

# Measuring and Classifying Determinants of Offshoring Tasks

## A Methodological Report on Outsourcing Potential and International Tradeability<sup>1</sup>

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### Abstract

Using representative German task data, the German Qualifications and Career Survey we analyze trade in tasks. We differentiate between outsourcing potential and international tradeability and systematically use (nearly) all of the determinants of task offshoring so far employed in the literature. Applying multivariate analysis, we are able to compute two indicators explaining the offshoring potential of an employee according to the tasks performed. We apply our results to analyze the effects of outsourcing potential and international tradeability on individual income. While finding significantly negative correlation between both dimensions and the outcome variable, the effect of outsourcing potential is far larger. More importantly, our results can be used in further analyses of the consequences of trade in tasks.

JEL-Classification: D23, F16, J24, O33

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

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# 1 Introduction: Background and Motivation

In recent years we observe that firms increasingly split their production processes into smaller parts called ‘tasks’, i.e. single duties performed by an employee. These tasks can often not be assigned alongside traditional high-skilled vs. low-skilled categories, such that the implications from traditional trade models might not hold when trade in tasks becomes more and more important. This concept is increasingly relevant as reduced transaction and transportation costs especially promote outsourcing and trading these tasks both nationally and internationally.

So far, the economic literature has analyzed the determinants of and the consequences from this new type of trade: the offshoring of intermediate input production (cf. Hogrefe, 2011 and the citations therein). However, a differentiation between outsourcing, i.e. buying intermediate inputs on the market instead of producing them inside the firm, and international trade, i.e. producing inputs of goods in another country (no matter if in-house or outside the firm), has been widely neglected in the literature so far. Moreover, a systematic *empirical* classification of tasks into whether they can easily be outsourced and/or internationally traded is missing. Instead, existing classifications of tasks into the above categories (outsourcability and tradability) are based on rather subjective procedures and are mostly limited to small numbers of characteristics (cf. Spitz-Oener, 2006: arbitrary classification of tasks via routineness and interactivity).

The main contribution of the present paper is to complement these existing lines of research by developing and testing a sound empirical identification of tradability and outsourcability of occupational activities. We thereby cover three main dimensions adding to the literature on trade in tasks: First, we differentiate between outsourcing and international trade. Second, we take a closer look at the determinants of outsourcing and trading specific tasks. Finally, our methodology allows us to supply task-, job-, or industry-specific indicators of outsourcability and tradeability. These can be linked with other datasets to further investigate the characteristics, the significance, the determinants, and the consequences of an increase in trade in tasks.

The paper proceeds as follows: In a first step, we lay out recent developments in the economic literature on international trade, with a focus on trade in tasks. We thereby present the principal theoretical considerations, empirical evidence and also the actual shortcomings regarding existing approaches and our contribution (Section 2). In Section 3, we introduce our data and present the construction of our variables, particularly focusing on the characteristics potentially determining outsourcability and tradability of tasks. The description of the methodology underlying the construction of two indicators (outsourcability and tradability) as well as a descriptive overview of the resulting aggregates is the content of Section 4. We then provide for a small application of our new indicators regarding their impact on employee income in Section 5, while Section 6 concludes.

## 2 Literature Review: Trade in Tasks

### 2.1 The Theory of Trade in Tasks

A growing number of recent theoretical models in international economics split activities necessary for the creation of goods and services into a continuous chain of different portions of value creation (“tasks”), which are internationally tradable to a different extent (“trade in tasks”). To a continuously increasing extent, internationalization does not only occur in trade of (final) products, but also by transferring different tasks in the production chain of final products to foreign facilities. This can be done within the own company or by trading with foreign companies. Several implications for the labour market can be derived from this new perception, which add to the traditional potential of explanation for high and low qualified employment.

A prominent theoretical framework proposed by Grossmann and Rossi-Hansberg (2008) models that products (goods and services) emerge by applying different tasks which are performed by either low-skilled or high-skilled labour, depending on the nature of the goods. In the basic model, trading tasks causes additional costs which are modelled as supplements to the wage costs in the foreign country. A dislocation of tasks to a foreign country occurs, as long as the sum of the (lower) foreign wage plus the trading costs is smaller than the (higher) domestic wage.

The effect of an exogenously caused decline in trade costs on wages of low qualified labour is ambiguous and consists of several components. There is a *productivity effect* since the execution of low qualified tasks in foreign countries leads to a reduction of costs of the final good, for whose production an intensive amount of low qualified labour is needed. The subsequent increase in demand for the good leads on the labour market to higher wages for low qualified labour. The *relative price effect* and the *labour supply effect*, in contrast, lead through the larger supply of the good on the world market and of low qualified labour on the domestic market to a reduction in wages of low qualified labour.

Kohler (2009) and Kohler and Wrona (2010) show that different effects are achieved on the labour market, if the adaption to shocks takes place differently as in the model of Grossman and Rossi-Hansberg (2008). If, for example, the assumption of full employment is cancelled out, technological innovations could lead, through costs savings in the home country, to positive employment trends.

The studies so far do not incorporate the organisation of international creation of value and therefore also not the kind of trading costs to overcome. Antràs and Helpman (2004, 2007) identify transaction costs, which do not only influence the decision to outsource single activities locally out of the company, but which influence also the kind of internationalization. It is important to differentiate internationalization of a company through (international) outsourcing, which leads to a state where certain tasks are executed by external companies, and through foreign direct investments (FDI). Outsourcing generally takes part if the input of the supplier is used intensively and can be assured easily by contracts. Costinot et al (2011) link the decision about the organisation of the international value creation to the degree of routine of tasks. Non-routine tasks are harder to assure contractually and are therefore more likely to be produced inside the company.

The present paper is attaching at both theories. In contrast to the point of view of Grossman and Rossi-Hansberg (2008), who expect that a drop in trading costs in tasks leads to further outsourcing

to foreign countries, it is assumed hereafter that the therefore increased bargaining power of the employers could also result in alternative solutions to reduce labour costs. These solutions could be for example lower wages or the increased use of atypical employment.

## **2.2 The Effects of Offshoring on Wages and Labour Demand**

A direct empirical survey about consequences of tradability of tasks on employment, types of employment and wages structures in Germany has, according to our best knowledge, not yet been done.

However, there have been several studies about the consequences of real offshoring on domestic employment. In total, there is no clear-cut effective direction. Concerning German direct investments in foreign countries, positive effects on employment are found by Buch et al. (2007) on the sector level and by Kleinert and Toubal (2007) on the company level. Based on linked data of the German "Federal Agency of Employment" (BA) and the "German Federal Bank" ("Microdatabase Direct Investments" MiDi), Becker and Muendler (2007) also come to the conclusion that companies which execute foreign direct investments have a lower probability of dismissing employees as comparable companies, which do not execute foreign direct investments. Additionally to the MiDi data, Becker and Muendler (2007) use data about Swedish multinational data and determine substitutive relationships between jobs in German parent companies and foreign branches. On the basis of own interviews, Marin (2004) concludes that there are negative but relatively small effects on employment caused by activities of German multinational companies in Eastern European countries. Milberg and Winkler (2009) use information from input-output charts about the share of imported intermediate products, which they use as a benchmark for offshoring. On this basis, they calculate a significant negative impact on the sectorial level.

Further empirical studies trait the impacts of realized offshoring on the structure of employment and wages. By using the "Socio-Economic Panel", Geishecker and Goerg (2008) come to ambiguous conclusions for low and high qualified labour. For low qualified workers, offshoring has wage reducing effects and for high qualified labour, offshoring leads to rising wages. Horgos (2007) confirms the outcome of an increase of the wage dispersion over all sectors, but he does not find a significant change for the manufacturing industry. While offshoring decreased the wage spread within the group of the low qualified, it increased the wage spread within the group of the high qualified. In a recent article, Horgos (2009) shows furthermore, that international outsourcing significantly increases unemployment of low qualified labour, especially in sectors with high wage rigidities. In contrast to these results, Marin (2010) shows that outsourcing of high qualified labour to Eastern Europe results, through a shift in relative prices, in a more favourable situation for low qualified domestic labour. Matte (2010a) examines the consequences of foreign direct investment in Germany on labour demand by using Linked-Employer-Employee data (LIAB). He differentiates between different levels of qualification. While offshoring increases employment high and low educated labour, there is no significant relationship for the medium qualification level.

