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## Offshoring potential and employment dynamics

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## **Offshoring Potential and Employment Dynamics**

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# Offshoring potential and employment dynamics

Bernhard Boockmann\*

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**Abstract:** This study addresses the impact of offshorability (a job characteristic indicating how easily a job can be offshored) on employment changes and worker mobility in Germany. A composite measure of offshorability for German data is used which broadens existing measurements such as Blinder (2009). Contrary to what the literature suggests, there is no evidence that net employment creation is higher in non-offshorable occupations. Furthermore, both hiring and job separation rates decline with offshorability. Results from a discrete-time hazard rate model confirm that the risk of exit from a job is smaller in more offshorable jobs; most of this is due to lower job-to-job mobility. The exception is for low-skilled workers, whose probability of leaving employment to other labour market states is higher if their jobs are more offshorable.

**JEL-Codes:** F16, F66, J63

**Key Words:** Offshorability, offshoring, employment, job stability, hiring, job loss

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## 1. Introduction

Over the last few decades, the potential for offshoring of local jobs (the possibility to relocate tasks and jobs abroad, whether to a foreign subsidiary or another company) has been a concern for policy-makers and academics alike. Both in manufacturing and services and with respect to skilled or less skilled labour, the perception has grown that many jobs (such as accountants, radiologists and production line workers) can be performed in a foreign country, with the products then sold to domestic customers. Changes in technologies, in particular computerization and standardization, as well as declining trade costs and the increase of actual offshoring<sup>1</sup> have contributed to this perception.

Potential (as opposed to realised) offshoring of tasks and jobs, termed offshorability in the following, is the central subject of this study. Offshorability, which is a job characteristic, must be distinguished from offshoring, which is an observable action. While the two are closely related, there are various reasons why offshoring potential may not be realised, such as cost considerations, different qualities of labour input, trade costs etc. The recent theoretical literature on trading tasks explicitly uses both terms: offshorability, typically captured by something like an offshoring cost schedule over different tasks, and actual offshoring – determined endogenously as the margin between tasks offshored and tasks not offshored, though offshorable (Grossman and Rossi-Hansberg, 2008).

One of the questions that will be examined in this paper is how the structure of employment with respect to offshorability changes over time. Does the number of highly offshorable jobs increase or decline relative to less offshorable jobs? A second question is whether offshorability constitute a labour market risk in the sense that it leads to involuntary job losses or employer changes. Do offshorable jobs have a greater

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1 In this paper, offshoring is understood in the sense of moving jobs to another country. In the trade literature, offshoring is sometimes identified with imports of intermediate goods or services from abroad (Feenstra and Hanson, 1997, 1999; Crinó, 2010), which can take even if jobs are not relocated.

risk of being dissolved? In this context, the study looks at hirings, separations and the likelihood of employment transitions out of existing jobs.

While a number of existing studies rank trade and offshoring low among the determinants of shifts in employment or other labour market changes (Amiti and Wei, 2005; Liu and Trefler, 2008), there have always been prominent trade economists arguing for a significant role of offshoring (Feenstra and Hanson, 2003; Feenstra, 2008). Recently, labour market impacts of trade and offshoring have been put back on the agenda due to the increasingly dynamic path of globalisation: for example, the fragmentation of the value chain and the trade of specific tasks and the increase in trade between industrial countries and emerging economies such as China or other East Asian countries. Seen from this angle, offshorability may be a predictor for future offshoring.

Measurement of offshorability is notoriously difficult. There is a range of existing measures; however, some of them are only loosely correlated (Blinder and Krueger, 2013). In this paper, a measure which unifies existing approaches is constructed on the basis of German data. It uses detailed information on tasks and job characteristics relating to offshorability. Based on this measure, I explore the relation between offshorability, on the one hand, and net employment changes, worker mobility rates and the individual risk of leaving the job, on the other.

An analysis of offshorability for Germany provides an interesting case of comparison to the US, to which most of the existing studies refer. The patterns and risks induced by offshorability may differ across countries. US jobs are probably more vulnerable to offshoring than German jobs, because there are many more English-speaking (than German-speaking) workers in primary destinations of offshoring, such as India. There is no previous evidence on the amount of employment risks due to offshorability in different countries; an international comparison is, therefore, particularly worthwhile.

In the following section, the relationship between offshorability and labour market developments is discussed on the basis of the existing empirical literature. Section 3 introduces the data, including the offshorability measure. In Section 4, I take a look at the development of employment, hirings and job separation at the occupational level. Section 5 deals with the impact of offshorability on job separation. Conclusions and suggestions for further research are contained in Section 6.

## **2. Previous empirical findings and open research questions**

Internationalization increasingly occurs in the form of relocation of individual activities ('tasks') to foreign locations, rather than by trading final products. Production is perceived as a value chain, the elements of which can be moved internationally (Baldwin and Robert-Nicoud 2014, Grossman and Rossi-Hansberg 2008, Kohler 2003). Against this background, the concept of offshorability of tasks and jobs has found increasing attention in the literature during the last decade. A rise in offshorability may increase the substitutability of workers located in different countries; it can, therefore, enhance risks for labour supply and lead to job losses (Geishecker, 2008; Görg and Görlich, 2012, Liu and Trefler, 2008) and occupation changes (Baumgarten, 2014). It may also change bargaining power on the labour market and put pressure on wages (Geishecker and Görg, 2013; Skaksen, 2004). Offshorability may also be viewed as a predictor for actual offshoring. For these reasons, offshorability clearly has policy relevance.

To which extent are jobs offshorable? This question is addressed in an expanding literature (see the overviews in Blinder 2009, Blinder and Krueger 2013, Püschel 2013, 2014). According to Blinder and Krueger's (2013) survey approach, roughly 25% of US jobs are offshorable. Using different methodologies, Blinder (2009) and Jensen and Kletzer (2006) come to similar conclusions, although they differ in the assignment of occupations and tasks to degrees of offshorability.

### **2.1 Changes in technology and offshorability**

There is little evidence on changes in the share of offshorable jobs in the stock of employment in industrial countries. From a theoretical perspective, technical change may favour less offshorable jobs. Thus, if technological change makes capital-labour substitution easier, more offshorable jobs may be more affected than less offshorable jobs due to the composition of tasks in these jobs. At the same time, technical progress may enhance offshorability, for instance, if increasing computerisation allows for the remote delivery of services (Blinder, 2009).

According to the literature, technological change has been a major source of changes in the structure of employment in many industrial countries in recent decades. Two main competing accounts can be distinguished: a skill and a task perspective.

Skill-biased technical change (SBTC) increases the demand for high-skilled labour relative to low-skilled labour by increasing the relative productivity of the former. A reason may be the complementarity between skills and technologies, such as information and communication technologies (Acemoglu 2002, Aghion 2002). The empirical analysis by Berman et al. (1994) shows that the shift to skilled labour occurs mainly within rather than across industries and is associated with innovations and ICT; this has been followed by a large number of studies. Ample empirical work (e.g. Katz and Murphy, 1992; Autor et al., 1998; Murphy et al., 1998; Card and Lemieux, 2001) confirms the implications of SBTC for the wage structure.

For the UK, Goos and Manning (2007) show that employment expanded in high-quality and low-quality jobs between 1979 and 1999 while it declined in medium-skilled jobs, where job quality is measured as the median wage in the beginning of the observation period. Evidence for this phenomenon, often termed ‘job polarization’, has also been found by other studies including Autor, Katz and Kearney (2006) and Autor and Dorn (2013). The ‘U-shaped’ relationship of the job polarisation hypothesis stands in contrast to skill-biased technological change, according to which the relation should be monotonic.

Goos and Manning (2007) go on to investigate various reasons for job polarisation. Their favoured explanation is the decline of routine tasks due to technological change, computerisation in particular, as put forward by Autor et al. (2003). According to this view, the use of ICT has not affected skills per se, but rather single tasks that could more or less easily be replaced by computers (see also Acemoglu and Autor 2011 for a summary of the task approach). In performing routine tasks, computers and workers are substitutes, while they are complements in performing non-routine tasks.

