International Outsourcing, the Nature of Tasks and Occupational Stability: Empirical Evidence for Germany*

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Abstract

Using a large administrative data set of individual employment histories in Germany, this paper studies how occupational stability is affected by the international fragmentation of production processes. Moreover, a rich data set on tasks performed in occupations is used to better characterize the sources of worker vulnerability. The impact of both international material outsourcing (in the manufacturing sector) and international service outsourcing (in the service sector) on occupational stability is found to vary with the intensity of non-routine and interactive tasks of the occupation. Stability is the less negatively affected the higher the degree of non-routineness and interactivity. While international service outsourcing is associated with an increase in overall stability, the impact of material outsourcing is slightly negative.

Key words: Occupational stability; International outsourcing; Duration analysis

JEL classification: F16, J23, J24, J63

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1 Introduction

Labour market adjustment needs caused by increased opportunities for global production sharing are of growing concern in industrialized countries (e.g. OECD, 2007). Advances in information and communication technology (ICT) and the lowering of transportation costs have led to the tradeability of formerly untradeable (intermediate) goods and services, making it feasible to break down the production process into ever finer stages, which do not require geographic concentration anymore. A boom in international outsourcing activities undertaken by firms in industrialized countries that take advantage of international labour cost differences and specialization patterns has been the consequence.[1] While there is a broad consensus on the existence of long-term efficiency gains due this changed division of labour, the necessary reallocation of resources may be associated with short-term costs that have to be taken into account when estimating the benefits of free trade.

Although these adjustment costs may become manifest in different forms, previous research has aimed to capture them by estimating the effect of international outsourcing on the incidence of unemployment or of leaving the current employer, thereby also addressing the question whether workers have become more vulnerable and employment relationships less stable.[2] This paper follows this stream of the literature but focuses on the risk of leaving the current *occupation*, not employment in general or the employer, which can be motivated on several grounds.

First, the recent phase of the international fragmentation of production processes can be best understood within the conceptual framework of trade in tasks as opposed to trade in (complete) goods (Grossman and Rossi-Hansberg, 2006). According to the related literature it is the type of tasks performed on the job that determines the degree of vulnerability towards foreign competition. Characteristics that have been put forward as being relevant in this context are the prevalence of routine tasks (Levy and Murnane, 2004, closely following Autor, Levy, and Murnane, 2003), the importance of codifiable rather than tacit information (Leamer and Storper, 2001) as well as the degree of geographical proximity and the amount of physical contact required (Blinder, 2006). These characteristics go beyond the traditional high-skill/low-skill divide and are more attached to the occupation than to the industry, the firm or the educational level. For example, high-skilled software programmers are probably more affected by foreign competition than less-skilled taxi drivers or nurses.

[1] With the term international outsourcing I refer to the relocation of activities abroad that previously have been performed in the home country, irrespective of whether this occurs through foreign direct investment or through contractual arrangements at arm's length.

[2] Recent examples include Geishecker (2008), Munch (2005), Bachmann and Braun (2008) and OECD (2007). A detailed literature review is given in the next section.

Second, leaving the occupation is associated with costs, since it involves a loss of specific human capital. Kambourov and Manovskii (2007) show that the returns to occupational tenure can be substantial and outweigh those to firm and industry tenure. Thus, the authors challenge the concepts of firm-specific (see Farber, 1999 for a survey) and industry-specific (Neal, 1995; Parent, 2000) human capital.[3] In a very related vein, Gathmann and Schönberg (2007) develop the concept of task-specific human capital and state that the extent to which skills can be transferred between occupations depends on the similarity of tasks performed in them.[4]

Third, in spite of some data limitations to be discussed in Section 3, including occupational changes allows to also consider adjustments within firms, adding an additional and potentially important feature to the analysis.[5] Finally, Germany is an interesting case to address since it is not only the largest country in the European Union but also very open to international trade. It generally features among the highest export levels of the world.

In the empirical analysis, which covers the years 1999 to 2003, a hazard model in discrete time (grouped into yearly intervals) is used to determine if and how international outsourcing affects the individual risk of leaving the current occupation and how the impact varies with the intensity of non-routine and interactive tasks of the occupation. Data on individual employment histories is taken from a two percent sample of administrative social security records. Supplementary information on the nature of tasks predominantly performed in occupations is drawn from a large survey of 30,000 employees and mapped into occupations building on a technique recently introduced by Becker, Ekholm, and Muendler (2007). Finally, indicators for international outsourcing are constructed at the industry level with data from German input-output tables. To account for the increased tradeability of services, separate measures are constructed for material and service outsourcing. Furthermore, the analysis is performed separately for the manufacturing and the service sector.