At the moment, there are studies emerging which concern impacts of offshoring on the distribution of employment by referring to the above explained different categories of tasks and different levels of qualification. Becker et al. (2009) find a positive relationship between the ratio of outsourced em-

ployment and the ratio of domestic employment within the company that is executing “non-routine” or “interactive” tasks. Additionally, there is an increase in the level of qualification, which exceeds the effect of the changed composition of tasks. Based on the scheme of Spitz-Oener (2006) and Becker et al. (2009), Baumgarten et al. (2009) find negative wage effects for medium and low qualified employees, especially when they perform few interactive, and therefore easy outsourceable tasks.

Most international studies report no negative employment impacts of offshoring (see e.g. Mankiw and Swagel, 2006, for an overview about the US-American and Crinò, 2009b, for an overview over the international empirical literature). The reason for that is found mostly in the small amount of realized offshoring in industrial countries, which serve, especially in the tertiary sector, as net recipients (see e.g. Amiti and Wei, 2005a,b, Borgha, 2005, together with Landefeld and Mataloni, 2004). However, there are different effects for single qualification groups and countries. Results of Hanson and al. (2003) imply that high qualified employees in a foreign subsidiary company complement high qualified labour in the US –American parent company, whereas low qualified labour in the US is replaced. In contrast to that, Harrison and MacMillan (2006) detect a substitutive relationship of low-wage countries and a complementary relationship for high-wage countries.

As it is for Germany, the evidence on the level of tasks is thinly spread. Mann (2005) calculates a loss of jobs, in which routine tasks are performed. Crinó (2009a) examines the impact of offshoring in the tertiary sector (approximated by using input-output charts), by estimating for single professions the labour demand function and by linking the consequent elasticities to employment attributes. While generally employment of high qualified labour rises and of low qualified falls, the professions within these groups that are the ones which are subject to a large degree of tradability.

### **2.3 Determinants of Offshoring and Trade in Tasks**

A sound empirical assessment of trade in tasks first and foremost needs an adequate operationalization regarding tradability and at the same time a viable operationalization of tasks themselves. This section first lays out the potential determinants of trade in tasks employed so far in the literature. We argue the existence of two shortcomings: a one-dimensional sight on offshoring and a selective and subjective use of factors determining trade in tasks.

Existing considerations on this refer to the theory of the firm and to the transaction cost approach (cf. Coase 1937, Ethier 1986, Barba-Navaretti/Venables 2004). The basic principle thereby is that the outsourcing potential increases with the tradability of processes or tasks, notwithstanding whether they are traded on the national or on the international market. Costinot et al. (2011) empirically confirm that non-standardized activities are rather traded inside the firm, whereas standardized tasks also can be obtained from independent providers (i.e., from the market).

Autor et al. (2003) conceive employment as a continuum of different tasks. Departing from the “Dictionary of Occupational Titles” (DOT),<sup>4</sup> Autor et al. (2003) distinguish between ‘routine tasks’ charac-

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<sup>4</sup> The DOT has been followed by the “Occupational Information Network” (O\*NET, cf. [www.onetonline.org](http://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

terized by a high level of substitutability and ‘non-routine tasks’ with a low level of substitutability. Thereby, shifts in employment structure are no longer being measured on the basis of indirect measures of qualification, but directly by the composition of tasks (cf. also Lanz et al., 2011).

Jensen and Kletzer (2007), as well as Crinò (2009) develop ranked orders of tasks according to their tradability. Jensen and Kletzer (2007) base their index on so-called ‘occupational requirements’: They assume that, for instance, tasks involving intensely modern information and communication techniques are characterized by high offshoring potentials. These techniques are, to a certain degree, standardized, or at least codifiable and the distance between supplier and customer is only of minor importance. Face-to-face communication, creativity and locational ties reduce tradability. Blinder (2009), on the basis of subjective judgments, puts different occupations in order according to their risk of being offshored. It is interesting (and may be an outcome of the subjective methodologies used in the studies) that, while Jensen and Kletzer (2007) find a positive correlation between skills and offshoring, Blinder (2009) draws a contrary conclusion from his results.

Costinot et al. (2011) link information on the characteristics of different tasks with regard to the complexity of problems to be resolved to the decisions of multinational enterprises to internationalize certain tasks by outsourcing or direct investments. Thereby, they assume that complex (non-routine) tasks may cause problems that cannot be resolved ex ante. As the adaptation costs occurring ex post are lower when a task is provided internally, multinational firms choose vertical integration for complex non-routine tasks. An empirical examination on the sector level approves the hypothesis by showing high correlations between shares of complex tasks and intra-firm trade. In a similar vein, Oldenski (2009) finds high (negative) correlations between the relocation and the complexity of tasks.

On the basis of the BIBB Survey – which is also used in the present paper –, Spitz-Oener (2006) examines the changes in tasks due to technological development. She thereby introduces a classification of tasks into five categories: ‘non-routine analytic’, ‘non-routine interactive’, ‘routine cognitive’, ‘routine manual’ and ‘non-routine-manual’. With the same dataset, Becker et al. (2009) establish a link to internationalization, thereby adding ‘interactive’, ‘non-interactive’ tasks to the already mentioned ‘routine’ and ‘non-routine’ tasks. Non-routine tasks are defined as tasks that cannot be simply repeated, interactive tasks require interactions between employees, clients or third parties. Becker et al. (2009) figure out that offshoring is accompanied by significant shifts to non-routine and interactive tasks in the home country.

According to recent findings by Costinot et al. (2011), outsourceability mainly depends on the potential for standardization, whereas international tradability refers to existing (international) trade barriers. The main determinant whether a certain task can be performed by a different company is the existence of a market for the respective task. Thereby, it is initially irrelevant for the outsourcing potential whether this task is tradable on a national or international level.

These approaches to the operationalization address single tasks, independently of their position within the value chain. This is also due to the fact that, at least for Germany, no data are available that would allow for an assignment of tasks into a sequential order of value creation.

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Occupations” (ISCO, most recent version from 2008, cf. <http://www.ilo.org/public/english/bureau/stat/isco/index.htm>) is more common.

Becker and Muendler (2011) add to that by deriving the impact of activities and performance requirements of occupations on a range of economic data, i.e. the German labor market and trade patterns over time. These job requirements include ‘Deadlines/pressure to perform’, ‘Improve/adopt new techniques’, ‘New situations/activities’, ‘Repeated work steps’, ‘Work procedure prescribed in detail’, ‘Financial losses by small mistakes’, ‘Minimum performance/time/quantity given to execute activity’ etc.

Further characteristics of activities, firms, sectors or tasks with implications for their relocation potential are, for instance, the application of ICT, the transferability and the codifiability of products or services, i.e. the potential to be documented as well as the degree of interactivity (OECD, 2006). Blinder (2006) adds activities which require physical contact or geographic proximity between supplier and customer to those which are difficult to relocate (cf. also Baldwin, 2006). On the basis of a literature review and on a small expert survey, Westner and Strahinger (2008) add further characteristics of activities which are conducive to offshoring, for instance: low business specificity, high modularity of activity, low regulatory constraints, low strategic importance and high stability of requirements.

**2.4 Operationalizing Offshoring and the Determinants of Trade in Tasks**

Our approach is mainly based on the same data as Spitz-Oener (2006) and Becker et al. (2009) use for their studies. However, the paper describes a new procedure to directly operationalize the dimensions international tradability and outsourcing potential that complements the existing literature. The literature on trade in tasks (and, more generally, on offshoring) has so far seen this procedure as a one-dimensional operation: firms either offshore tasks or not. Our approach is supposed to contribute to these studies by categorizing tasks according to two dimensions, namely ‘international tradability’ and ‘outsourcing potential’, where one does not require the other (see figure 1).