On the empirical side, Autor et al. (2003) find that computerisation is associated with reduced labour input of routine manual and routine cognitive tasks and increased labour input of non-routine cognitive tasks. While many low-skilled workers do routine tasks, there is no one-to-one relation between tasks and skills: for example, many non-routine tasks in sales, restaurants and personal services are performed by low-skilled workers. Using direct data on task content, Spitz-Oener (2006) confirms these results; a considerable amount of these changes occurs within occupations. Goos et al. (2014)

analyse changes in the employment structure of 16 European countries from 1993 to 2006. They find that a large share of the explanation for polarisation rests with technological change and the decline of routine jobs. Globalization (offshoring) and changes in consumer demand explain polarisation to a lesser extent. Ebenstein et al. (2011) look at sectoral differences. They classify occupations as routine and non-routine; routine occupations have declined in employment in manufacturing from 1984 to 2002 but have expanded in services; non-routine occupations show employment growth in both sectors.

What does technical change imply for employment changes in more or less offshorable jobs? For the US, results by Blinder and Krueger (2013) show that more educated workers tend to have more offshorable jobs. If the composition of employment shifts to high skilled workers, as the SBTC hypothesis implies, overall offshorability of employment increases.

The link between task content and offshorability has also been addressed in the literature. Autor et al. (2003) argue that trade and technology may have a joint impact, in the sense that the jobs that can be routinized due to technological change are also the ones that are most likely to be shifted abroad (a similar argument is made by Levy and Murnane, 2004). Similarly, Oldenski's (2012a, 2012b) findings suggest that relocation and the complexity of tasks are negatively related; production involving routine tasks is more likely to be offshored. Autor (2010) stresses that many tasks that can be automated but cannot be relocated (e.g., stacking shelves in a supermarket), while some offshorable tasks cannot be automated (e.g., call centres). Based on survey data collected specifically for measuring offshorability (described further below), Blinder and Krueger (2013) find only a small correlation between routine work and offshorability.

Apart from these composition effects, technical progress may affect offshorability of jobs in a direct way. Working with a computer or over the internet opens new ways of communication and delivery of services. Therefore, jobs that require working with a computer are more offshorable. The number of jobs without computer use declines; hence, average offshorability rises.

## **2.2 Offshoring, onshore task composition and employment risks**

Since offshorable jobs are more easily relocated abroad and non-offshorable jobs remain, offshoring of jobs changes the composition of jobs in the home country. Over time, changes in trade costs have facilitated offshoring. *Ceteris paribus*, one would expect average offshorability of jobs at home to decline.

Becker and Muendler (2012) link the increasing share of non-offshorable jobs to changes in the German import structure. Using detailed data on task requirement, they estimate the responsiveness of onshore tasks to trade flows. According to their findings, there has been a shift towards less offshorable activities between 1979 and 2006; these changes occurred mostly within sectors and occupations. Thus, offshoring is linked to specialisation in non-offshorable activities. Clearly, this does not imply a causal effect of offshorability on offshoring of jobs. Indeed, empirical results by Eppinger (2014) suggest that services imports occur less intensively in industries using offshorable jobs. These industry differences are most likely due to remaining trade barriers preventing the offshoring of offshorable jobs

According to Lanz, Miroudot and Nordås (2011), import penetration in services shifts the task content of domestic production towards information intensive tasks at the expense of manual tasks. However, the magnitude of the effect is relatively small.

Other contributions address compositional changes in employment with respect to routineness. If routine work declines and offshorability is positively related to routines, offshorability is bound to decrease.<sup>2</sup> A recent assessment of the labour market consequences of offshore activities by Becker, Ekholm, and Muendler (2013) looks at the effect on German multinational enterprises (MNEs). Their results suggest that increased foreign activity shifts onshore employment towards the execution of non-routine and interactive tasks and increases the share of skilled labour.

In a similar vein, Hogrefe (2013) links the effects of offshoring to task composition. The cost or employment share of routine tasks is regressed on offshoring, measured as the share of imported intermediates. He expects a negative sign if routine

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2 Following the SBTC perspective, Hijzen, Görg and Hine (2005) study the effects of offshoring on changes in the skill structure. According to their results, international outsourcing has a strong negative impact on the demand for unskilled labour but has increased the demand for skilled labour.

tasks can be more easily offshored. Hogrefe (2013) uses panel data for 19 German manufacturing industries and finds that offshoring influences routine tasks more strongly negatively than non-routine tasks.

Compositional shifts in employment associated with offshoring are brought about by changes in hirings, job losses and employer or occupation changes. A number of studies have looked at employment dynamics (job reallocation, hirings or separations) as a consequence of offshoring. For instance, Baumgarten (2014) studies the relationship between offshoring and the individual risk of leaving the occupation. Moreover, a rich data set on tasks performed in occupations is used to better characterise the sources of worker vulnerability. The earlier literature is surveyed in Crinó (2009, section 2.2). Recent contributions include Amiti and Wei 2005, Bachmann and Braun 2011, Geishecker 2008, Crinó 2010, Görg and Görlich 2012, and Liu and Trefler 2008.

If there is, as Becker and Muendler (2012) suggest, a shift away from offshorable activities, jobs in which these activities are performed should be more likely to end involuntarily. The only study, however, that links offshorability to the risk of job loss, employer or occupational changes is Blinder and Krueger (2013). These authors find that offshorability does not have systematic effects on the probability of layoff.

### **2.3 Measurement of offshorability**

Blinder and Krueger (2013) define offshorability as the ‘ability to perform one’s work duties (for the same employer and customers) in a foreign country but still supply the good or service to the home market.’ Offshorability is, therefore, a job characteristic and does not require that jobs have actually moved.

The offshorability of a job is influenced by a potentially large number of properties and requirements. Selecting and measuring these features are serious challenges; existing approaches differ substantially in methodology and results.<sup>3</sup> While there may be agreement that the tasks of a computer programmer are more offshorable

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3 The measurement of offshorability of jobs is given additional complexity if one considers jobs as bundles of tasks. Lanz, Miroudot and Nordås (2011) argue that offshorable tasks are often complementary to tasks that cannot be offshored. Their assessment of the offshorability of a job requires that one takes into account all tasks performed on the job.

than that of a taxi driver, distinctions become more difficult in intermediate cases.<sup>4</sup> Recent surveys of approaches to measure offshorability are contained in Blinder and Krueger (2013), Brändle and Koch (2014) and Püschel (2014). The following list gives an overview of empirical approaches towards measuring offshorability:

- Blinder (2009) uses a subjective assignment of offshorability to occupations, based on descriptions of activities contained in the Occupational Information Network (O\*Net) data. He assigns occupations to four different categories, depending on the degree of offshorability. As it is based on occupation-level data, the study inevitably misses any within-occupation variability in the degree of offshorability.
- Crinò (2010) classifies occupations according to three task characteristics: routineness, the requirement of face-to-face contact, and use of ICT on the job. Based on information from the O\*Net database, he also includes the importance of these characteristics for each occupation.
- Becker and Muendler (2012) ‘let the data speak for themselves’. They use a variety of indicators for offshoring potential in parallel and look at changes in these indicators separately. Indicators can be grouped in activity content (for instance, repair/maintain, cook or drive) and performance requirements, such as the need to perform multiple activities on the same jobs.<sup>5</sup>
- Jensen and Kletzer (2006) exploit the geographic concentration of service activities within the United States to identify offshorability. The idea is that services with a high concentration are traded domestically and hence, these activities can be classified as potentially tradable also internationally. Jensen and Kletzer (2010) acknowledge the shortcomings of this measure; however, when they compare the ranking based on their original measure with several job characteristics that relate to offshorability, they find a high correlation.

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4 ‘Think, for example, about accounting, the filing of documents, watch repair, and paralegal work. The degrees of offshorability of tasks like these are matters of subjective judgment’ (Blinder and Krueger 2013).

5 In a similar way, other authors look at single indicators; for instance, Nedelkoska (2013) looks at the codifiability of a job’s content only.

- Goos et al. (2010) construct an offshorability indicator based on actual offshoring. Their indicator uses offshoring announcements contained in factsheets in the European Restructuring Monitor (ERM) on more than 400 restructuring cases and aggregates this information by occupation. The difference to the other measures is that it identifies offshorability with offshoring. It is also unclear how representative these data are for total offshoring.
- A particularly careful approach to measure offshorability is adopted by Blinder and Krueger (2013). First, they re-code answers to an existing survey, based on job characteristics related to offshorability, such as the ones introduced earlier in this section. Second, they conduct an own survey, which elicits the respondents' own assessment of the offshorability of the job. Comparing these different measures, they find a relatively high level of agreement.