The main result obtained in this paper is that the impact of both international material outsourcing (in the manufacturing sector) and international service outsourcing (in the service sector) on occupational stability varies with the intensity of non-routine and in-

[3] In their study on the US Kambourov and Manovskii (2007) estimate that ceteris paribus five years of occupational tenure are associated with an increase in wages in the range of 12 to 20 percent.

[4] According to Gathmann and Schönberg (2007) task-specific human capital accounts for 25 to 40 percent of overall wage growth over a ten year period in Germany.

[5] Zimmermann (1998) provides a detailed picture of the different forms of job mobility in Germany. He uses survey data from the German Socioeconomic Panel (GSOEP) and finds that changes of occupation occur more frequently than changes of the workplace. Moreover, within-firm changes are more important than changes outside the firm. In contrast, in a more recent contribution based on administrative data Gathmann and Schönberg (2007) find that the annual mobility rate across 64 aggregated occupational groups is 12.4 percent for male workers – compared to 18.8 percent who change the establishment in a given year.

teractive tasks of the occupation. Stability is the less negatively affected the higher the degree of non-routineness and interactivity. While international service outsourcing is associated with an increase in overall stability, the impact of material outsourcing is slightly negative.

The paper is structured as follows. The next section discusses the related literature. The third section describes the data used for the analysis, while the fourth section contains a description of the empirical strategy and the estimation method. The fifth section discusses the estimation results, the sixth section contains some extensions and robustness checks, and the last section concludes.

2 Related literature

While, starting with Feenstra and Hanson (1996, 1999), the early empirical literature on the labour market effects of international outsourcing focused on aggregate labour demand and wages for different skill groups, the analysis of short-term dynamics has been initiated only recently. More specifically, this paper is related to a limited but growing number of studies that estimate the effect of international outsourcing on worker flows at the micro level. Micro-level studies have the advantage that they suffer less from endogeneity and aggregation bias than for example industry-level studies in the line of Kletzer (2000), who analyzes industry displacement rates in response to increasing foreign competition (cf. Geishecker, 2008). In contrast, the labour market behavior of an individual worker can be expected not to influence industry aggregates.

Egger, Pfaffermayr, and Weber (2007) employ a dynamic fixed effects multinomial logit to quantify the impact of international outsourcing and trade on the sectoral reallocation of workers. Based on a sample of Austrian male workers in the time period 1988-2001, they find that international economic factors negatively affect the probability of both staying in and moving into the manufacturing sector. The effect is even more pronounced for those industries in the manufacturing sector that have a revealed comparative disadvantage. Using data on the Danish manufacturing sector for the years 1992 to 2001, Munch (2005) estimates a competing risks duration model and finds that international outsourcing increases both the job-to-job and the job-to-unemployment hazard. While low-skill workers are particularly affected by the former, the latter is more relevant for the high-skilled. In both cases the quantitative impact is rather limited, however.

Turning to related studies on Germany, Geishecker (2008) chooses a very similar approach to Munch (2005). Using survey data for the time period 1991-2000 and the manufacturing sector, he only considers the hazard of leaving employment. He arrives at the conclusion that outsourcing significantly reduces individual employment security. This holds for all educational subgroups: low-, medium- and high-skilled. He cannot, however, reject the hypothesis of a uniform effect across skill groups. Bachmann and Braun (2008) expand on this analysis. Using data of German administrative social security records and focusing on the years 1991 to 2000, they estimate hazard models for both match separations and the competing exit states unemployment, non-participation and employment with a new employer. They find no effect of international outsourcing on overall job stability in the manufacturing sector. Only the probability of a transition to non-participation is found to increase with outsourcing intensity. This effect is strongest for medium-skilled workers. In contrast, they even find strong and positive effects of outsourcing in the service sector, particularly for high-skilled workers. The authors hint at positive productivity effects as a potential explanation for this at first sight surprising result.