**Figure 1: Organizational and Spatial Dimensions of Trade in Tasks**

		Outsourcing Potential (organizational relocation)	
		Low	High
International Tradability (spatial relocation)	Low	A) In-house production	B) Outsourcing
	High	C) FDI	D) Offshoring

*Source: Own illustration*

On the basis of this operationalization, barriers or stimuli to international trade as well as barriers or stimuli to outsourcing can be distinguished and identified. Thereby, not only spatial and purely economic aspects, but also factors such as cultural distance or institutional or political divides can potentially be captured. The four cells displayed in figure 1 are supposedly not independent from each other, but the categorization allows drawing conclusions on firm strategies regarding the relocation of tasks on different organizational and spatial levels:

- Cell A refers to tasks which are non-standardized and which are subject to international trade barriers. Therefore, the probabilities of organizational and spatial relocation are low.
- Tasks classified in cell B are characterized by high potentials of organizational relocation (as, for instance, standardization is high), but similarly to cell A barriers to international trade are significant. These tasks and/or occupations are probable to be outsourced on national or even on the regional levels.
- On the contrary, activities allocated to field C display, for instance, low levels of standardization and are thus difficult to be organizationally relocated; however, barriers to international trade of these activities are low. Therefore, these tasks are likely to be relocated spatially within the firm, e.g. by foreign direct investments.
- Last but not least, field D covers tasks and occupations with both a high organizational and spatial relocation potential. The activities allocated to that field are most probable to be subject to international outsourcing.

This two-dimensional perception of offshoring tasks allows us to fully capture determinants that potentially only affect one of the two dimensions. In the traditional concept of offshoring this could lead to non-conclusive results as to whether such determinants really influence offshoring as a whole. It also helps us to distinguish between determinants that affect the home country labour demand or wages directly (spatial relocation) and determinants that only have indirect effects. As to our knowledge, such a distinction has, surprisingly, not been done in the literature before.

**Table 1: Overview of Theoretical Predictions of Determinants of Offshoring Tasks**

Task Characteristic	Outsourcing Potential	International Tradability
Codifiability	++	+
Routine	++	+
Information and Communication Technologies	+	++
Undesirability		+
Deadlines, Pressure to Perform		-
Number of Tasks, Multitasking	-	-
Cultural Linkage		--
Geographic Restrictions		--
Interactivity		--
Complementary Tasks	--	--
Demanded Knowledge	--	--
Complexity	--	-
New Scopes	--	-

*Note: ++/-- indicate unambiguously positive/negative predictions, +/- indicate possible positive/negative predictions; Source: Literature Review.*

Table 1 summarizes the theoretical predictions the literature on offshoring and trade in tasks has so far generated on how different characteristics affect the outsourcing potential and the international tradeability of a task. A more elaborate explanation of each and every characteristic, its potential influence on the two offshoring dimensions, and the literature where we found them is displayed in the Appendix (A1). We differentiate between unambiguously positive/negative predictions and such that have been found to either affect offshoring or not. It is also important to see that, while for



some characteristics we expect them to have the same influence on both dimensions of offshoring, this is not always the case.

After having laid out our contribution to the literature, we now describe the data we use to operationalize the different characteristics and the method we use to generate valuable indicators of outsourcing potential and international tradeability.

## 3 Data and Measurement

### 3.1 The Data

Our research bases on several cross sections of the German Qualification and Career Survey of Employees (BIBB Survey).<sup>5</sup> The purpose of this representative employee survey is to describe employment and its characteristics from a wide range of perspectives, e.g. to demonstrate trends and features of a changing working environment and to enable its empirical quantification. Up to now, the data include five cross-sections based on telephone interviews carried out in 1979, 1985/86, 1991/92, 1998/99 and 2005/06, each covering 20,000 to 30,000 individuals. For detailed information on the survey, see [www.bibb.de](http://www.bibb.de).<sup>6</sup>

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

Each of the five cross sections of the BIBB Survey is based on 20.000-30.000 telephone interviews with individual employees<sup>7</sup> and has a more or less consistent structure with regard to individuals, occupations, tasks and the respective characteristics. Some partial inconsistency over time, however, makes the comparability of the data somewhat complicated and/or requires special consideration (cf. Becker and Muendler 2012, Görlich, 2010). For the subsequent analyses, we therefore use data from the latest three available samples of the BIBB Survey, namely from 1991/92, 1998/99 and 2005/06.<sup>8</sup> Also, we restrict our sample to workers aged 15-65 and drop public servants, retirees, un-

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<sup>5</sup> 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.

<sup>6</sup> A sixth wave of the survey has been finished in spring 2012, but the data will be available only in 2014.

<sup>7</sup> In 1991/92, the survey also contains a small subsample of unemployed individuals and other groups of workers, mainly from the context of the former German Democratic Republic, which are not relevant to the subject of our paper and which we thus exclude from our sample.

<sup>8</sup> 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.

employed and self-employed as well as marginal employees from the sample. These groups are of minor relevance with regard to trade in tasks.

The BIBB Survey does not contain information on all potential task characteristics which have been identified in the literature to be relevant determinants of the tradability and the outsourcing potential of tasks (see section 2). An own additional survey based on a sample of German economists is therefore been performed with the aim of classifying specific tasks along a series of characteristics where the BIBB Survey provides only sparse or no information. In this survey, which we further call IAW Survey, 15 economists from our institute have classified 35 tasks (e.g. conduct vehicles, analyze and research, lead negotiations) which are also included in the BIBB Survey along the dimensions “locational ties”, “complexity” and “interactivity”.<sup>9</sup> In the survey, the respondents assign values between one and four to indicate the intensity of the different tasks with regard to the above characteristics. We then compute the median for each task and merge this information to the BIBB Survey.

### **3.2 Identifying and Constructing of Characteristics Determining Tradability and Outsourcing Potential**

A first step is to find operationalization’s of the characteristics that potentially determine the outsourcing potential and the international tradability of tasks (see table xxx, section 2). A large number of the variables in question can be directly extracted from the data, although in some cases we took several single variables to create one characteristic as an indicator. For example, in the case of *undesirability*, we use information on several negative properties of a workplace, such as smoke, noise or danger and sum them up into one variable capturing the overall undesirability of a workplace. In some cases, there are various options to define a characteristic via the variables available and alternative measures are included in the data. Last but not least, for some characteristics the data do not contain information in every wave, such that we do not include them here, but can potentially use them in analyses of other time periods or more specific research questions.<sup>10</sup> It is also possible to control for the robustness of our indicators by using earlier waves of the BIBB Survey and different specifications of characteristics.

Table 2 contains detailed descriptions of the information underlying the variables used as a basis for the assignment of characteristics to tasks. In many cases, standardization of the variables across the waves had to be performed.<sup>11</sup>

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<sup>9</sup> For more detailed information on the expert survey see Annex A1.

<sup>10</sup> These variables include Concentration on one Task, High Financial Losses from Mistakes, Required Minimum Performance, and Writing Skills. Potentially, the BIBB Survey further offers even more variables.

<sup>11</sup> Detailed information and Stata Programs are available upon request.

**Table 2: Operationalization of Task Characteristics**

Characteristic	Source	Underlying question / information	Development, 1991-2006*
Codifiability	BIBB	Every step of the execution of my tasks / activities is stipulated in detail (4-5 scale)	
Routines	BIBB	The operation cycles of my work are exactly and constantly repeating (4-5 scale)	
Information and Communication Technologies (ICT)	BIBB	My daily work involves working with computers, data processing equipment or similar devices (scale based on number of entries for different devices)	
Undesirability	BIBB	My daily work is demanding or painful in physical respect (e.g. hazardous workplace, work in painful positions, undesirable noise, temperature or hygiene)	
Pressure to Perform	BIBB	My daily work is characterized by tight deadlines or by high pressure to perform	
Number of Tasks	BIBB	Sum of different tasks performed by a single worker (standardized to a 4-scale measure)	
Cultural Linkage I: Law	BIBB	My daily work requires specific knowledge of law and justice	
Cultural Linkage II: Writing	BIBB	My daily work requires specific knowledge with regard to the German language (as this item was not part of the 1991 survey, it was imputed for that year on the basis of information from 1979, 1998 and 2006)	
Locational Ties	IAW	Information from the task based expert survey (see annex A1)	
Interactivity	IAW	Information from the task based expert survey (see annex A1)	
Complementary Tasks	BIBB	Number of complementary tasks performed by a single worker (for methodology cf. Görlich, 2012)	
Number of Skills	BIBB	Number of skills / fields of knowledge necessary for execution of work (e.g. knowledge in law, mechanics, language etc.)	
Complexity	IAW	Information from the task based expert survey (see annex A1)	
New Scopes	BIBB	My work involves addressing new problems and challenges or testing new procedures or processes	

\* Note: Bars for 1991, 1998 and 2006 (left to right), respectively. Darker areas denote higher intensities/larger values of the variables. Most variables are available with a 4-scale measurement, some only in binary form (e.g. ICT, Law). Source: BIBB Survey 1991, 1998, 2006; IAW Survey; own calculations.