Blinder (2009) stresses the conflict between objective measures of offshorability, which often yield implausible rankings of occupations, and subjective measures, which often involve arbitrary choices. In this paper, objective and subjective measurements are combined using an objective weighting procedure. I follow the methodology of most papers and select a number of job characteristics that are related to offshorability. While most of the characteristics are measured objectively, I have to take recourse to subjective assessments with respect to one important characteristic, ties to a specific location. Using the methodology of Brändle and Koch (2014), which is described in more detail in the following section, a comprehensive measure on the basis of principle component analysis is derived.

### **3. Data**

The data source for information about tasks used in this paper is the German Qualification and Career Survey of Employees (BIBB Survey). This data source is merged to a large-scale administrative dataset, which contains detailed information about employment and mobility.

### 3.1 Offshoring potential

The BIBB data is also used by other studies for Germany, such as Becker and Muendler (2012) and Spitz-Oener (2006, 2009). Six cross sections of the data are available, the first dating from 1979 and the most recent from 2011/12. Each contains a wealth of information on up to 30.000 employees and their jobs. For reasons of comparability, the first cross section used in this study is the 1991 survey;<sup>6</sup> furthermore, I only use the 2005/06 survey and not the 2011/12 survey because the employment data ends in 2007/08. Consistent with the choices for the employment data, the data is restricted to workers aged 15 to 65 years and excludes public servants, retirees, unemployed and self-employed individuals, as well as marginal employees not required to pay social security contributions.

The offshorability indicator is derived in several steps; the derivation follows Brändle and Koch (2014) who developed the measure. On the basis of existing literature (Blinder, 2009; Crinó, 2010; Moncarcz et al., 2008 and others), they identify five job characteristics with a direct bearing on offshorability:

- Interactivity with customers and co-workers, in particular the need for face-to-face communication (as opposed to remote interaction, e.g. via the internet);
- Locational ties, i.e. the requirement of physical closeness to a work location or work unit (Blinder 2009);
- Cultural linkages, such as knowledge of law, institutions, languages etc. which facilitate the delivery of a service;
- Complementarity of tasks within a job, which increases the unbundling cost of offshoring a specific job;
- The use of information and communication technology (ICT) in a job.<sup>7</sup>

The first four of these job characteristics are barriers to offshoring, while the use of ICT is believed to facilitate offshoring. The hypothetical direction of influence of these characteristics on offshorability is included in Column 1 of Table 1.

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6 See Hall (2009) for a general data description. Rohrbach-Schmidt and Tiemann (2013) contain additional information on the measurement of tasks and the comparability between surveys.

7 According to Blinder (2006) the key attribute of offshorability of a service is ‘whether the service can be delivered electronically over long distances with little or no degradation in quality’.

In addition to these five measures, a number of other factors are identified that may also influence the offshoring potential of a job. Among these are the codifiability and routineness of a job. Complex (non-routine) tasks may cause frictions in the production process which are more difficult to settle if production takes place abroad. Codifiability (or standardisation) of tasks refers to the possibility to describe a certain activity in a way that it can be performed by another company, either located in the home country or abroad. According to the extant literature, these characteristics have an unambiguous impact on the outsourcing decisions of firms, while their impact on offshoring is less direct (Brändle and Koch, 2014). Therefore, a measure of offshorability is constructed that includes only the first five job characteristics and construct an alternative measure that also takes into account routineness and codifiability as a robustness check.

The BIBB data contain direct information on most of these job characteristics. Brändle and Koch (2014, Table 2 and Appendix Table 1) describe exactly how the indicators are derived from the data. Interactivity is derived from respondents' agreements to statements such as 'daily work involves direct contact with clients or patients', 'daily work involves convincing others' and 'daily works involves negotiating agreements'. Cultural linkages are approximated by the statement that 'daily work requires specific knowledge of law and justice (yes or no).' The complementarity measure is the number of complementary tasks performed, relative to all tasks performed. ICT means working with a computer (yes/no).

Codifiability is derived from answers to the statement that 'every step of the execution of tasks / activities is stipulated in detail (never, seldom, often, and always)'. Routineness means that 'the operational cycles of work are exactly and constantly repeating (never, seldom, often, and always)'.

Only direct questions on locational ties are unavailable. Therefore, I use a subjective coding derived from the judgmental procedure in Blinder (2009), based on task descriptions in the O\*NET data. The coding has been implemented by Schrader and Laaser (2009) and is described in detail there; it is based on tasks descriptions from the BERUFENET database for 3.100 occupations.

The offshorability measure has the form

$$offshoring\ potential_i = \sum_{j=1}^n weight_j \cdot job\ characteristic_{ij},$$

where the weights are derived by Principal Components Analysis (PCA). Different to Brändle and Koch (2014), who also derive a measure of outsourceability, the basis of the PCA are the five or seven variables just defined.<sup>8</sup> Based on the criterion that the Eigenvalues should be larger than unity, the number of PCA components is restricted to two.

Table 1 contains the scoring coefficients of the PCA. The left part of the table shows the coefficients for the version with five job characteristics. For the offshorability index, all job characteristics are required enter the index with the sign derived from theory. The first component does not fulfil this criterion. Rather, it seems to capture the difference between high-skilled service jobs (jobs characterised by the use of ICT, knowledge of the law, interactivity, complementarity but not by locational ties), on one hand, and low-skilled manual jobs, on the other. By contrast, the second component conforms to an inverse measure of offshorability. The largest coefficient in absolute value is that for locational ties, which underscores the importance of this characteristic for offshorability. The coefficients for interactivity, knowledge of law and use of ICT have a similar and somewhat lower magnitude while complementarity of tasks only marginally determines offshorability.

The second PCA with seven variables adds a flavour of outsourcing to the measure. If offshoring is usually combined with outsourcing, the second component would be preferable. Again, locational ties are the most important job characteristic, followed by computer use, codifiability and routines (again, all coefficients have a similar magnitude). Compared to the first measure, interactivity and knowledge of law lose their importance. Complementarity has the ‘wrong’ sign now, but as before, the influence of this characteristic on the second component is low.

The distribution of the two measures is shown in Figure 1. Both indexes have a bimodal distribution, suggesting that jobs are either offshorable or not. Although the coefficients of the job characteristics are quite different between the two offshorability

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8 Another difference to Brändle and Koch is that I include only the cross-sections 1991, 1998/99 and 2005/06. Nevertheless, the offshorability measure is very similar to theirs in terms of the weights of the components.

measures derived, the Prais-Winston rank correlation of the two measures is very high (0.96). Therefore, the results are shown only for the first of these two alternatives in the following.

As a check on the results, I use Blinder's eyeball test and examine whether the lists of the most and least offshorable occupations according to different measures correspond to the expectation. Figure 2 contains the results for the 10 most and least offshorable occupations. The lists do not contain occupations which one would intuitively rank very differently with respect to offshorability. This is also true for the other occupations not displayed here and for the second offshorability measure.<sup>9</sup>

The two lists in Figure 2 group together occupations which do not seem to have much in common except their offshorability: the economic sectors in which these jobs are frequent, the tasks typically involved with them and the required skill levels are very different among the two groups. This confirms the interpretation of the second component of the PCA as a measure for offshorability.

Finally, it has to be stressed that the offshorability measure is constant over the observation period. In principle, the three cross-sections of the BIBB data would allow performing separate PCAs; however, this would come at the cost of having fewer observations in each of these estimations.<sup>10</sup>

### **3.2 Employment data**

To estimate the impact of offshorability on employment and worker mobility, longitudinal information on the latter is needed. As the BIBB data contain only cross-sections and have a limited sample size, the offshorability indicators are merged to a large-scale administrative dataset, the Sample of Integrated Labour Market Biographies of the Institute for Employment Research (IAB) of the Federal Employment Agency, abbreviated to SIAB.

The SIAB data originate from the public pension system.<sup>11</sup> They contain information on employees in Germany from 1975 to 2008. Civil servants ('Beamte')

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9 A complete list of occupations is available from the author.

10 Findings by Brändle (2014, figure 3.2) suggest that the rise in average offshorability has a similar magnitude whether or not one allows for changes in the PCA coefficients in different cross-sections.

