two years, have new computer programs have been introduced in your workplace? We are not talking about new release versions of existing programs here	F324: If working with computers: In the following, we are interested in which way do you work with computers. Are you exclusively a computer user, or does your work with computers include more than just using them? F326: What percentage of your time in your work do you spend, on average, working on a computer? f1001_02: In the last two years, have new computer programs have been introduced in your workplace? We are not talking about new release versions of existing programs here	Variable is constructed on a 4-point scale. For 1991 and 1998, 0: no ICT use and 4: 5 or more items. For 2006 and 2012: 1: not working with computers and an additional point for each of the following: working with computers as more than a user, new computer programs introduced in the workplace or spends more than 75% of work time on a computer

Interactivity (INT)	*How often does it happen in your job...* V189: that you are dependent on others V190: that you have to negotiate *Answers may be given on a scale from 1 (practically always) to 5 (practically never)*	V198: How often does it happen in your job that you have to negotiate? *Answers may be given on a scale from 1 (often) to 3 (never)*	How often does it happen in your job... f325_03: that you have to convince other people and negotiate compromises? f325_06: that you give talks or lectures/speeches f325_07: that you will have contact with customers, clients or patients? *Answers may be given on a scale from 1 (often) to 3 (never)*	How often does it happen in your job... F327_05 that you have to convince other people and negotiate compromises? F327_06 that you have to communicate with other people in your job? *Answers may be given on a scale from 1 (often) to 3 (never)*	1991 is reduced to a 3-point scale. For all years, the interactivity variable is the average response for each of these questions listed
Locational Ties (LOC)	Uses questions about occupation	Uses questions about occupation	uses questions about occupation	uses questions about occupation	Defined on the basis of 3-digit professions according to Blinder (2006) and Schrader and Laaser (2009)
Cultural Linkage: Law (LAW)	V95: Do you require knowledge of labor law for your job? *(yes/no)* V96: Do you require other legal knowledge for your job? *(yes/no)*	V223: Do you require knowledge of labor law for your job? *(yes/no)* V224: Do you require other legal knowledge for your job? *(yes/no)*	f403_04: Do you require legal knowledge for your job? *Please answer with "No knowledge" (1), "basic knowledge" (2) or "specialist knowledge" (3)*	F403_01: Do you require legal knowledge for your job? *Please answer with "No knowledge" (1), "basic knowledge" (2) or "specialist knowledge" (3)*	Consistent coding of scales: For 2006 and 2012, transformed into dummy variable with specialist knowledge: 1
Cultural Linkage: Writing Skills (WRI)	No relevant survey question. Data imputed	V214: Do you require knowledge of written German for your job? *(yes/no)*	f403_09: Do you require knowledge of written German for your job? *Please answer with "no knowledge" (1), "basic knowledge" (2) or "specialist knowledge" (3)*	F403_05: Do you require knowledge of written German for your job? *Please answer with "no knowledge" (1), "basic knowledge" (2) or "specialist knowledge" (3)*	Consistent coding of scales: For 2006 and 2012, transformed into dummy variable with specialist knowledge: 1. For 1991 and all other missing observations, median writing skill from other waves by occupation is used to impute a value
Cultural Linkage: Foreign Languages (LAN)	V274-V279: Do you need knowledge of the following languages: English, French, Italian, Spanish, Russian, other? *(yes/no) separately for each language*	V726-V734 (F50401-F50409): Do you need knowledge of the following languages: English, French, Greek, Italian, Portuguese, Spanish, Russian, Turkish, other? *(yes/no) separately for each language*	f406_01-f406_10: Do you need knowledge of the following languages: English, French, Russian, Spanish, Turkish, Italian, Greek, Portuguese, Polish, other? *(yes/no) separately for each language*	F403_10: Do you require basic or specialist knowledge of languages other than German in your work? *Please answer with "no knowledge" (1), "basic knowledge" (2) or "specialist knowledge" (3).* F403_11: Is English the language of which you require this specialist knowledge/knowledge? If yes... How proficient do you have to be in English? Do you need to be: *F404_01 proficient in speaking *F404_02 proficient in writing *F404_03 business fluent	Consistent Coding of Scales: transformation into 4-point scales. For 1991, 1998 and 2006, 4-point scale is based on the number of languages required where 4: 3 or more languages. For 2012, 4 point scale based on F403_10 for 1, 2, 3, and 4 if F404_02 or F404_03 are true
New Scopes (NEW)	How often does it happen in your job... V186: that you are facing new tasks which you have to think through and get familiar with? V187: that you improve existing procedures or try out something new?	*How often does it happen in your job…* V267: that you are facing new tasks which you have to think through and get familiar with? V268: that you improve existing procedures or try out something new? *Answers may be given on a scale from*	How often does it happen in your job... f411_04: that you are facing new tasks which you have to think through and get familiar with? f411_05: that you improve existing procedures or try out something new?	How often does it happen in your job... F411_04: that you are facing new tasks which you have to think through and get familiar with? F411_05: that you improve existing procedures or try out something new?	Consistent Coding of Scales: transformation of variables from 5-point scale in 1991 and 1998 and from 3 point scale for 2006 and 2012 into a 4-point scale