It can be seen from the small graphs in Table 2 that most of the variables show a clear-cut development within the period of observation. For instance, it can be observed that the use of ICT increases significantly, as does the number of executed tasks, the number of necessary skills or the number of complementary tasks. Only slight and rather unspecific changes can be observed with regard to the significance of the codifiability of tasks, routines or pressures to perform.

### 3.3 Further preparation of data

Apart from our task characteristics, the BIBB survey further contains valuable information we use for our analysis. First, we can use information to generate aggregates of the two indicators of offshoring; second, we can use individual and household information to apply our two indicators within the data as a first pass to their quality.

After having generated our two indicators, this information is disaggregated on the individual level. To further use the data we can aggregate the data on different levels. First and probably most interesting, we have information the job classification of each employee, at the Kldb1988 4–digit level. This very detailed information can, for example, be merged to the labor market data from the Federal Employment Agency ([www.fdz.iab.de](http://www.fdz.iab.de)). Second, we have information on the industry classification of each employee and can therefore aggregate our indicators at the industry level (approximately NACE 2-digit level). Furthermore, we can also use information on the region of the employee (German State).

In a first application of our indicators we perform a Mincerian wage regression in Section 5, where we can make use of income information in the BIBB survey. Fortunately, there are also information on personal characteristics that potentially influence income, such as age, education and tenure; and household information such as marital status and the number of children.

An overview of all variables used is displayed in Table A3 in the Appendix.

## 4 Empirical Method

### 4.1 Overview: Objectives and methodology of analysis

The main objective of the present paper is to supply task-, job-, or industry-specific indicators of outsourceability and international tradeability empirically deduced from the data described above. These indicators will be applied for an exemplary analysis of the effects of outsourcing and international tradability on wages, but they are also aimed at a more general applicability in future studies involving further datasets.

In order to achieve the indicators, we use the rich information contained in our data (see Section 3.1) referring to individuals, their job job-related tasks as well as the characteristics of these tasks. As outlined in Section 2, various characteristics of tasks that might possibly have an impact on the outsourceability and on the international tradability of these tasks have been identified in the literature. We have information on most of these tasks (and, partially, beyond) in our data (see Section 3.2).

Taking advantage of a Principal Component Analysis (PCA), which we present below in Section 4.2, we aim at condensing the available information into (ideally) two indicators, one representing the outsourcing potential and the other international tradability. On the methodological side, we do not rely on a single ‘best’ PCA-specification. Thereby, we develop a technique allowing us to extract robust indicators from a series of PCA-specifications. We then present selected results for our indicators in Section 4.4, with a special focus on industry aggregates.

## 4.2 Principal Components Analysis (PCA)

Principal component analysis is a multivariate method that allows the reduction of potentially multicollinear information, while regaining a maximum of variance explanation. By decomposing the covariance matrix of a number of variables, PCA gains the leading eigenvectors as a series of uncorrelated linear combination of the characteristics.

Principal component analysis (PCA) is commonly thought of as a statistical technique for data reduction. It helps you reduce the number of variables in an analysis by describing a series of uncorrelated linear combinations of the variables that contain most of the variance. For an introduction, see Rabe-Hesketh and Everitt (2007, chap. 14). The objective of PCA is to find unit-length linear combinations of the variables with the greatest variance. The first principal component has maximal overall variance. The second principal component has maximal variance among all unit length linear combinations that are uncorrelated to the first principal component, etc. All principal components combined contain the same information as the original variables, but the important information is partitioned over the components in a particular way: the components are orthogonal, and earlier components contain more information than later components. PCA thus conceived is just a linear transformation of the data. It does not assume that the data satisfy a specific statistical model.

The principal components have several useful properties. They are uncorrelated (orthogonal) among each other. The leading principal components have maximal generalized variance among all linear combinations. It is also possible to interpret PCA as a fixed effects factor analysis with homoscedastic residuals

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

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. It follows that  $E(Y)$  is a matrix of rank  $f$ , with  $f$  typically substantially less than  $n$  or  $p$ . Thus we may think of PCA as a regression model with a restricted number but unknown independent variables. We may also say that the expected values of the rows (or columns) of  $Y$  are in some unknown  $f$ -dimensional space. For more information on these properties and for other characterizations of PCA, see Jackson (2003) and Jolliffe (2002).

## 4.3 Treatment of the results of the PCA and identification of indicators

The results of a principal components analysis in general strongly depend on the selection of variables included in the model. Note that, as described in the sections above, we can potentially use both some more characteristics or even leave some of the characteristics used, probably without anyone noticing. Taking a decision for one specific (unique) specification therefore seems somewhat arbitrary. A simple way to overcome that difficulty could be to choose a model including all available variables; however the availability of variables depends on the dataset at hand and the number of variables potentially never reaches an end. Moreover, the quality of variables in a given specification

of a PCA also depends on the choice of the total set of variables and results can easily change with the inclusion or exclusion of single variables.

To overcome these shortcomings, we take an alternative way of generating and treating the results of the PCA by running all possible specifications beginning with the maximum number of variables (i.e. 12 characteristics of tasks, cf. Table 2) and then excluding up to five variables.<sup>12</sup> From the resulting total number of 1,024 specifications, we calculate the means of the component loadings.<sup>13</sup> To gain the two indicators on offshoring tasks, we then calculate the individual outsourcing potential and international tradeability as linear combinations of the mean factor loadings (see Table 3) and the individual task characteristics, here exemplary for the first indicator:

$$Outsourcing_i = 0.57 Routine_i + 0.62 Codifiability_i - 0.32 ICT_i + \dots$$

When using the factor loadings, we interpret, according to our theoretical predictions from Table 1, a combination of components 1 and (the negative of) component 3 as outsourcing potential and (the negative of) component 2 as international tradeability.

**Table 3: Mean Loadings of Characteristics for First Three Components (N=1,024 PCA Specifications)**

Variable	Component 1		Component 2		Component 3	
	mean	sd	mean	sd	mean	sd
Codifiability	-0.20	0.17	0.41	0.19	0.37	0.38
Routines	-0.19	0.16	0.27	0.28	0.43	0.45
ICT	0.40	0.15	0.05	0.13	0.08	0.17
Undesirability	-0.20	0.17	0.47	0.19	-0.01	0.35
Pressure to Perform	0.16	0.07	0.52	0.11	0.17	0.36
Number of Tasks	0.39	0.13	0.30	0.15	0.04	0.28
Locational Ties	-0.38	0.24	0.10	0.17	-0.06	0.23
Interactivity	0.26	0.15	-0.38	0.23	0.17	0.30
Complementary Tasks	0.47	0.13	0.15	0.12	0.05	0.20
Number of Skills	0.33	0.13	0.22	0.16	-0.05	0.28
Complexity	0.43	0.16	-0.07	0.17	0.10	0.20
New Scopes	0.29	0.13	0.32	0.20	-0.05	0.35
						N=1024

Our results show robustly high loadings for the characteristics codifiability, routine, interactivity and complexity on the first component of the PCA, which we define as outsourcing potential. Thus, we conclude that codifiability and routine have a positive impact, whereas interactivity and complexity negatively influence the outsourcing potential. At the same time, undesirability and geographic re-

<sup>12</sup> Note that leaving out more variables significantly increases the possible specifications to a computationally difficult amount.