11 For a full description of the SIAB, see Dorner et al. (2011).

and self-employed individuals are not contained in the data because they do not contribute to the pension system. Although the data contains information on marginal employment, the data is confined to employment subject to social security contributions. By excluding marginal employment not liable to social security, a more homogenous sample is obtained, as there is much higher mobility in marginal than in regular employment. Apprentices are also excluded. The data is further restricted to male and female workers between 18 and 62 years of age.

The data cover the time span from 1975 to 2008. This period is divided into three intervals: 1975 to 1984, 1985 to 1994, and 1995 to 2008. The measure of occupation refers to the activity actually performed at the reference date rather than the occupation in which the individual earned a degree. The classification is based on the 3-digit level of the official classification of the Federal Employment Agency. From these, 120 categories with a similar number of cases in the sample are created.

The data further contain information about socio-demographic characteristics such as educational and vocational training degrees, job type (such as blue collar or white collar worker, full time or part time, or home workers/freelance workers), age, gender and citizenship. The industry affiliation of the employer (15 categories) and the federal state (16 categories) are also recorded in the data. Since the data contain the complete work history of the individuals, it is possible to construct measures of tenure and job experience. Summary statistics of all variables are contained in the Appendix.

### **3.3 Merging task and employment data**

As the two datasets cannot be merged at the individual level, information on offshorability is imputed in the SIAB data using a regression-based procedure. Offshorability is predicted in the BIBB data, using a linear regression of the PCA result on occupation, industry and a number of personal characteristics. The coefficients from this regression are then multiplied with the characteristics as measured in the SIAB data and aggregated to form the offshorability index.

An alternative procedure would be to simply calculate average offshorability by occupation and transfer these averages to the SIAB. In the tasks-based literature, offshoring potential is introduced as a concept that is strongly linked to the occupation, which are viewed as bundles of tasks (see e.g. Hogrefe 2013). However, using between-

occupation differences in offshorability only would overlook the fact that individuals in the same occupation but with different characteristics, such as skill levels, will be assigned systematically different tasks. Moreover, offshorability between workers in the same occupation may differ across industries. For instance, the tasks of a cook working for a producer of ready-to-serve meals can probably be easily offshored while those of a cook in a restaurant cannot. For these reasons, I follow Blinder/Krueger (2013) and take the heterogeneity of offshorability within occupations into account.

The results from the offshorability regression are contained in Table 2. With an  $R^2$  of 0.55, the share of the overall variance of offshorability explained by these variables is quite high but not perfect (see the last line of the table). Experience has a negative effect in the relevant range, while the effect of age is positive. Individuals with tertiary education have lower offshorability. Foreigners have less offshorable jobs while men have more offshorable jobs.

The within- and between occupation  $R^2$  show that most of the explained variation in offshorability is between occupations, not within occupations. The within-occupation  $R^2$  (from a regression of offshorability on the X's when transforming the data such that the occupation-specific mean of offshorability is taken out) is only 0.047, while the between  $R^2$  (obtained from a regression where all other covariates are held fixed) is almost six times higher. Hence, there is some improvement over simpler alternatives, although the offshorability measure is driven to a large extent by the original Blinder-type measure of ties to location which is applied at the occupation level.<sup>12</sup> Clearly, this conclusion depends on the fine measurement of occupations in the data while industries are measured much more coarsely.<sup>13</sup>

The merger with the SIAB data requires that the independent variables are defined in the same way. A comparison of the variables contained in Table 2 with Table A1 in the Appendix shows that for all individual characteristics used in the regression there is a corresponding variable in the SIAB data. The occupational classification in the

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12 In the illustrative example used above, a cook in the tourism industry is predicted to have an offshorability of -0.58 while a cook working in the food industry has an offshorability of -0.47. As hypothesized above, the tasks of a cook in the food industry are more offshorable, but the difference is less than one would perhaps expect.

13 A possible extension would be to consider interactions between occupations and other characteristics.

SIAB data consists of 120 occupational groups; the more detailed 5-digit classification in the BIBB data was aggregated accordingly.

#### **4. Evidence on employment changes, hirings and separations at occupation level**

In this section, I look at the relation between offshorability, on the one hand, and employment changes as well as worker mobility, on the other.

Our measure of employment change is the change in the employment share of the occupation over an interval of (approximately) ten years (1976 to 1984, 1985 to 1994 and 1995 to 2007). It indicates how many jobs have been created relative to the size of the occupation.

Figure 3 shows net employment changes (measured in percent) in the 120 occupations in the SIAB data by period. Occupations are ordered by average offshorability, with the least offshorable occupations on the left. Each dot in the graph represents an occupation. The curve smoothes the data points using a locally weighted regression with bandwidth 0.8.<sup>14</sup> Due to the relatively large time span, the variation of employment changes is large; the standard deviation of the percent employment change increases over the three sub-periods from 20.6 to 32.6.

The graphs show that employment changes do not seem to be strongly related to offshorability. There is some evidence of a relative increase in employment in the least offshorable occupations, in particular in the earlier decades. Several highly offshorable occupations, such as data processing specialists, have also gained in relative size. While there is a weak negative relation in the middle of the distribution in the period from 1985 to 1994, there is no visible difference in employment growth particular in this part of the distribution in the first and third decades. Overall, the pattern of employment changes by offshorability is stable over time. There is no indication that offshorable jobs are disappearing.

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14 The local linear regression does not use employment shares as weights. Hence, each occupation has equal influence on the smoothed profile regardless of its size. Further results (available on request) show that weighting by occupation size influences the relationship between employment changes and offshorability only to a minor degree. In part, this is due to the small sampling error in a large sample.

To measure worker mobility, I use the hiring rate and the separation rate. The hiring rate is the ratio of the number of hirings to the stock of employees. In each of the 120 occupations, the number of hirings is aggregated within the three sub-periods. The stock of employees is measured on June 30<sup>th</sup> of each year and these annual measurements are summed over the sub-periods. Thus, the hiring rate is a long-run equivalent to the usual mobility rates calculated on an annual basis (see, for instance, Davis et al., 1996). The definition of the separation rate is analogous to the hiring rate. To calculate it, all separations are included regardless of the destination state.<sup>15,16</sup>

The upper panel of Figure 4 shows the smoothed relationship between hirings and offshorability for the three sub-periods, applying the same smoothing process used for Figure 3 above. The curves suggest that in tendency there have been more inflows into jobs in less offshorable occupations as compared to more offshorable occupations, but the effect is slightly non-monotonic: the least offshorable occupations have experienced lower accession rates than occupations ranked in the middle. The differences in the hiring rate are substantial. The general pattern is similar over time; however, the accession rate has somewhat increased in the last decade of the observation period.

The relation between job separations and offshorability is shown in the lower panel of Figure 4. Given that net job creation is only little affected by offshorability (see

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15 A further issue is whether recalls to the same employer are counted as hirings and separations. In this data, all transitions to and from the employer are counted among hirings and separations; recalls are not excluded. This must be taken into account in the interpretation, in particular in occupations with seasonal fluctuations such as occupations in the construction industry where recalls are frequent. See Boockmann and Steffes, 2010, for a more detailed discussion.

16 The formula for the rates is

$$R_{j,\underline{t},\bar{t}}^k = \frac{\sum_{i=1}^n \sum_{t=\underline{t}}^{\bar{t}} r_{ijt}}{\sum_{i=1}^n \sum_{t=\underline{t}}^{\bar{t}} E_{ijt}},$$

where  $R_{j,\underline{t},\bar{t}}^k$  is the rate measured in the consecutive time intervals from  $\underline{t} \in 1976, 1985, 1995$  to  $\bar{t} \in 1984, 1994, 2007$ ,  $k \in 1, 2$  refers to either hirings or separations,  $j$  denotes the occupation and  $i$  the individual,  $r_{ijt}$  is hirings or separations in period in occupation  $j$  and period  $t$  and  $E_{ijt}$  is the stock of employment measured at a reference date in period  $t$ .