	Answers may be given on a scale from 1 (practically always) to 5 (practically never)	*1 (practically always) to 5 (practically never)*	Answers may be given on a scale from 1 (often) to 4 (never). f325_01: that you must respond to unforeseen problems and solve them? f325_05: that you need to identify and close gaps in your knowledge? *Answers may be given on a scale from 1 (often) to 3 (never)*	Answers may be given on a scale from 1 (often) to 4 (never). F327_01: that you have to react to and solve problems? F327_03: that you need to identify and close gaps in your knowledge? *Answers may be given on a scale from 1 (often) to 3 (never)*	

Source: BIBB Survey, waves 1991, 1998, 2006, 2012, own compilation.

Table A3 Correlations between Indicators on Offshoring and Outsourcing Potentials and External Indicators (Level of Industries)

	OFFSHORING	OUTSOURCING	Spitz-Oener	Becker et al.	Blinder
OFFSHORING	1.0000				
OUTSOURCING	-0.1438	1.0000			
Spitz-Oener (2006)	0.5956	0.4244	1.0000		
Becker et al. (2013)	-0.4555	-0.5443	-0.6773	1.0000	
Blinder (2009)	-0.8815	0.1823	-0.5433	0.4607	1.0000

Source: Own calculations based on the BIBB Survey, waves 1991, 1998, 2006 and 2012.

Table A4 Correlations between Indicators on Offshoring and Outsourcing Potentials and External Indicators (Level of Individuals)

	OFFSHORING	OUTSOURCING	Spitz-Oener	Becker et al.	Blinder
OFFSHORING	1.0000				
OUTSOURCING	0.1794	1.0000			
Spitz-Oener (2006)	0.1897	0.3023	1.0000		
Becker et al. (2013)	-0.1670	-0.2510	-0.2775	1.0000	
Blinder (2009)	-0.4056	0.1449	-0.1057	0.0970	1.0000

Source: Own calculations based on the BIBB Survey, waves 1991, 1998, 2006 and 2012.

IAW-Diskussionspapiere

Die IAW-Diskussionspapiere erscheinen seit September 2001. Die vollständige Liste der IAW-Diskussionspapiere von 2001 bis 2011 (Nr. 1-84) finden Sie auf der IAW-Internetseite http://www.iaw.edu/index.php/IAW-Diskussionspapiere.