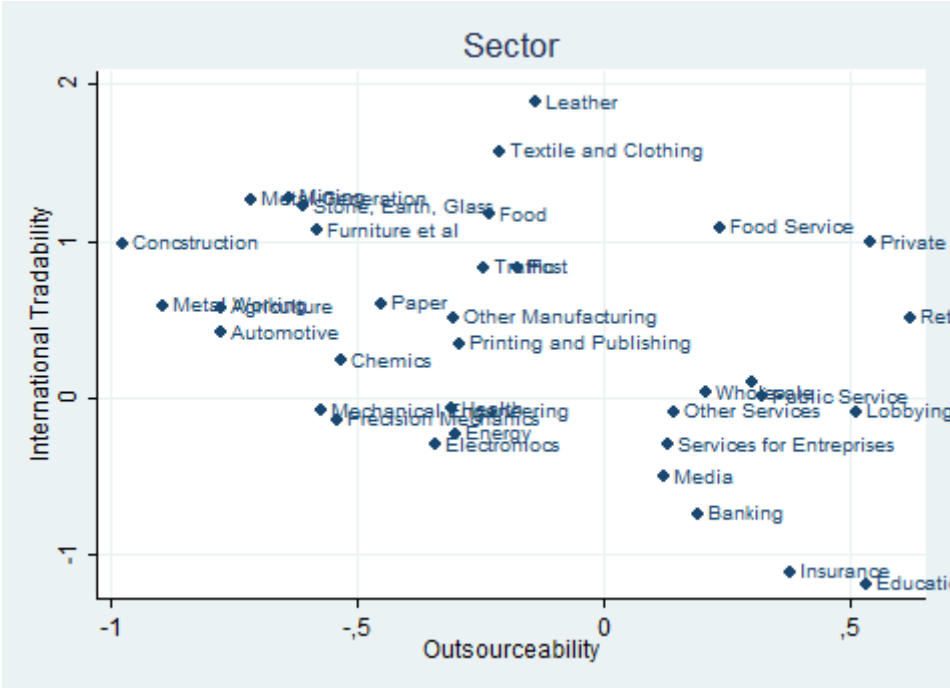
<sup>13</sup> As robustness check, we also calculate a version including also the variables ('law' and 'writing' (as proxies for the significance of cultural proximity)), which generally yielded only weak results in terms of significance for the overall results of the PCA. The inclusion of these two variables caused only minimal changes in the results of our analysis. A second robustness check is performed by de-pooling the data and generating indicators for each wave of the BIBB survey. Also, we use the traditional method of using only the specification including all 14 variables. There were also only minor differences in the results.

strictions show significant loadings on the second component that we define as international tradeability (see Table 3).<sup>14</sup>

### 4.4 Results

The resulting loadings of the two components “Outsourceability” and “International Tradability” are then aggregated on the levels of occupations and sectors.<sup>15</sup> For sectors, Figure 2 displays the results graphically. Whereas most service sectors are characterized by high levels of outsourcing potentials and relatively low levels of tradability, many manufacturing industries take an opposite position (for more detailed statistics, see Annex A4).

**Figure 2: Outsourcing Potential and International Tradability by Sector**



Source: BIBB Survey 1991, 1998, 2006, IAW calculations. Based on mean component loadings from 1024 PCA Specifications

More importantly, we can see that the traditional, one-dimensional view of offshoring potential does not seem plausible anymore. Instead of aligning from lower left to higher right, the opposite seems to be true. Only a few sectors are characterized by both low and high outsourcing potential and international tradeability.

<sup>14</sup> It can also be seen from the table that the quality of the loadings (in terms of variation of values) declines from component 1 to component 3.  
<sup>15</sup> On these levels, it is possible to match them to other datasets later on for further analyses.

## 5 An Application on Employee Income

In this section we run a first application of our two indicators of task offshoring. The BIBB Survey data features information on individual wages as well as individual, household (and some firm) characteristics. We run a Mincer (1974) wage equation on the two measures outsourcing potential and international tradeability:

$$y_{it} = \alpha_{it} + \beta_1 \text{outsourcing}_{it} + \beta_2 \text{trade}_{it} + \gamma \mathbf{X}_{it} + \varepsilon_{it},$$

where  $y_{it}$  either embodies nine brackets of monthly gross income, ranging in a 500 Euro scale from <500 to >4000 Euros per month, or the log monthly gross income of individual  $i$  at time  $t$ .<sup>16</sup> We estimate the coefficients  $\beta_1$  and  $\beta_2$  using ordinary least squares and can interpret them as either the (linear) probability of reaching a higher income bracket or a percentage change in income.

As we know from Section 2, theoretically the effect of offshoring on wages is ambiguous. However, as we have disentangled offshoring alongside the two dimensions of outsourcing potential and international tradeability, we might draw additional conclusions regarding which effect empirically dominates. From the empirical literature, we would expect a negative correlation between the outsourcing potential of the task an employee performs as well as between the international tradeability of these tasks and an employee's income.

An important benefit from directly using the BIBB Survey data is that our variables of interest do not represent aggregate indicators, but individual ones. Hence, we do not lose information or variation, as we would when aggregating the offshoring indicators first. However, there is also a downside of this approach, we have to rely on relatively mediocre information on wages and firm level characteristics, and we cannot control for unobserved heterogeneity because of the non-panel character of the data.

Several control variables are included. On the individual level, we control for the sex and the age of the employee as well as for his type of schooling and for additional qualification such as vocational training or university. We also have information on employee tenure and experience as well as on foreign origin/citizenship. There is also information on the household the employee lives in, its size, whether there are kids and whether the employee's partner is working. Information on the firm is relatively sparse and contains only the industry classification and the firm size. Additionally, we control for the Region (Bundesland), the year, and the job group of the employee.

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<sup>16</sup> While the latter is the definitely preferable variable, it is only available for the wave 2006.



**Table 4: Outsourcing Potential, International Tradeability, and Employee Income**

Variable	Income Class		In Monthly Gross Wage	
Outsourcing Potential	-0,3872***	-0,1267***	-0,1674***	-0,0486***
	-0,0031	-0,0036	-0,003	-0,0033
International Tradeability	-0,3696***	-0,0457***	-0,1519***	-0,0244***
	-0,0046	-0,0053	-0,0045	-0,0046
Control Variables	No	Yes	No	Yes
N. of Obs.	58998	35464	13616	7333
F-Stat	9989,03	847,35	1800,64	199,93
R squared	0,25	0,66	0,21	0,67
AIC	231489,9	113101,46	27978,68	7746,79

*Note: Standard deviation in parentheses:  $p < 0.10$ ,  $** p < 0.05$ ,  $*** p < 0.01$ . See Table A4 for the exact control variables; Source: BIBB/IAB/BAuA Worker Survey 1991, 1998, 2006 (Income Class); 2006 (In Monthly Gross Wage); Own Calculations.*

Table 4 displays the results of interest, while Table A4 in the Appendix displays the full table. Columns 2 and 3 show the results for income brackets as dependent variable, while columns 4 and 5 do so for the log income. In columns 2 and 4 we can see both the direct and the indirect effects of the two indicators on the dependent variable, while we control for the indirect effects using the mentioned control variables in columns 3 and 5. First, we find that both indicators are significantly negatively correlated with the wage of an employee. This holds independently of our choice of dependent variable and when we add control variables. However, the effects for the log income are smaller and the control variables explain about two thirds of the raw difference in income. However, the effects of the two indicators are economically significant as well: a higher outsourcing potential of one standard deviation decreases the probability of being in a higher income bracket by 28%, and is correlated with an 11.5% lower log income. As regards international tradeability, the effects are somewhat smaller: an employee performing tasks that are one standard deviation more internationally tradeable than the mean has a 6% lower probability of being in a higher wage bracket and is correlated with a 2.9% lower log income.

The control variables employed are mainly all statistically significant and have the theoretically expected sign and magnitude. Regression diagnostics tell us that we can explain a large part of the variation in the dependent variable, which especially holds when including only the two offshoring indicators. We have to note, however, that because of the BIBB Survey being a repeated cross-section only, we cannot control for unobserved heterogeneity and refrain therefore from interpreting our results as causal.