Figure 3), it is not surprising that the pattern of separations looks similar to hirings: occupations with high hiring rates also have high separation rates. As a result, job stability increases with offshorability. Again, the effect is not monotonic. In the last sub-period (1995-2007), the average separation rate over occupations is higher than in the earlier periods, reflecting an overall decline in employment.<sup>17</sup>

The result that both the hiring and the separation rate are relatively high in occupations with low offshoring potential implies that there is more churning (i.e., hiring and exit from jobs in existing positions) in these jobs. If the alternative measure of offshorability (including routine and codifiability as further aspects of offshorability) is used, the effects become stronger and the curves of hirings and separations are declining almost monotonically. The same happens if a smoothing procedure more robust to outliers (least absolute deviations instead of least squares) is applied. Thus, the finding of a negative relation between offshorability and worker mobility is quite robust to alternative specifications.

It is difficult to find an explanation for the fact that more offshorable jobs have less churning and more job stability.<sup>18</sup> Less offshorable occupations with high mobility include construction sector occupations (bricklayers, roofers, main construction workers) or gardeners. A number of occupations with low offshorability, however, have low mobility rates, such as train drivers, motor vehicle repairers and home wardens. Among jobs with high average offshorability, there are low-mobility jobs mainly in manufacturing (typesetters, technical draughtspersons) but also a few high-mobility jobs (such as musicians and other artists). To shed more light on the observed differences, the data is split into manufacturing and services (excluding agriculture, the energy sector and the construction industry) and separate mobility rates as well as average offshorability for the occupations are calculated within each sector.<sup>19</sup> This

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17 According to the figures of the Federal Employment Agency, employment subject to social security payments fell from 28,1m in 1995 to 26.9m in 2007 (Bundesagentur für Arbeit 2012).

18 In the literature, a number of papers have stressed occupation as a predictor for job mobility (e.g. Boockmann and Steffes 2010), but there is no research on what explains differences in job mobility across occupations.

19 Results are available from the author on request.

differentiation shows that the negative relation between churning and offshorability is due to occupations in manufacturing.

The finding that there tends to be less mobility on more offshorable is consistent with recent results by Eppinger (2014). According to his conclusions, many offshorable jobs are found in industries with low services imports. Although offshoring would be an option, there must be reasons why the offshoring potential of these jobs remains largely unexploited. This resistance to offshoring may also render these jobs particularly stable.

Potentially, the stability of highly offshorable jobs can have a large number of reasons. If jobs are not tied to the location, workers who need to move for personal reasons can take their job with them. Another possible explanation is based on idiosyncratic job requirements in location-specific jobs. Presumably, a lathe operator or cutter faces similar job requirements in all companies and, consequently, needs to engage less in job search. By contrast, conditions for wardens or music teachers may differ between jobs so that it takes more job search and mobility until a good match is found. In our data, these differences are visible also within occupations: a cook in the food production industry has more job stability on average than a cook working in the hospitality industry; the annual job exit probability in the data is 0.22 in the former case and 0.35 in the latter.

Workers in non-offshorable occupations are likely to differ in a variety of aspects; for instance, they may be of different age and have different qualifications and work experience. It is likely workers with certain characteristics are drawn systematically into particular occupations and have different job exit rates. For instance, Pellizari (2011) shows that there is higher mobility in elementary occupations; these occupations also have a high share of low-skilled workers. In the next section, the individual determinants of job (in)stability will be separated from the effect of offshorability using a regression framework.

## **5. Offshoring potential and job changes**

In the following, the difference in job stability between workers in offshorable and non-offshorable jobs will be estimated, controlling for worker characteristics.

The dependent variable in the following is the annual transition probability from one employer to another or to a labour market state other than employment such as

unemployment and not being in the labour force. A transition is recorded if it takes place between June 30th and the same date in the following year; I disregard much of the short-term mobility taking place within a year and only look at the employee's main job (that with the highest daily wage). In some of the estimations, I differentiate between job-to-job changes and transitions to other labour market states. The reason is that these two types of transitions may be behaviourally different: while leaving one's job for another (potentially better) job is often a deliberate choice within the development of one's career, transition to unemployment or non-employment typically occurs involuntarily. Characteristics such as education and vocational qualifications may predispose employees differently to leave their jobs to these destination states.

I estimate the determinants of job exit for the individuals, given that the individual has been in the job for  $\tau$  years. The time-discrete hazard rate  $h_{it,t-1}(\tau, x_{it}, \delta, \beta)$  is the probability that individual  $i$  is not observed in employment in company  $j$  in year  $t$ , conditional of the fact that the individual was employed in this company in the previous year:

$$P(e_{ijt} = 0 | e_{ijt-1} = 1) = h_{it,t-1}(\tau, x_{it}, \delta, \beta) = \Phi(D_{it}^{\tau'} \delta_{\tau} + x'_{it} \beta).$$

In addition to tenure, this probability depends on a vector of characteristics  $x_{it}$  and parameters  $\beta$  and  $\delta$ . Tenure is modelled as a discrete step function with a set of tenure dummies  $D_{it}^{\tau}$ . For estimation, a probit model is used. In the regressions which differentiate between destination states, a competing risks model of the destinations-specific hazard rates to a new job and other employment states is used. Assuming that the transitions risks to both states are independent, individuals making a transition to one state are treated as censored at the time of transition.

In order to make the data in the regression more homogenous, it is restricted to a flow sample of jobs that started in 1991 at the earliest. As East Germans enter the data mostly in 1994, the first year of observation for East German workers is 1995.

The independent variables include a polynomial of age, gender, education, job status and German citizenship. In addition, industry, year and federal state dummies are included in the specification. Occupation fixed effects are not controlled for; as the regression of offshorability in Table 2 has shown, the variation in predicted

offshorability arises mainly between occupations and not within occupations. Conditioning on occupations would, therefore, eliminate a large part of the variation in the offshorability measure.

Results for the estimations are contained in Table 3. The table contains average marginal effects from the probit estimation. From Column 1, job exit is influenced negatively by offshorability. However, the effect is quantitatively small. An increase in offshorability by one standard deviation is associated with a decline in the job exit probability by less than one percentage point; given the average job exit probability of 24.6% in the sample, this translates into a reduction by close to four percent.

Worker characteristics, such as skills, tenure and job position, influence the job exit probability in the expected direction. Tenure strongly reduces the job exit probability. The coefficients imply that duration dependence is monotonically negative. Compared to newly hired workers, employees with five years tenure have a 15 percentage points lower job exit probability. Females have a slightly lower probability of leaving their jobs. Education and job type have a strong influence on the job exit probability. Workers without completed vocational training or university degree have substantially higher transition probabilities. Unskilled blue collar workers and home workers are more likely to change than white collar or skilled blue collar workers.

Columns (2) and (3) show that the lower job exit probability in occupations with high offshoring potential is mostly due to job-to-job mobility, less due to transitions to other labour market states. Thus, workers with offshorable tasks switch jobs less frequently than workers whose tasks cannot be offshored. However, the sign of the coefficient for offshorability is still negative, indicating that offshorability does not create additional risks of job loss on average.

Regarding the other determinants of mobility, duration dependence is stronger for job-to-job changes than transitions to other states. There are also some differences with respect to education; university graduates have lower job mobility but do not make transitions to other states with lower probability than the base group. Females have a lower propensity to change jobs, but are more likely to transit out of employment.

Offshorability may have a different impact on workers with different skills. For instance, offshorable low-skilled jobs may be more easily offshored than offshorable high-skilled jobs if unskilled labour is relatively more abundant and cheaper in foreign

countries. Therefore, the estimations are repeated for three skill groups: the unskilled (without completed vocational training), medium-skilled workers (with vocational training degree) and high-skilled workers (with university degree).

The results are contained in Table 4. Coefficients for the personal characteristics are estimated but are not displayed in the table. There are several differences between skill groups. The effect of offshorability on job exit by low-skilled workers is small and positive. In the other two skill groups, the effect is negative, as in the full sample. The positive effect among the low-skilled is entirely due to transitions out of employment while the effect on job-to-job changes is negative. This can be interpreted in the sense that offshorability creates additional risks of unemployment and labour force exit for low-skilled workers. Among medium-skilled workers, the negative effect of offshorability on job-to-job changes is relatively large while offshorability reduces the probability of leaving for other labour market states mainly for university graduates.

## **6. Conclusions**

The empirical results of this study show that offshorability varies substantially across occupations, while there is less systematic variation within occupations. A major finding is that, despite the threat of offshoring, offshorable jobs are characterised by a high degree of job stability. In particular, hiring and job separation rates tend to be lower in more offshorable jobs in manufacturing. Regression results confirm the inverse relationship between offshorability and job mobility. Further results show that this is mostly due to fewer job-to-job changes and less churning in offshorable occupations.