Taken together, the evidence on skill-dependent effects of international outsourcing on employment stability – with skill usually being defined according to educational attainment – is rather mixed, thus further encouraging the analysis of other relevant job or worker characteristics. Against the background of an ever-increasing pool of highly educated workers in countries like India and China, authors such as Leamer and Storper (2001), Levy and Murnane (2004) as well as Blinder (2006) have pointed to the nature of performed tasks on the job as a more important determinant of worker vulnerability. Grossman and Rossi-Hansberg (2006) formalize this notion in their theoretical framework of trade in tasks. Partly, this literature resembles the one on the role of tasks in explaining labour market effects of technological change (cf. Autor, Levy, and Murnane, 2003; Spitz-Oener, 2006), which is not surprising as particularly international service outsourcing is strongly driven by advances in ICT. Accordingly, in the model of Grossman and Rossi-Hansberg (2006) falling offshoring costs are associated with a productivity effect that benefits the factor whose tasks are more easily offshored, thus playing a similar role to labour-augmenting technological progress. However, the benefits rather accrue in the long run and the model does not make any predictions on (possibly adverse) short-term dynamics.

On the empirical side, there are a few studies that relate occupations and tasks to offshoring, but they do so within a classical labour demand estimation framework. Information on employment prospects of individual workers is lost in this context. Crinò (2007) estimates demand elasticities for different US white-collar occupations in a structural model of firms' behavior. He finds that, within skill groups, service offshoring penalizes tradeable occupations and benefits complex non-tradeable occupations. related paper Becker, Ekholm, and Muendler (2007) analyze how the onshore workforce composition of German multinational enterprises (MNEs) responds to a change in their offshore employment levels, thus proxying foreign direct investment (FDI) expansions. They obtain as a result that an increase in the offshore employment leads to a relative increase in the number of high-skilled workers and to a relative shift towards more non-routine and interactive tasks where the former effect is more pronounced.

A recent study that looks, among other things, at the occupational dimension of offshoring from an individual-level perspective and thus chooses an approach that is more comparable to the one used in this paper, is by Liu and Trefler (2008). They use US Data (from the Current Population Survey) for the time period 1996 to 2005 and find that the probability of changing the occupation is positively (negatively) related to the import (export) of services from (to) low-wage countries. This effect is economically small, however.

This study contributes to the literature in the following ways. First, to the best of my knowledge it is the first one to relate individual occupational stability to international outsourcing for a European country. Moreover, compared to the study on the US by Liu and Trefler (2008) the longitudinal information on individual employment histories is more extended. Second, it maps task categories into occupations, thus allowing for a more detailed identification of characteristics that have an influence on the vulnerability of occupations. Third, it differentiates between international material and international service outsourcing, thus expanding on Bachmann and Braun (2008) who consider (narrow) outsourcing in the manufacturing and in the service sector. Fourth, it considers a more recent time frame than most of the other studies. While international outsourcing was almost unanimously increasing between the years 1990 and 2000, this has not been the case in all industries in more recent years. It is interesting to see whether against this background similar results are obtained.

3 The data

3.1 Individual employment histories

The principal data set used in the empirical analysis is the IAB Employment Sample.[6] It is a two per cent sample of administrative social security records, which is provided by the Institute for Employment Research (IAB) and the German Federal Employment Agency.[7] The population is the universe of employees in Germany who were employed in a job covered by social security at least once in the time period 1975-2004 (for employees in western Germany) or 1992-2004 (for employees in eastern Germany). This includes roughly 80 per cent of all employees. Civil servants and self-employed are not included.

[6]See Bender, Haas, and Klose (2000) as well as Drews (2007) for a detailed description of the data.

[7]The weakly anonymised data was first accessed during a stay at the Research Data Center (FDZ) of the German Federal Employment Agency at the IAB and subsequently via controlled remote data processing.

The social security records are based on notifications issued at the beginning and end of each employment and unemployment spell. Moreover, employers send an updating report on behalf of their employees at the beginning of each calendar year. It has to be noted that unemployment spells only cover individuals who are entitled to unemployment benefits. If someone neither is employed in a job covered by social security nor draws any form of unemployment benefits she can be considered to be non-participating.

Among the information provided for the employment spells – which are the ones of interest in the present analysis – are the exact starting and end dates of a particular employment relationship, some demographic characteristics of the individual (date of birth, gender, nationality, education[8]), the (top-coded) wage, the industry, an establishment identifier[9], the size of the establishment, and the region of the workplace. Most interesting for the research question at hand, the occupation at the three-digit level is provided.[10]

With respect to the outcome variable of interest, that is the indicator whether an individual has left her occupation, the notification scheme has the consequence that intra-establishment occupation changes can only be observed at an annual basis, while changes of the occupation going along with an establishment change and transitions into non-employment are in principle available on a daily basis. To account for this fact and to use a data set as homogeneous as possible, I will focus on yearly time intervals throughout the analysis.[11]

Due to the administrative nature of the data its reliability and quality can be regarded as being very high. Other advantages are the large sample size and the absence of problems common to many survey-based panel data sets such as panel attrition or recall bias. Another advantage applicable particularly to the present study is the fact that the occupational coding is identical to the one used in the German Qualification and Career Survey where the task data is drawn from. This makes it possible to map task contents into occupations.