This section delivers a first application of our contribution to the trade in task literature, namely the distinction between outsourcing potential and international tradeability when analysing the effects of offshoring, and the creation of two comprehensive indicators. We can see that our indicators might actually work pretty well and capture a large amount of variation that, up to date, cannot be accounted for by other variables such as education.

## 6 Conclusions

In this paper we analyze the outsourcing potential and the international tradeability of tasks and their impact in individual income using German task data.

So far, the empirical evidence on the trade in tasks has focused on grouping certain tasks regarding their offshoring potential. While the trade in tasks literature has precisely modeled the effects of falling offshoring costs and rising intra-firm division of labor, there is, until now, a substantial degree of imprecision in analyzing offshoring as a one-dimensional decision (cf. Hogrefe, 2011). Contrary, the decision to outsource a certain job or task, i.e. buying intermediates on the market instead of producing them inside the firm might be driven by other factors than international tradeability, i.e. producing a good abroad, either inside the firm (foreign direct investments, FDI) or outside the firm (offshoring). Hence, while transaction costs, for example in the form of the degree of routine of a task may influence the outsourcing decision, this might not affect its international tradeability. Contrary, transportation costs, cultural factors or trade barriers are not likely to affect outsourcing while being important determinants of international trade. The contribution of this paper is therefore (a) to test the theoretical hypotheses regarding the consequences of offshoring on individual income using factors which determine the offshore potential of certain tasks besides routine and interactivity and (b) to differentiate between the effects of outsourcing potential and international tradability.

To address these questions, we use recent waves (1991, 1998, 2006) of the German Qualifications and Career Survey (BIBB Survey), a representative, individual-level dataset containing rich information on the actual work environment of employees, including tasks, job characteristics, professions, wages, and demographic variables. Instead of analyzing groups of tasks (Spitz-Oener, 2006), we use direct information on job properties, which can be linked to the outsourcing potential as well as to the international tradability of a job. Additionally to the determinants covered in most of the literature so far (routines, interactivity and ICT use), we include a larger number of further characteristics. We use principal component analysis, a mathematical procedure that uses an orthogonal transformation to reduce our set of possibly correlated determinants into a smaller set of linearly uncorrelated components in such a way that these explain the largest possible variance in the data. We end up with two indicators along the two dimensions of offshoring. By aggregating these indicators onto occupation or industry level we can see that most sectors are characterized by either high outsourcing potential or by high international tradeability, but seldom by both.

Finally, we run a Mincer wage equation with the two measures including several control variables both on the individual as well as on the firm level. We find that both effects are significantly correlated with the income of an employee, in such a way that both the outsourcing potential of a job and international tradeability are associated with a lower income of the employee. The effects are economically significant as well.

Our research contributes to the trade in tasks literature and sheds further light on the economic consequences offshoring. In distinguishing between outsourcing and international tradability, we can assess that the effect of the offshoring potential on wages in Germany is driven to a larger extent by international tradeability and to a lesser extent by the outsourcing potential of a job. Furthermore, by including various properties of tasks performed by employees, we are able to open the black box behind the offshoring potential of different jobs.

Regarding further work, our analysis sets us in a position where we can link the components gained from the task information of the BIBB survey with official linked-employer-employee data (the IAB LIAB) via the 3-digit KldB-88 occupational level. This opens up new possibilities in analyzing, for example, why offshoring of tasks does not explain recent changes in the German wage structure (cf. Antonczyk et al., 2009), or how offshoring affects other variables such as the employee structure of a firm or the bargaining power of trade unions.

## 7 References

- Amiti, M. / Wei, S. (2005a): Fear of Outsourcing: Is it Justified?, in: *Economic Policy*, 20, 308-348.
- Amiti, M. / Wei, S. (2005b): Service Offshoring, Productivity, and Employment: Evidence from the United States, IMF Working Paper 05/238.
- Antràs, P. / Helpman, E. (2004): Global Sourcing, in: *Journal of Political Economy*, 112 (3), 552-580.
- Antràs, P. / Helpman, E. (2007): Contractual Frictions and Global Sourcing, CEPR Discussion Paper 6033.
- Autor, D.H. / Levy, F. / Murnane, R.J. (2003): The skill content of recent technological change: An empirical exploration, in: *The 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. / Venables, A. (2004): *Multinational Firms in the World Economy*, Princeton University Press.
- Baumgarten, D. / Geishecker, I. / Görg, H. (2010): Offshoring, Tasks, and the Skill-Wage Pattern, CEPR Discussion Paper 7756.
- Becker, S. / Ekholm, K. / Muendler, M. (2009): Offshoring and the Onshore Composition of Tasks and Skills, CEPR Discussion Paper 7391.
- Becker, S. / Muendler, M. (2007): The Effect of FDI on Job Security, in: *The B.E. Journal of Economic Analysis & Policy*, 8 (1), 1-44.
- Becker, Sascha O. and Muendler, Marc-Andreas, Trade in Tasks: A Preliminary Exploration with German Data, 2012, EFIGE working paper 45.
- Blinder, A. S. (2006): Offshoring: The next Industrial Revolution?, in: *Foreign Affairs* 85.
- Blinder, A.S. (2009): How Many US Jobs Might be Offshorable?, in: *World Economics*, 10 (2), 41-78.
- Borga, M. (2005): Trends in Employment at U.S. Multinational Companies: Evidence from Firm-Level Data, in: *Brookings Trade Forum*, 135-163.

Buch, C. / Schnitzer, M. / Arndt, C. (2007): FDI and Domestic Investment: An Industry-Level View, CEPR Discussion Paper 6464.

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

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

Crinò, R. (2009a): Service Offshoring and White-Collar Employment, UFAE and IAE Working Paper 775.09.

Crinò, R. (2009b): 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.

Geishecker, I. / Görg, H. (2008): Winners and losers: A micro-level analysis of international outsourcing and wages, in: *Canadian Journal of Economics*, 41 (1), 243-270.

Görlich, D. (2010): Complementary Tasks and the Limits to the Division of Labour, Working Paper, Kiel Institute for the World Economy. Kiel.

Grossman, G.M. / Rossi-Hansberg, E. (2008): Trading Tasks: A Simple Theory of Offshoring, in: *American Economic Review*, 98 (5), 1978-1997.

Hanson, G. / Mataloni, R. / Slaughter, M. (2003): Expansion Abroad and the Domestic Operations of U.S. Multinational Firms, mimeo.

Harrison, A. / McMillan, M. (2006): Outsourcing Jobs? Multinationals and US Employment, NBER Working Paper 12372.

Hogrefe, J. (2011): Offshoring and Relative Labor Demand from a Task Perspective, Mimeo.

Horgos, D. (2007): Labor Market Effects of International Outsourcing: How Measurement Matters, SOEPpaper 58.

Horgos, D. (2009): International Outsourcing and Wage Rigidity: A Formal Approach and First Empirical Evidence, SOEPpaper 166.

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

Jensen, B. / Kletzer, L. (2007): Measuring Tradable Services and the Task Content of Offshorable Services Jobs, in: Abraham, K. / Harper, M. / Spletzer, J. (eds.): *Labor in the New Economy*, University of Chicago Press.

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

Kleinert, J. / Toubal, F. (2007): The Impact of Locating Production Abroad on Activities at Home, Tübingen Diskussionsbeitrag 314.

Kohler, W. / Wrona, J. (2010): Offshoring Tasks, yet Creating Jobs?, CESifo Working Paper 3019.