The only exception from this pattern concerns low-skilled workers; here, offshorability increases the probability of leaving employment to other states, such as unemployment and being out of the labour force. For this group, offshorability constitutes an additional employment risk. However, the effect is quantitatively small.

Against the background of public concerns, the fact that employment stability is higher in offshorable jobs is surprising. Among possible explanations are a greater specificity of job requirements in location-bound and, hence, non-offshorable tasks. This could give rise to a higher intensity of job search and more job-to-job mobility.

The analysis could be extended to include further job or company characteristics. It could also be linked to wage determination, which is likely to be

influenced by the offshorability of jobs, too. Furthermore, if employment stability is an element of job quality, one could investigate whether offshorable jobs have higher job quality also in other respects. These issues, however, must be left to further research.

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**Table 1: Scoring coefficients from the PCA analysis**

| Variable                   | Expected impact<br>on offshorability | Alternative 1 |             | Alternative 2 |             |
|----------------------------|--------------------------------------|---------------|-------------|---------------|-------------|
|                            |                                      | Component 1   | Component 2 | Component 1   | Component 2 |
| Interactivity              | -                                    | 0.432         | 0.435       | 0.377         | -0.093      |
| Complementarity            | -                                    | 0.557         | 0.134       | 0.478         | 0.133       |
| Locational ties            | -                                    | -0.315        | 0.698       | -0.215        | -0.618      |
| Knowledge of<br>German law | -                                    | 0.380         | 0.401       | 0.305         | -0.005      |
| Computer use               | +                                    | 0.510         | -0.382      | 0.405         | 0.467       |
| Codifiability              | +                                    |               |             | -0.398        | 0.447       |
| Routine                    | +                                    |               |             | -0.410        | 0.417       |
| Eigenvalues                |                                      | 1.762         | 1.169       | 2.042         | 1.237       |
| Proportion                 |                                      | 0.352         | 0.234       | 0.292         | 0.177       |
| Rho                        |                                      | 0.586         |             | 0.468         |             |

**Table 2: Predicting offshorability in the BIBB data**

| Variables   | Coeff.               |
|---|----------------------|
| Age   | 0.011***<br>(0.003)  |
| Age squared /100  | -0.010**<br>(0.004)  |
| Experience  | -0.015***<br>(0.002) |
| Experience squared /100   | 0.020***<br>(0.004)  |
| Tenure: 1 year or less (baseline)   |                      |
| 2 years   | -0.107***<br>(0.033) |
| 3 years   | -0.126***<br>(0.033) |
| 4 years   | -0.116***<br>(0.034) |
| 5 years   | -0.108***<br>(0.034) |
| 6 years or more   | -0.170***<br>(0.032) |
| Gender: male (baseline)   |                      |
| Female  | 0.098***<br>(0.0084) |
| Working time: full time   |                      |
| Part time < 18h/week  | 0.097***<br>(0.016)  |
| Part time > 18h/week  | 0.093***<br>(0.010)  |
| German citizen (baseline)   |                      |
| Foreign citizen   | -0.088***<br>(0.016) |
| Education: lower secondary school degree,<br>no vocational qualification (baseline) |                      |
| Lower secondary school,<br>vocational qualification                                 | 0.042*<br>(0.022)    |
| Upper secondary school,<br>no vocational qualification                              | -0.017<br>(0.021)    |
| Upper secondary school,<br>vocational qualification                                 | -0.102***<br>(0.025) |
| Degree from a university of applied<br>sciences                                     | -0.189***<br>(0.023) |
| University degree   | -0.170***<br>(0.024) |
| Occupation dummies (119)  | YES                  |
| Industry dummies (14)   | YES                  |
| Federal state dummies (15)  | YES                  |
| Observations  | 62,095               |
| R <sup>2</sup> within occupations   | 0.047                |
| R <sup>2</sup> between occupations  | 0.273                |
| R <sup>2</sup> pooled   | 0.551                |

Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Table 3: Offshorability and transitions from jobs (1991-2008)**

|  | Job exit             | Job-to-job           | Job-to-other states  |
|--|----------------------|----------------------|----------------------|
| Offshorability   | -0.009***<br>(0.000) | -0.006***<br>(0.000) | -0.003***<br>(0.000) |
| Tenure: 1 year or less (baseline)  |                      |                      |                      |
| 2 years  | -0.038***<br>(0.001) | -0.039***<br>(0.000) | 0.002***<br>(0.000)  |
| 3 years  | -0.100***<br>(0.001) | -0.080***<br>(0.001) | -0.018***<br>(0.000) |
| 4 years  | -0.132***<br>(0.001) | -0.102***<br>(0.001) | -0.029***<br>(0.000) |
| 5 years  | -0.152***<br>(0.001) | -0.119***<br>(0.001) | -0.034***<br>(0.001) |
| 6 years or more  | -0.202***<br>(0.001) | -0.161***<br>(0.001) | -0.048***<br>(0.000) |
| Age  | -0.022***<br>(0.000) | -0.005***<br>(0.000) | -0.013***<br>(0.000) |
| Age squared / 100  | 0.026***<br>(0.000)  | 0.003***<br>(0.000)  | 0.018***<br>(0.000)  |
| Gender: male (baseline)  |                      |                      |                      |
| Female   | -0.010***<br>(0.000) | -0.010***<br>(0.000) | 0.002***<br>(0.000)  |
| Education: lower secondary school degree, no vocational qualification (baseline) |                      |                      |                      |
| Lower secondary school, vocational qualification                                 | -0.037***<br>(0.001) | -0.017***<br>(0.001) | -0.017***<br>(0.000) |
| Upper secondary school, no vocational qualification                              | 0.028***<br>(0.002)  | -0.000<br>(0.001)    | 0.031***<br>(0.001)  |
| Upper secondary school, vocational qualification                                 | -0.036***<br>(0.001) | -0.023***<br>(0.001) | -0.012***<br>(0.001) |
| Degree from a university of applied sciences                                     | -0.039***<br>(0.001) | -0.021***<br>(0.001) | -0.019***<br>(0.001) |
| University degree  | -0.016***<br>(0.001) | -0.021***<br>(0.001) | 0.009***<br>(0.001)  |
| In vocational training (baseline)  |                      |                      |                      |
| Blue collar, unskilled   | 0.070***<br>(0.004)  | 0.014***<br>(0.004)  | 0.046***<br>(0.002)  |
| Blue collar, semi-skilled  | 0.043***<br>(0.004)  | 0.006<br>(0.004)     | 0.028***<br>(0.002)  |
| Blue collar, skilled   | 0.034***<br>(0.004)  | -0.008*<br>(0.004)   | 0.032***<br>(0.002)  |
| White collar   | 0.020***<br>(0.004)  | -0.009**<br>(0.004)  | 0.019***<br>(0.002)  |
| Home workers   | 0.090***<br>(0.011)  | 0.016*<br>(0.009)    | 0.063***<br>(0.007)  |
| Part time < 18h/week   | 0.050***<br>(0.004)  | -0.010***<br>(0.004) | 0.049***<br>(0.002)  |
| Part time > 18h/week   | 0.035***<br>(0.004)  | -0.009**<br>(0.004)  | 0.033***<br>(0.002)  |
| German citizen (baseline)  |                      |                      |                      |
| Foreign citizen  | -0.025***<br>(0.001) | 0.010***<br>(0.001)  | -0.034***<br>(0.000) |

**Table 3: Offshorability and transitions from jobs (1991-2008)**

|                            | Job exit  | Job-to-job | Job-to-other states |
|----------------------------|-----------|------------|---------------------|
| Occupation dummies (119)   | NO        | NO         | NO                  |
| Industry dummies (14)      | YES       | YES        | YES                 |
| Year dummies (16)          | YES       | YES        | YES                 |
| Federal state dummies (15) | YES       | YES        | YES                 |
| Number of observations     | 4,245,363 | 4,245,363  | 4,245,363           |
| Pseudo-R <sup>2</sup>      | 0.072     | 0.063      | 0.063               |

Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. All coefficients are marginal effects from probit estimation. All estimations further contain 14 industry dummies, 15 dummies for German federal states and 16 year dummies.