[8]I define three educational categories. 1) Low: no vocational training, no A-level; 2) Medium: A-level and/or vocational training; 3) High: university or technical college. Note that the information given in the social security records on the education sometimes suffers from a poor quality, which manifests itself in missing values or inconsistencies across consecutive spells of the same individual. Therefore I use an imputation procedure proposed by Fitzenberger, Osikominu, and Völter (2006), which helps to overcome this problem.

[9]Unfortunately, no information beyond the establishment level is available. Establishments belonging to the same firm have different identifiers.

[10]The occupational classification of the German Employment Agency consists of five levels. The fourth (three-digit) level consists of 319 occupational 'minor groups', the third (two-digit) level contains 83 occupational 'groups', the second level differentiates between 33 occupational 'sections', and the highest level consists of 6 occupational 'areas' (Bundesantalt für Arbeit, 1988).

[11]See Section 4 for a detailed description of the empirical strategy.

3.2 Data on the nature of tasks

Data on task contents of occupations is drawn from the 1998/99 wave of the German Qualification and Career Survey, which was jointly carried out by the Federal Institute for Vocational Education and Training (BIBB) and the IAB and covers about 30,000 individuals between 16 and 65 years.[12] The distinct advantage of this survey, previously used for example by DiNardo and Pischke (1997) and Spitz-Oener (2006), is that respondents do not only state their occupation but also whether they perform certain tasks on the job and which tools they use. Becker, Ekholm, and Muendler (2007) propose a technique to map task contents into occupations that enables them to obtain measures of non-routineness and interactivity. Their approach rests on the idea that the workplace-related tools used by the average worker in a certain occupation allow to infer the corresponding nature of tasks. I largely follow their proposition. In detail, the variable construction is as follows:

Non-routineness: I choose exactly the same approach as Becker, Ekholm, and Muendler (2007) and use their scheme to classify each of the 81 questioned workplace-related tools as being sign of a routine or non-routine activity.[13] In a next step the number of tools characterizing a non-routine activity is averaged over two-digit occupations.[14] A measure of task intensity lying in the range between 0 and 1 is then obtained by normalizing this figure with respect to the maximum in any occupation.

Interactivity: This measure consists of two components and aims to capture the need of both geographic proximity and interpersonal contact (cf. Blinder, 2006). The first component follows the proposition of Becker, Ekholm, and Muendler (2007). Again, certain tools are classified as interactive and the number of interactive tools is averaged over occupations. In contrast to Becker, Ekholm, and Muendler (2007) I add a second component because I find that the tools list alone is not able to capture in a fully satisfactory way the highly interpersonal nature of classical service-oriented occupations such as hairdressers, waiters, teachers, among others. To correct for this, I make use of the questionnaire on 13 job-related tasks and classify two of them, i.e. "training and teaching others" as well as "providing for, waiting on and caring for people" as (strictly) interpersonal activities (cf. table 11).[15] In analogy to above, I calculate averages over occupations. There is no straightforward way of merging the two components so that I choose the following approach. I first rescale them in

[12]The study is also available for cross-sections of the years 1979, 1985/86 and 1991/92. The most recent wave has been chosen because the sample year corresponds to the starting year of the empirical analysis.

[13]The authors' preferred strict classification is used. The categorization is given in table 10.

[14]A few occupations had to be grouped to have a sufficient number of observations per occupation.

[15]Certainly, a few other job-related tasks could also be classified as interactive. My choice, however, is explicitly driven by the perceived shortcoming of the tools list.

such a way that they exhibit the same mean and the same standard deviation. For every occupation, I keep the maximum of the two components. Finally, I proceed with the normalization described above.

Non-routineness/interactivity: The maximum of the previous two measures is proposed as third measure, assuming that either of the two characteristics, a high degree of interactivity or a high degree of non-routineness, has a stabilizing effect on occupational matches.[16] This way only the occupations that score poorly in both dimensions display a low task intensity figure.