IAW-Diskussionspapiere seit 2011:

Nr. 85 (Juni 2012)
From the Stability Pact to ESM – What next?
Claudia M. Buch

Nr. 86 (Juni 2012)
The Connection between Imported Intermediate Inputs and Exports: Evidence from Chinese Firms
Ling Feng / Zhiyuan Li / Deborah L. Swenson

Nr. 87 (August 2012)
EMU and the Renaissance of Sovereign Credit Risk Perception
Kai Daniel Schmid / Michael Schmidt

Nr. 88 (September 2012)
The Impact of Random Help on the Dynamics of Indirect Reciprocity
Charlotte Klempt

Nr. 89 (Oktober 2012)
Specific Measures for Older Employees and Late Career Employment
Bernhard Boockmann / Jan Fries / Christian Göbel

Nr. 90 (Oktober 2012)
The Determinants of Service Imports: The Role of Cost Pressure and Financial Constraints
Elena Biewen / Daniela Harsch / Julia Spies

Nr. 91 (Oktober 2012)
Mindestlohnregelungen im Maler- und Lackiererhandwerk: eine Wirkungsanalyse
Bernhard Boockmann / Michael Neumann / Pia Rattenhuber

Nr. 92 (Dezember 2012)
Turning the Switch: An Evaluation of the Minimum Wage in the German Electrical Trade Using Repeated Natural Experiments
Bernhard Boockmann / Raimund Krumm / Michael Neumann / Pia Rattenhuber

Nr. 93 (Januar 2013)
Outsourcing Potentials and International Tradability of Jobs
Evidence from German Micro-Level Data
Tobias Brändle / Andreas Koch

Nr. 94 (Februar 2013)
Firm Age and the Demand for Marginal Employment in Germany
Jochen Späth

Nr. 95 (Juli 2013)
Messung von Ausmaß, Intensität und Konzentration des Einkommens- und Vermögensreichtums in Deutschland
Martin Rosemann / Anita Tiefensee

Nr. 96 (Oktober 2013)
Flexible Collective Bargaining Agreements: Still a Moderating Effect on Works Council Behaviour?
Tobias Brändle

Nr. 97 (Oktober 2013)
New Firms and New Forms of Work
Andreas Koch / Daniel Pastuh / Jochen Späth

Nr. 98 (November 2013)
Non-standard Employment, Working Time Arrangements, Establishment Entry and Exit
Jochen Späth

IAW-Diskussionspapiere

Nr. 99 (Dezember 2013)
Intraregionale Unterschiede in der Carsharing-Nachfrage – Eine GIS-basierte empirische Analyse
Andreas Braun / Volker Hochschild / Andreas Koch

Nr. 100 (Dezember 2013)
Changing Forces of Gravity: How the Crisis Affected International Banking
Claudia M. Buch / Katja Neugebauer / Christoph Schröder

Nr. 101 (Januar 2014)
Vertraulichkeit und Verfügbarkeit von Mikrodaten
Gerd Ronning

Nr. 102 (Januar 2014)
Vermittlerstrategien und Arbeitsmarkterfolg: Evidenz aus kombinierten Prozess- und Befragungsdaten
Bernhard Boockmann / Christopher Osiander / Michael Stops

Nr. 103 (April 2014)
Evidenzbasierte Wirtschaftspolitik in Deutschland: Defizite und Potentiale
Bernhard Boockmann / Claudia M. Buch / Monika Schnitzer

Nr. 104 (Mai 2014)
Does Innovation Affect Credit Access? New Empirical Evidence from Italian Small Business Lending
Andrea Bellucci / Ilario Favaretto / Germana Giombini

Nr. 105 (Juni 2014)
Ressourcenökonomische Konzepte zur Verbesserung der branchenbezogenen Datenlage
bei nicht-energetischen Rohstoffen
Raimund Krumm

Nr. 106 (Juni 2014)
Do multinational retailers affect the export competitiveness of host countries?
Angela Cheptea

Nr. 107 (August 2014)
Sickness Absence and Work Councils – Evidence from German Individual and
Linked Employer-Employee Data
Daniel Arnold / Tobias Brändle / Laszlo Goerke

Nr. 108 (Oktober 2014)
Exploiting the Potential for Services Offshoring: Evidence from German Firms
Peter Eppinger

Nr. 109 (Oktober 2014)
Capital Income Shares and Income Inequality in 16 EU Member Countries
Eva Schlenker / Kai D. Schmid

Nr. 110 (Oktober 2014)
Offshoring and Outsourcing Potentials of Jobs – Evidence from German Micro-Level Data
Tobias Brändle / Andreas Koch