**Table 4: Offshorability and transitions from jobs (1991-2008) by skill groups**

|                                   | Job exit             | Job-to-job           | Job-to-other states  |
|-----------------------------------|----------------------|----------------------|----------------------|
| <hr/>                             |                      |                      |                      |
| Low-skilled workers               |                      |                      |                      |
| Offshorability                    | 0.002***<br>(0.001)  | -0.002***<br>(0.001) | 0.003***<br>(0.000)  |
| Number of observations            | 869,916              | 869,916              | 869,916              |
| Pseudo-R <sup>2</sup>             | 0.110                | 0.093                | 0.062                |
| <hr/>                             |                      |                      |                      |
| Medium-skilled workers            |                      |                      |                      |
| Offshorability                    | -0.010***<br>(0.000) | -0.008***<br>(0.000) | -0.002***<br>(0.000) |
| Number of observations            | 2,930,721            | 2,930,721            | 2,930,721            |
| Pseudo-R <sup>2</sup>             | 0.059                | 0.057                | 0.053                |
| <hr/>                             |                      |                      |                      |
| High-skilled workers              |                      |                      |                      |
| Offshorability                    | -0.010***<br>(0.001) | -0.003***<br>(0.000) | -0.008***<br>(0.000) |
| Number of observations            | 444,726              | 444,726              | 444,726              |
| Pseudo-R <sup>2</sup>             | 0.028                | 0.024                | 0.062                |
| <hr/>                             |                      |                      |                      |
| Control variables (as in Table 3) | YES                  | YES                  | YES                  |
| Occupation dummies                | NO                   | NO                   | NO                   |
| Industry dummies                  | YES                  | YES                  | YES                  |
| Federal state dummies             | YES                  | YES                  | YES                  |
| <hr/>                             |                      |                      |                      |

Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 All coefficients are marginal effects from probit estimation.

**Figure 1: Distribution of offshorability (1975 to 2008)**

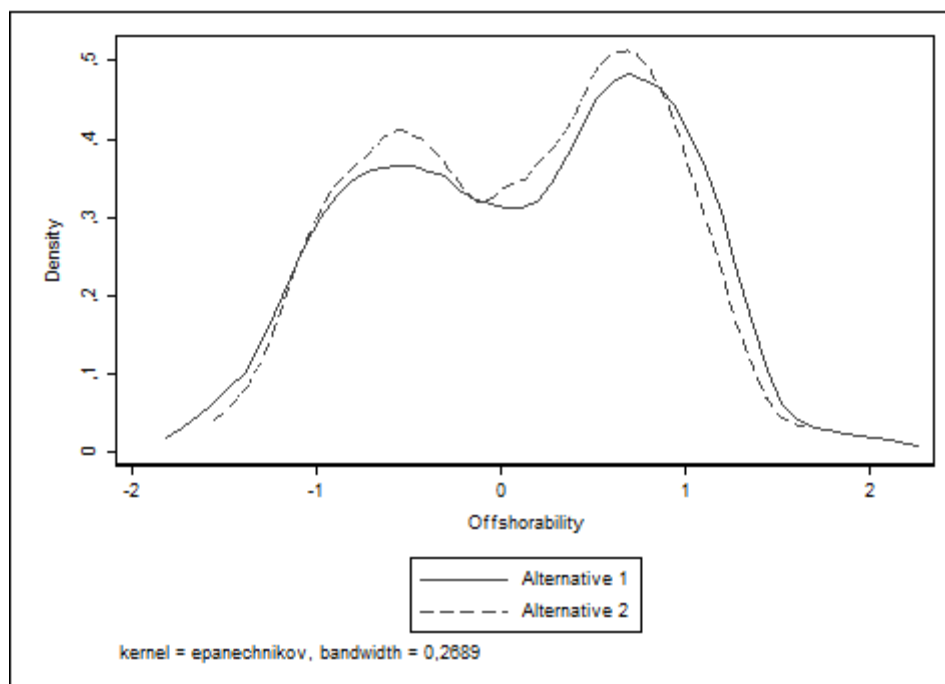
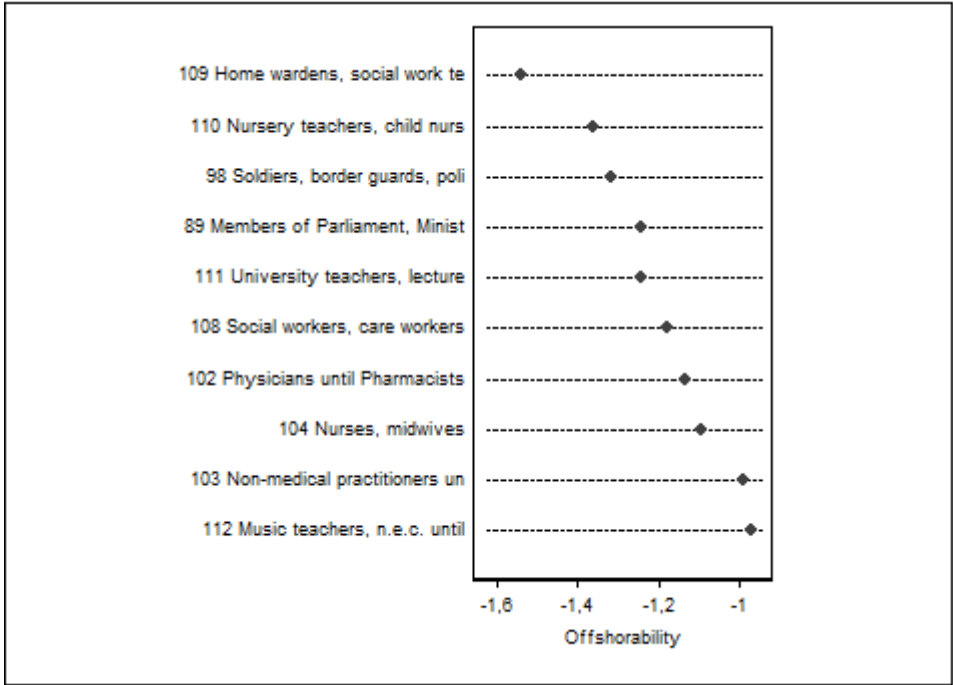
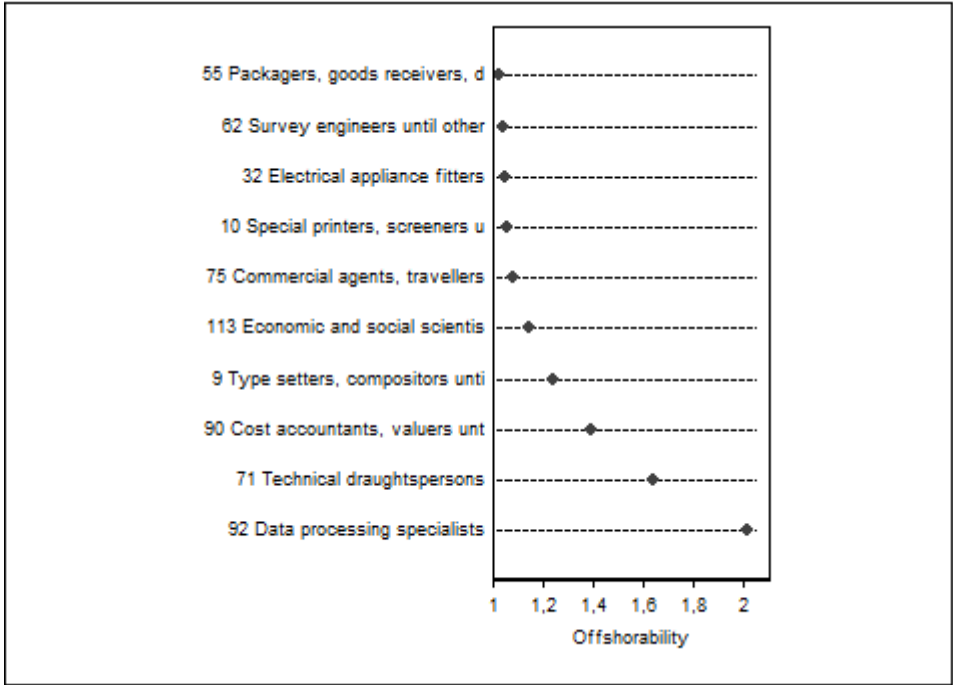