The resulting task intensity figures are proxies. Nevertheless, they are largely consistent with intuition. The occupations chemist/physicist/mathematician, engineer and physician/pharmacist, for example, display the highest degree of non-routineness, whereas unskilled construction workers, cleaning service workers and textile processing workers are at the bottom end of this ranking. With respect to the degree of interactivity, clergymen, teachers as well as again physicans/pharmacists score highest and unskilled workers, beverage producers and molders/casters lowest.[17]

3.3 Industry-level data

The industry-level variables of greatest interest for the present analysis are indicators for international outsourcing intensity. Largely following the proposition of Feenstra and Hanson (1996, 1999) I measure the latter as the share of imported intermediate inputs in total production. Making use of input-output tables supplied by the German Federal Statistical Office, which explicitly differentiate between domestic and foreign inputs at the industry level, I calculate two measures. The first one captures international material outsourcing. As the concept of material outsourcing is probably not very meaningful for the service sector – at least not as a potential substitute for domestic labour – I calculate it for the manufacturing industries only. The chosen measure restricts attention to inputs imported by the domestic (two-digit) industry i from the same industry abroad:

$$OUT_{it}^{Material} = \frac{Imported\,Intermediates_{\,iit}}{Y_{it}} \tag{1}$$

In the terminology of Feenstra and Hanson (1999) this corresponds to the narrow concept of international outsourcing. Compared to a broader measure which includes intermediate

[16]Note that the measure of interactivity is higher on average. Assuming that this is only due to the chosen construction of the task measures and has no deeper meaning, I again force the two measures to have a common mean and standard deviation before keeping the maximum. Afterwards, I again normalize the obtained figure with respect to the maximum in any occupation.

[17]Detailed results are available on request.

inputs imported from any other (manufacturing) industry j abroad it probably better captures the idea of a make-or-buy decision and hence, is the preferred one.

International service outsourcing is approximated through the share of imports from commercial service industries abroad in industry output:

$$OUT_{it}^{Services} = \frac{\sum_{l \in CS} Imported\, Intermediates_{\,lit}}{Y_{it}} \tag{2}$$

where I closely follow Amiti and Wei (2005a,b, 2006) as far as the industries included in the numerator of the latter measure are concerned.[18] In both cases production Y_{it} is measured as the industry's production value.

Industry variables are at the NACE Rev.1.1 two-digit level (WZ2003). Comparable input-output tables are available for the time period 1995 to 2004. Figure 1 displays the development of the proposed measures over time and differentiated by the sector of economic activity. It becomes apparent that outsourcing activities have slowed down a bit at the beginning of the new century. Indeed, material outsourcing in the manufacturing sector peaks in the year 2000, whereas international service outsourcing reaches its maximum in 2001 (service sector) and 2002 (manufacturing sector), respectively. This also confirms that material and service outsourcing follow different time paths and consequently, can be identified separately in the empirical analysis. Furthermore, the sector-level figures mask considerable heterogeneity in the development over time across two-digit industries – which will be the relevant level of aggregation in the subsequent analysis.

Other industry control variables are chosen in accordance with the cited empirical literature. I include a measure of net exports ($exports_{it} - imports_{it}$) in the model, to control for the effects of export orientation and import competition. Data is again taken from the input-output tables. Moreover, industry output (Y_{it}) and the capital-output ratio (K_{it}/Y_{it}) are included, aiming to capture other time-varying industry characteristics. The data is provided by the German Federal Statistical Office.[19] Production values are converted into constant prices by applying the price indices implicit in the volume indices, whereas imports and exports are deflated with the price indices for manufactured goods and services imports and exports, respectively.[20] This information is again provided by

[18]In particular, these comprise: Post and telecommunications (NACE Rev.1.1 code 64); banking and financial intermediation services (65); insurance services (66); activities related to financial intermediation and insurance (67); renting of machinery and equipment (71); computer and related activities (72); research and development (73); other business activities (74).

[19]Gross capital values for the industry "activities related to financial intermediation and insurance (NACE Rev.1.1 code 67)" are not available. I impute them with the weighted average of the industries "banking and financial intermediation services (65)" and "insurance services (66)". It has to be noted, however, that treating this information as missing instead and hence, loosing all the observations of this industry, does not change estimation results in a meaningful way.

[20]Volume indices for the production values are available at the higher-aggregated NACE subsection, not

the German Federal Statistical Office. Finally, note that time-invariant characteristics are controlled for in the empirical analysis via a full set of industry dummy variables.

Unfortunately, the NACE classification is used in the individual employment data only from 1999 onwards.[21] This shortens the time period available for the empirical analysis.

3.4 Further variables and sample restrictions

I further include time dummies, region dummies and the regional unemployment rate as supplied by the Federal Employment Agency in order to capture general and regional economic conditions.