- Kohler, W. (2009): Offshoring: Why Do Stories Differ?, in: G. Tondl (ed.): The EU and Emerging Markets. Springer-Verlag, 17-49.
- Landefeld, J.S. / Mataloni, R.J. (2004): Offshore Outsourcing and Multinational Companies, BEA Working Paper 2004-06.
- Lanz, R.; Miroudot, S. & Nordås, H. K. (2011): Trade in Tasks (117), Technical report, OECD.
- Mankiw, N. / Swagel, P. (2006): The Politics and Economics of Offshore Outsourcing, in: *Journal of Monetary Economics*, 53 (5), 1027-1056.
- Mann, C.L. (2005): Offshore Outsourcing and the Globalization of U.S. Services: Why Now, How Important, and What Policy Implications?, in: Bergsten, C.F. (ed.): *Foreign Economic Policy for the Next Decade*, Peterson Institute for International Economics, Washington.
- Marin, D. (2004): A Nation of Poets and Thinkers: Less so with Eastern Enlargement? Austria and Germany, Centre for Economic Policy Research, CEPR Discussion Paper 4358.
- Marin, D. (2010): The Opening Up of Eastern Europe at 20-Jobs, Skills, and 'Reverse Maquiladoras' in Austria and Germany, Discussion Paper in Economics 11435.
- Mattes, A. (2010a): The Impact of Horizontal and Vertical FDI on Labor Demand for Different Skill Groups, IAW Discussion Paper 59.
- Milberg, W. / Winkler, D. (2009): Errors from the "Proportionality Assumption" in the Measurement of Offshoring: Application to German Labor Demand, SCEPA Working Paper 2009-12.
- Mincer, Jacob (1974): *Schooling, Experience and Earnings*, Columbia University Press: New York.
- 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.
- 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.
- Westner, M.K. / Strahringer, S. (2008): Evaluation criteria for selecting offshoring candidates: an analysis of practices in German businesses, in: *Journal of Information Technology Management* 19 (4), 16-34.

## 8 Appendix

### 8.1 Annex A1: Potential Determinants of Offshoring Tasks

In the following we elaborately describe the potential determinates of offshoring that have been used in the literature before and that we further think might be relevant for our analysis.

**Codifiability:** The term refers directly to the question whether it is possible to describe a certain task in a way that it can be performed in a production facility abroad or by another company. Thus, our hypothesis is that outsourcing potential is positively correlated with codifiability.

**Routine:** The meaning is intuitive, namely whether the same task is performed over and over again by an individual. Therefore, there should be a positive impact of this characteristic on both the outsourcing and offshoring-potential of a certain task.

**Undesirability:** Refers to properties of tasks that might be problematic in terms of environmental protection, pollution control or harmful to the employee's health. In this context we conclude that these features are likely to increase the attractiveness of developing and emerging countries with lower legal constraints relative to developed economies. More precisely, we used variables on 'negative' working conditions i.e. carrying heavy loads, smoke or dust, extreme temperatures, noise or unfavorable body posture. With regards to the codification of this variable we experiment with several versions. One method would imply to codify a dummy-variable where persons who mentioned one of the conditions get assigned a one whereas other is getting a zero. Furthermore, we coded a variable where we calculated the mean of the 'condition-variables' for every person.

**Cultural Linkage:** This characteristic is linked to the question whether the pursuit of a task is limited to a cultural area. Thus, whether the performance of a certain task requires country-specific know-how (i.e. knowledge of a country's legal framework) or other common background knowledge of a cultural area. Furthermore, language skills i.e. good knowledge of orthography is defined as another crucial cultural-specific factor. Subsequently, we assume this cultural linkage to have a negative impact on international tradability. This also contains language skills.

**Information and Communication Technology (ITC):** Is an umbrella term that includes any sort of communication device or application.<sup>17</sup> In our model it mainly refers to the usage of computers.

**Geographic Restrictions:** Refers to the question whether the performance of a task is restricted to a certain (geographic) place. In this context mining could be mentioned as a classical example. Thereby, we assume the geographic restriction to be the main determinant of the international tradeability in the form of a negative correlation.

**Interactivity:** Describes whether a task requires personal interaction such as personal customer contact. We put forward the hypothesis that a high interactivity of a task negatively influences its outsourcing potential.

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<sup>17</sup> <http://searchcio-midmarket.techtarget.com/definition/ICT>, 10.04.2012

**Complexity:** Among others, the complexity of a certain task is particularly determined by its diversity. Furthermore, the required qualification (e.g. university degree) is used as an indicator. We can separate our hypothesis on this into a) transaction costs (see routine) and b) qualification?

**New Tasks:** Amount of problems that require new thinking or new learning. How frequent do you improve something or learn something new.

**Knowledge:** Amount of formal knowledge that has to be there to fulfill a task.

**Multitasking:** High level span of competence indicates multitasking and therefore a lower offshoring probability.

**Task Complements:** Task complementarities limit the division of labor and increase the unbundling costs from outsourcing a specific job (Görlich 2010).

**Financial loss by small mistake:** Serves as a measure for the importance of a certain task or process to the overall performance of a company. Thereby, we assume that financially risky tasks have a lower potential for outsourcing. This might be due to the fact that the overall company may suffer severe losses if a treaty is not fulfilled by the counterparty in the outsourcing process.

**Minimum performance/time to execute:** This characteristic refers to the question whether a certain quantity has to be executed in a specific time. Usually, this might be the case with low-skilled work (e.g. assembly line work). Consequently, we assume a positive influence on the outsourceability of a task.

**Deadlines/pressure to perform:** The meaning is once again intuitive, namely whether a certain task has to be done under a great time pressure. However, the effect on the outsourcing potential is supposed to be ambiguous. On the one hand, the variable might again include low-skilled jobs that need to be performed in a certain time (see Minimum performance per time). On the other hand, this certainly also holds true for higher-skilled tasks i.e. managerial functions.

**Concentration on activity:** Refers to the question whether a certain task requires the strong concentration to be performed. Since this is obviously some sort of measure for the complexity of task as well, we assume this characteristic to have a rather negative impact on the outsourcing potential.

## 8.2 Table A2: Expert Survey on Task Characteristics

In the survey, which has been answered by 15 experts from the field of economics, the respondents were asked to evaluate a list of 35 tasks with regard to the three characteristics “locational ties”, “interactivity” and “complexity”. The evaluation was based on the assignment of different levels of relevance between 1 (irrelevant for the task) and 4 (very important for the task).

Task	Locational Ties			Complexity			Interactivity		
	mean	p50	std	mean	p50	std	mean	p50	std
Stetting-up Machines	2,9	3	1,10	2,1	3	0,59	1,9	2	0,70
Operating Machines	2,7	3	0,90	2,5	2	1,06	1,5	1	0,74
Maintaining Machines	2,9	3	1,07	2,9	3	0,74	1,6	2	0,51
Operating Vehicles	2,8	3	1,26	2,0	2	1,00	1,3	1	0,62
Repairing, Restoring	3,2	4	1,08	2,9	2	0,95	1,4	1	0,63
Growing of Plants, Farming of Animals	3,6	4	0,63	2,8	2	0,86	1,6	1	0,74
Mining of Raw Materials	3,9	4	0,26	2,6	2	1,02	1,9	1	0,52
Treating of Materials, Cooking of Food	2,9	3	0,99	1,8	2	0,77	2,3	2	0,80
Assembling/Installing of Buildings, Facilities, Equipment	3,7	4	0,82	2,9	3	0,46	2,1	2	0,64
Catering, Serving	3,4	4	1,12	1,4	1	0,63	3,7	4	0,59
Cleaning, Ironing, Deepcleaning	2,3	3	1,18	1,2	1	0,41	1,5	1	0,76
Removing of Waste	3,0	4	1,25	1,1	1	0,35	1,3	1	0,46
Packing, Mailing	2,7	3	1,18	1,2	1	0,41	1,3	1	0,49
Sorting, Archiving	2,3	3	0,98	1,9	2	0,70	1,5	1	0,64
Analyzing, Researching	1,6	1	0,63	3,9	4	0,26	2,7	3	0,82
Building, Installing	3,6	4	0,84	2,9	2	0,70	2,3	2	0,80
Production of Products & Merchandise	2,2	3	1,08	2,7	2	0,72	1,9	2	0,83
Constructing, Modeling	1,9	2	0,77	3,4	4	0,83	2,1	3	0,80
Buying, Selling, Advertising	2,0	2	1,07	2,1	2	0,83	3,7	4	0,59
Writing Works	1,3	1	0,62	1,7	1	0,72	1,6	1	0,76
Investigating, Analyzing of Information	1,1	1	0,26	3,1	3	0,80	2,2	2	1,09
Computing, Bookkeeping	1,1	1	0,35	2,9	3	0,86	1,5	1	0,52
EDV-Tasks	1,9	2	0,83	3,1	3	0,64	1,7	2	0,59
Securing, Guarding	3,7	4	0,59	1,8	1	1,08	2,4	2	0,63
Interpreting of Laws, Certifying	1,8	1	0,94	3,5	4	0,52	2,1	3	0,83
Educating, Teaching	3,0	3	0,85	3,4	3	0,63	4,0	4	0,00
Nursing, Subserving, Medical/Cosmetical Treating	3,2	4	1,01	3,0	3	0,78	3,9	4	0,26
Publishing, Framing	1,5	1	0,52	3,0	3	0,68	2,7	3	0,72
Hiring of Employees	2,3	2	1,11	2,7	3	0,90	3,7	4	0,49
Instructing/Introducing of Employees	3,2	3	0,77	2,9	3	0,74	3,9	4	0,35
Disposing/Coordinating (Management/Controlling)	2,4	2	0,99	3,3	3	0,59	3,4	3	0,63
Bargaining	2,5	2	1,09	3,5	4	0,52	3,9	4	0,26
Organizing, Planing	1,5	2	0,64	3,1	3	0,74	2,9	3	0,70
Consulting of Others	2,0	2	0,65	3,0	3	0,76	3,9	4	0,35
Advertising, Public Relations/Marketing	1,6	2	0,63	2,5	3	0,64	3,4	4	0,83