Figure 2: Most and least offshorable occupations

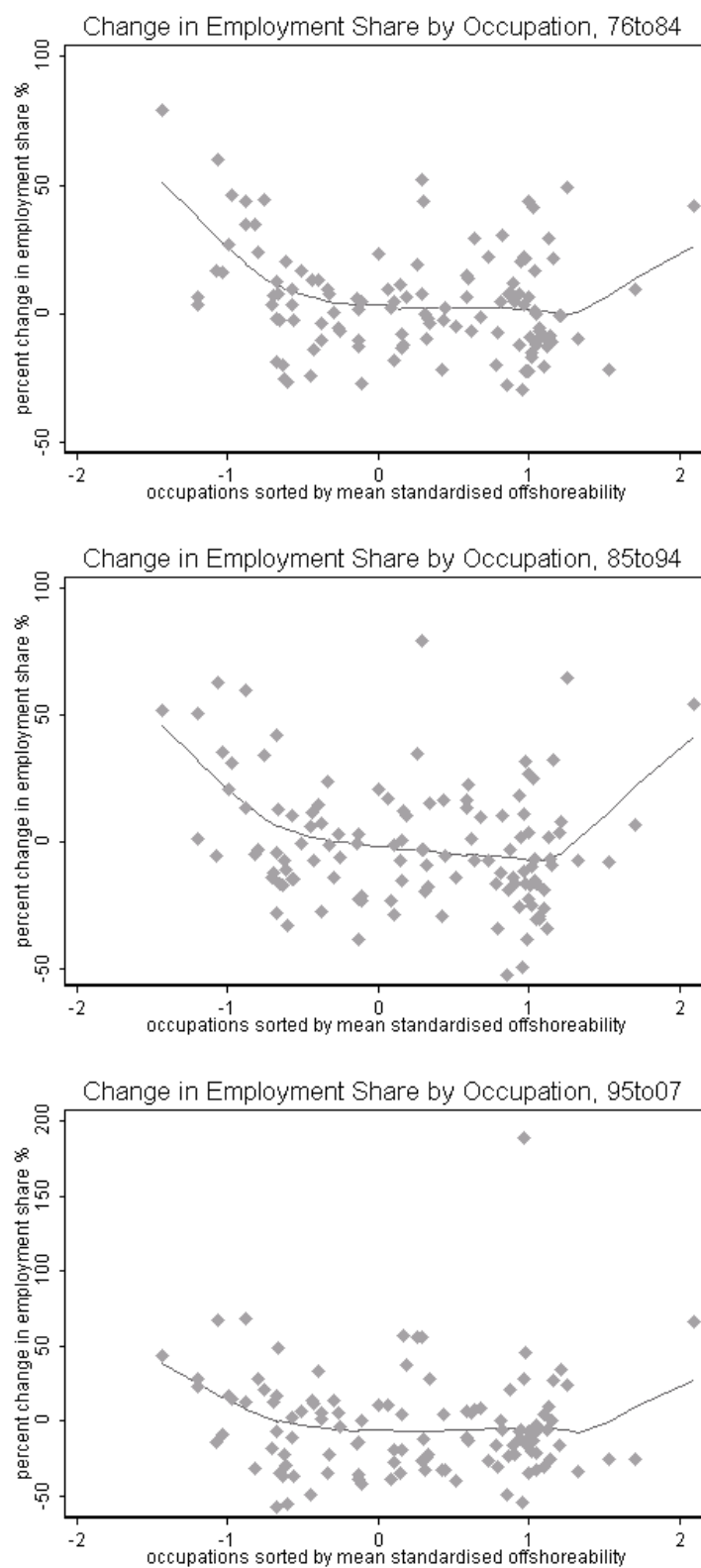
a) Least offshorable occupations



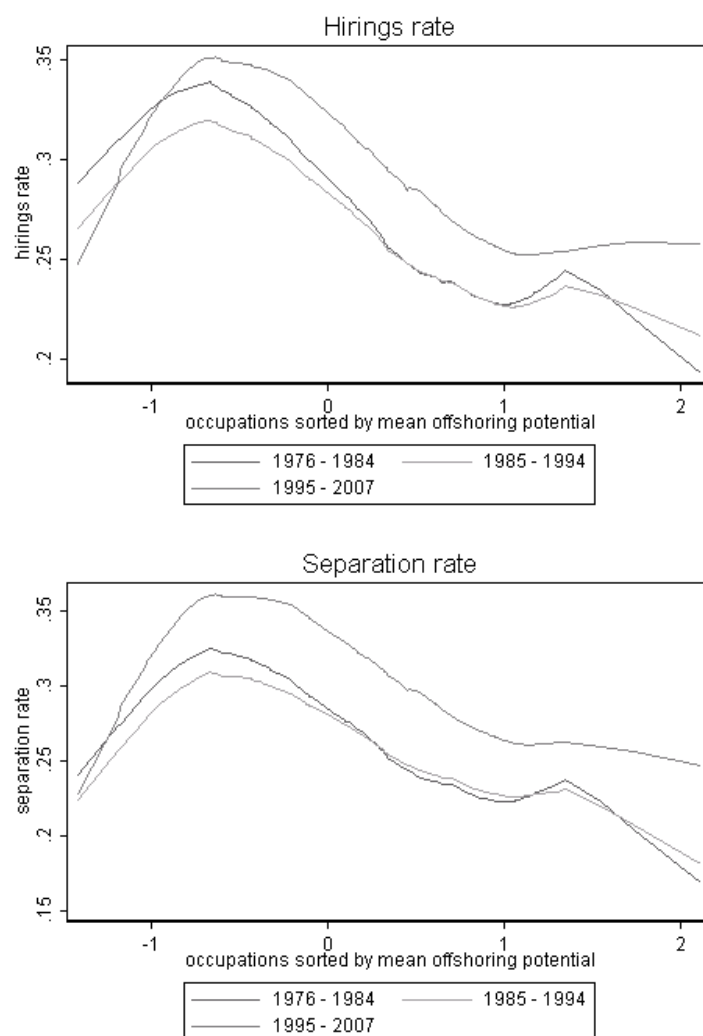
b) Most offshorable occupations



**Figure 3: Offshoring potential and employment changes, 1976 to 2007**



**Figure 4: Offshoring potential and employment dynamics, 1976 to 2007**



## Appendix

**Table A1: Summary statistics of the SIAB data**

| Variable   | Observations | Mean   | Std. dev. |
|--|--------------|--------|-----------|
| Job exit   | 6,313,600    | 0.246  | 0.431     |
| Job-to-job change  | 6,313,600    | 0.169  | 0.375     |
| Exit to other states                                       | 6,313,600    | 0.076  | 0.266     |
| Offshorability   | 4,590,540    | -0.092 | 1.033     |
| Tenure   | 6,785,821    | 2.997  | 3.441     |
| Experience   | 6,785,821    | 10.140 | 7.708     |
| Age  | 6,785,821    | 37.707 | 10.628    |
| Gender: female   | 6,785,821    | 0.454  | 0.498     |
| Lower secondary school degree, no vocational qualification | 6,543,107    | 0.117  | 0.322     |
| Lower secondary school, vocational qualification           | 6,543,107    | 0.675  | 0.468     |
| Upper secondary school, no vocational qualification        | 6,543,107    | 0.014  | 0.117     |
| Upper secondary school, vocational qualification           | 6,543,107    | 0.047  | 0.212     |
| Degree from a university of applied sciences               | 6,543,107    | 0.039  | 0.193     |
| University degree  | 6,543,107    | 0.068  | 0.252     |
| Blue collar, unskilled                                     | 6,782,640    | 0.201  | 0.401     |
| Blue collar, semi-skilled                                  | 6,782,640    | 0.204  | 0.403     |
| Blue collar, skilled                                       | 6,782,640    | 0.011  | 0.103     |
| White collar   | 6,782,640    | 0.422  | 0.494     |
| Home workers   | 6,782,640    | 0.000  | 0.021     |
| Part time < 18h/week                                       | 6,782,640    | 0.024  | 0.154     |
| Part time > 18h/week                                       | 6,782,640    | 0.135  | 0.342     |
| German citizenship   | 4,872,615    | 0.891  | 0.312     |

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