I restrict the analysis to full-time workers. Hence, I discard apprentices, trainees, marginal and part-time employed as well as workers, who are currently on leave due to military service, child-bearing etc. In addition, I do not consider spells in agricultural and mining occupations. If an individual has more than one occupation at the same time, I only use information on the highest-paying one. Furthermore, spells with missing information in any of the covariates apart from the education – where I explicitly control for this aspect through a 'missing-education' dummy – are dropped.

To ensure maximum possible comparability I apply the same sample restrictions to the survey on tasks. There I restrict attention to workers covered by social security with a working week of more than 20 hours.

Summary statistics of the variables included in the empirical analysis are displayed in Table 1.

4 Empirical strategy and estimation method

It is common for studies on individual job separations to control for state or duration dependence. The longer a match persists the more match-specific human capital is accumulated and the less likely a dissolution occurs. The discussion on occupation-specific human capital (cf. Kambourov and Manovskii, 2007) shows that the same argument can be put forward to occupational matches. Hence, a duration model, which explicitly controls for the time spent in the occupation, seems to be appropriate.

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division level.

[21] For the years 1999 to 2002 only the NACE Rev.1 industry coding (WZ1993) is given, which in a few cases differs from the NACE Rev.1.1. The recoding from NACE Rev.1 to NACE Rev.1.1 has been done with the official recoding scheme provided by the German Federal Statistical Office (based on the five-digit level). If one Rev.1 code is associated with many Rev.1.1 codes, the industry information has been set to missing.

Occupational spells are constructed from the individual employment histories as the consecutive time working in a given two-digit occupational category. Focusing on the two- rather than the three-digit level reduces potential problems of measurement error. I define an occupational spell as having ended if at least one of the following conditions is met: a) the individual experiences a spell of unemployment b) there is a change in the two-digit occupational category of the individual or c) the social security records display an interruption of more than 60 days in the employment history of the individual. The latter case is interpreted as an intervening spell of non-participation.

As mentioned in Section 3, intra-establishment occupation changes are only measured at a yearly basis. Hence, even though all other changes are measured at daily frequency, a specification in discrete time – grouped into yearly intervals – is chosen. Since most occupational spells last for several years, this should not bias the results. Moreover, I am not interested in the exact pattern of duration dependence *per se* but only want to control for it. In accordance with the notification scheme for the social security records, the 1st of January of each year is taken as the date of reference, i.e I analyze whether occupational spells running at the beginning of the year end in failure by the end of the year.[22] Grouping the time variable in the stated way further has the advantage of being consistent with the main variables of interest, that is the outsourcing indicators, which are available at an annual basis only.

The empirical analysis covers the time period from 1999 to 2003. The choice of the starting year is driven by the availability of the NACE industry classification in the individual employment data, whereas the year 2004 had to be excluded because I allow for a transition period of up to 60 days to determine whether a spell has ended in failure. The data is organized in person-year form, as suggested by e.g. Allison (1982) and Jenkins (1995). The hazard of leaving the occupation is defined as the exit probability in the time interval $[t-1,\, t)$ conditional upon survival up to $t-1$.

$$\lambda_i(t, X_{it}) = Pr(t-1 \leq T < t | T \geq t-1, X_{it}), \tag{3}$$

where T denotes the duration and X_{it} is a vector of individual characteristics. The unconditional probability of leaving the occupation in time interval $[t-1,\, t)$ is

$$Pr(T = t | X_{it}) = \lambda_i(t, X_{it}) \times \prod_{j=1}^{t-1} (1 - \lambda_i(j, X_{ij})). \tag{4}$$

[22] This strategy leads to an underrepresentation of short occupational spells since it excludes the ones that start after the 1st of January and end before the year is over. It can be expected, however, that the duration of these (very) short spells is not primarily driven by international factors.

By choosing a cloglog distribution for the hazard rate – which is the appropriate choice if one assumes a proportional hazard model for the underlying data process in continuous time – equation (4) reads

$$Pr(T = t|X_{it}) = \left(1 - \exp\left(-\exp\left(\alpha_t + \beta' X_{it}\right)\right)\right) \times \prod_{j=1}^{t-1} \exp\left(-\exp\left(\alpha_j + \beta' X_{ij}\right)\right), \qquad (5)$$

where α_t is the baseline hazard, that captures duration dependence. Since little is known about its exact functional form, I opt for a flexible approach and model it through a set of interval dummy variables, thus assuming a piece-wise constant baseline hazard. In particular, the chosen intervals are $(0;1]$ years; $(1;2]$ years; $(2;3]$ years; $(3;4]$ years; $(4;5]$ years; $(5;7]$ years; and > 7 years. This choice is much in line with Geishecker (2008) and Bachmann and Braun (2008) and ensures full flexibility at the beginning of an occupational spell, where most of the movements can be expected to take place.