Source: Own Survey based on N=15 economists (IAW Survey).



### 8.3 Table A3: Overview of Variables used in Section 4.4 and Section 5

Variable		Observations	Mean	Std. Dev.	Minimum	Maximum
beruf2	Job Classification, Kldb1988 2 Digit	67.250	63,92	21,61	1	99
beruf3	Job Classification, Kldb1988 3 Digit	67.411	641,95	217,12	10	970
beruf4	Job Classification, Kldb1988 4 Digit	67.411	6.426,18	2.166,58	110	9911
berufsabschnitt	Job Classification (33 Groups)	67.250	22,79	8,61	1	33
berufsbereich	Job Classification (broad)	67.250	4,30	0,96	1	6
branche	Industry Classification	66.040	39,26	19,28	1	67
wizwe	Sector	66.307	2,90	1,49	1	5
land	State	67.327	7,55	4,59	1	16
wage	Gross Monthly Income, detailed	13.616	2.461,84	1.836,35	1	50000
einkommen	Gross Monthly Income, grouped	58.998	4,10	1,99	1	9
age	Age	67.411	40,09	10,59	18	65
azeit	Working Time	66.933	37,78	10,41	5	168
experience	Experience	66.943	20,78	11,55	0	53
gebland	National Origind	67.382	0,07	0,25	0	1
hhsiz	Household Size	67.411	2,07	1,08	1	9
indikdet	Firm Size Class	65.634	3,11	1,66	1	6
jahr	Year	67.411	1.997,17	5,77	1991	2006
kenntnis	Qualification	63.984	1,87	1,06	1	4
kids	Number of Kids in Household	67.391	0,52	0,50	0	1
partwork	Partner Works	46.870	0,33	0,47	0	1
schule	Education	66.151	1,99	1,04	1	4
sex	Sex	67.411	0,45	0,50	0	1
staat	Foreign Citizenship	67.193	0,04	0,18	0	1
stib	Job Position	66.373	1,64	0,48	1	2
tenure	Tenure	64.686	11,12	9,52	0	50

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

#### 8.4 Table A4: Indicator Summary Statistics by Sector

Industry	N	mean (trade)	sd (trade)	mean	
				(outsourcing)	sd (outsourcing)
Agriculture	320	-0,78	1,41	0,57	2,31
Private Households	30	0,54	1,36	0,99	1,41
Mining	620	-0,64	1,38	1,28	2,45
Chemics	2.694	-0,53	1,38	0,24	2,59
Stone, Earth, Glass	625	-0,61	1,36	1,22	2,42
Metal Generation	1.194	-0,72	1,38	1,27	2,49
Metal Working	1.550	-0,90	1,33	0,59	2,35
Mechanical Engineering	2.871	-0,57	1,32	-0,09	2,58
Automotive	3.274	-0,78	1,32	0,41	2,51
Electronics	2.506	-0,34	1,23	-0,30	2,51
Precision Mechanics	508	-0,54	1,35	-0,14	2,29
Furniture etc	1.813	-0,58	1,34	1,07	2,46
Concstruction	4.690	-0,98	1,33	0,99	2,30
Paper	377	-0,45	1,43	0,60	2,49
Printing and Publishing	826	-0,29	1,33	0,34	2,36
Leather	130	-0,14	1,28	1,89	2,55
Textile and Clothing	990	-0,21	1,36	1,57	2,41
Food	1.595	-0,23	1,51	1,17	2,31
Other Manufacturing	1.887	-0,30	1,41	0,51	2,54
Retail	6.385	0,62	1,56	0,51	2,01
Wholesale	2.366	0,21	1,27	0,03	2,36
Post	924	-0,17	1,27	0,83	2,45
Traffic	2.223	-0,24	1,36	0,83	2,38
Banking	1.718	0,19	1,03	-0,75	1,83
Insurance	849	0,38	1,04	-1,11	1,92
Food Service	1.359	0,24	1,47	1,09	2,21
Health	5.197	-0,31	1,50	-0,07	2,19
Services for Enterprises	2.590	0,13	1,19	-0,30	2,15
Education	3.493	0,53	1,40	-1,19	2,15
Public Service	4.391	0,32	1,25	0,01	2,26
Lobbying	1.797	0,51	1,31	-0,09	2,48
Media	752	0,12	1,30	-0,51	2,23
Energy	948	-0,30	1,36	-0,23	2,39
Other Services	2.548	0,14	1,35	-0,09	2,66
<b>Total</b>	<b>66.040</b>	<b>-0,14</b>	<b>1,45</b>	<b>0,24</b>	<b>2,41</b>

Source: BIBB Survey 1991-2006, own calculations

**Table A5: Outsourcing Potential, International Tradeability, and Employee Income**

Variable	Income Class		In Monthly Gross Wage	
Outsourcing Potential	-0,3872***	-0,1267***	-0,1674***	-0,0486***
	-0,0031	-0,0036	-0,003	-0,0033
International Tradeability	-0,3696***	-0,0457***	-0,1519***	-0,0244***
	-0,0046	-0,0053	-0,0045	-0,0046
Sex		-0,8666***		-0,2298***
		-0,0214		-0,0135
Age		0,0237***		0,0060***
		-0,0021		-0,0017
Tenure		0,0171***		0,0116***
		-0,0008		-0,0006
Experience		-0,0108***		-0,0022
		-0,002		-0,0016
Working		0,0674***		0,0272***
		-0,0012		-0,0005
Hauptschule (reference)				
Realschule		0,1158***		0,0224*
		-0,0166		-0,013
Abitur		0,4160***		0,1174***
		-0,0273		-0,0178
Vocational Training (reference)				
School Education		0,0580**		0,0313**
		-0,023		-0,0155
Firm Qualification		0,0097		-0,0597*
		-0,0158		-0,0352
University		0,5079***		0,1108***
		-0,0371		-0,0209
Blue-Collar (reference)				
White-Collar		0,3179***		0,1131***
		-0,0212		-0,016
Household		0,0172**		0,0018
		-0,0077		-0,0095
Kids		0,0025		0,0301**
		-0,0138		-0,0136
Partner is Working		0,1094***		0,0368***
		-0,0148		-0,0119
Foreign Citizenship		0,0618		0,011
		-0,0448		-0,032
Constant	4,1502***	0,0279	7,3479***	6,1883***
	-0,0074	-0,1545	-0,0071	-0,165
Dummy Variables	No	Yes	No	Yes
N. of Obs.	58998	35464	13616	7333
F-Stat	9989,03	847,35	1800,64	199,93
R squared	0,25	0,66	0,21	0,67
AIC	231489,9	113101,46	27978,68	7746,79

Note: Standard deviation in parentheses:  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; Dummy variables contain Region (Bundesland), Firm size classes, Industry classification, Job classification and Year;

Source: BIBB/IAB/BAuA Worker Survey 1991, 1998, 2006 (Income Class); 2006 (In Monthly Gross Wage); Own Calculations