Multiple occupational spells are explicitly allowed for. Let K denote the total number of spells by each individual and let d_{ik} be a censoring indicator, which takes the value of 1 if the k-th occupational spell of individual i is completed and 0 otherwise. The likelihood function to be maximized then is

$$L = \prod_{i=1}^{n} \prod_{k=1}^{K} \left(\frac{1 - \exp\left(-\exp\left(\alpha_t + \beta' X_{it}\right)\right)}{\exp\left(-\exp\left(\alpha_t + \beta' X_{it}\right)\right)} \right)^{d_{ik}} \times \prod_{j=1}^{t} \exp\left(-\exp\left(\alpha_j + \beta' X_{ij}\right)\right). \qquad (6)$$

Since most occupational spells started before 1999, I face a problem of left truncation or delayed entry. However, as the records contain information on the individual employment histories since 1975 (western Germany) and 1992 (eastern Germany), respectively, and given the chosen specification of the baseline hazard, I am able to tackle this problem with standard techniques by correcting for the elapsed duration. Results do not change in a qualitative way, however, if I include additional dummies for durations of more than seven years and drop all the observations belonging to eastern German spells that started before 1992. Note that I discard the option of a flow-sampling scheme, because the period of analysis from 1999 to 2003 would then leave me with short occupational spells, only. Previous research, however, has shown that the (negative) impact of international outsourcing increases with employment duration (cf. Geishecker, 2008), so that a lot of relevant information would be lost.

Ignoring unobserved individual heterogeneity can lead to biased estimation results of the baseline hazard and the response of the hazard rate to changes in the exogenous variables (e.g. Lancaster, 1990). This problem has been shown, however, to be particularly severe in the presence of a wrong functional form of the baseline hazard and less so when a flexible specification is chosen (cf. for example Han and Hausman, 1990; Meyer, 1990; Dolton and van der Klaauw, 1995). Moreover, as the main interest lies in the effects of the exogenous variables and not in the pattern of duration dependence, it does not matter whether the latter can be given a causal interpretation or whether it rather reflects a selection effect. Hence, I do not explicitly control for unobserved heterogeneity for the largest part of the analysis, but I do adjust the standard errors allowing for intra-individual correlations. Furthermore, I check if the results react sensitively when a normally distributed random effect is allowed for in the regression. It has to be noted, however, that doing so with the left-truncated sample at hand does not take account of the potential self-selection into longer occupational spells based on unobservables, either (also cf. Geishecker, 2008).

A cautionary remark has to be made with regard to statistical inference and significance testing of the model parameters. It is known that including aggregate variables in a regression at the micro-level can potentially lead to (downward) biased standard errors due to contemporaneous correlation (cf. Moulton, 1986, 1990). This applies to this study, which includes variables at the level of the industry, the region, and the occupation. As Geishecker (2008) observes in his related study, the problem with the remedies most often used in the literature is that they rest on the assumption of a large number of groups relative to the number of observations – which is not the case in the present study. However, I am able to significantly reduce intra-group residual correlation by including a full set of industry and region dummies, which account for the time-constant part of it. Since the period of analysis is fairly short, this seems to be a reasonable approach. As far as the occupation-specific task variables are concerned, I am not able to apply the same strategy because these variables are time-constant themselves. However, I also estimate several model specifications that (at least partially) circumvent this problem, such as supplementing the task measures with a dummy variable for production-oriented (as opposed to service-oriented) occupations or replacing them altogether with indicator variables for occupational groups.

5 Estimation results

As Bachmann and Braun (2008) point out, there are remarkable differences between the manufacturing and the service sector as far as the effect of international outsourcing on employment stability is concerned. Therefore the model in equation (6) is estimated separately for both sectors.[23] As a consequence, I right-censor occupational spells that are continued in a sector that is not under consideration.

[23]The manufacturing sector comprises the NACE codes 15-37. In the service sector I restrict attention to private (for-profit) services, that is the NACE codes 50-74.

I choose six different model specifications. Models 1 and 2 include the degree of non-routineness among the regressors, models 3 and 4 the degree of interactivity and models 5 and 6 the maximum of the two. The even-numbered specifications allow for interaction effects between the task measures and international outsourcing intensity – which is one of the main points of interest in the present analysis.

Estimation results are given in Tables 2 and 3. Before turning to the coefficient of the outsourcing indicators, I briefly summarize the effects of the other variables. They are in line with previous studies on both employment stability and occupational mobility whose interplay determines the duration of occupational matches (e.g. Farber, 1999; Kambourov and Manovskii, 2008).

Higher tenure in occupation reduces the risk of experiencing a failure. This supports the view of occupation-specific human capital but might also reflect a sorting mechanism. Furthermore, occupational stability increases in age – with the exception of the age category 60–65 where retirement decisions become increasingly important. Lower-educated people and foreigners are more likely to leave the present occupation, probably reflecting their greater difficulty in acquiring occupation-specific human capital. Interestingly, women are more likely to end their occupational spell in the manufacturing sector but less likely to do so in the service sector. Another result is also striking. Whereas the coefficient of the 'high-education' dummy variable is always significantly negative in services, as could be expected, it is totally unstable across the different specifications in the manufacturing sector. This holds true for the level of significance as well as the direction of the effect, pointing at different correlation structures with the three task measures. Turning to the latter, it becomes apparent that spells in occupations characterized by a high (low) degree of non-routine and interactive tasks are less (more) likely to end.

As far as the other industry-level variables are concerned, net exports do not display any significant effect. The capital-output ratio is not related to the risk of leaving the occupation in services but has a strong stability-reducing effect in manufacturing – possibly capturing the impact of technological change. The regional unemployment rate does not matter for occupational stability in manufacturing but is negatively related to the hazard rate in services. This might be due to a reduction in voluntary occupation-to-occupation transitions caused by a lack of alternative job offers.

Finally, occupational stability increases with establishment size with the exception of the largest category ($>$ 1000 employees), where it starts to decrease again, particularly in the service sector. Important internal labour markets could be the reason for the latter result.

International outsourcing in the manufacturing sector

The three basic specifications without interaction terms reveal that the risk of leaving the occupation significantly increases with international material outsourcing and significantly decreases with international service outsourcing (cf. Table 2). Hence, the latter does not act in a disrupting but in a stabilizing way. This findig is consistent with the view that in the manufacturing sector service outsourcing indeed acts in a manner similar to technological progress and has a productivity-enhancing effect (cf. Grossman and Rossi-Hansberg, 2006). As a consequence, the value of occupational matches also increases and less of them are destroyed. Moreover, international service outsourcing apparently does not substitute for the work performed in occupations domestically, at least as far as the employed population is concerned. The effect is also quantitatively important, with a one-percentage-point increase in outsourcing intensity leading to a reduction in the hazard rate of around $\exp(-0.19) - 1 = -17$ percent. However, one has to keep in mind that the level of service outsourcing in the manufacturing sector still is quite low. Between 1999 and 2003 the overall increase was about 0.22 percentage points, so that the cumulated stability increasing effect over the sample period amounts to about 4 percent. On the other hand material outsourcing, which is more substitutional to the work accomplished in the manufacturing sector at home, reduces occupational stability. The economic significance, however, is almost negligible with a one-percentage-point increase in outsourcing intensity being associated with a rise in the hazard rate of merely 0.6 percent, which is much lower than the marginal effect of about six percent that Geishecker (2008) found in his study on employment security. Apart from the different definition of the dependent variable the inspected time frame might play a role here, as a lot of the adjustments have probably already been undertaken before the end of the 1990s.

Including interaction terms between the outsourcing indicators and the task measures shows that the impact of material outsourcing is the more (less) stability-reducing the lower (higher) the degree of non-routineness and interactivity (as well as the maximum of both) of one's occupation. The coefficient of the interaction term is negative and highly significant in all specifications. In contrast, the impact of service outsourcing does not depend in a significant way on the task intensities.

International outsourcing in the service sector

Even though the import of services in the service sector can be expected to play a similar role to the import of goods in the manufacturing sector, that is being more of a substitute than a complement for the work performed in the home country, the three basic specifications all yield a negative and significant effect on the risk of leaving the occupation (cf.

Table 3). This result is in line with Bachmann and Braun (2008), although the analyzed outcome variables and the service outsourcing indicators used differ slightly. Turning to the quantitative importance, the hazard of leaving the occupation in the service sector decreases by about 2.5 percent on average if outsourcing intensity rises by one percentage point. Note that overall outsourcing intensity in the sector amounted to around 1.7 percent in 2003. The picture is more diverse, however, when the effect is allowed to vary with the intensity of non-routine and interactive tasks of the occupation. As with material outsourcing in the manufacturing sector, the coefficient of the interaction term is negative and significant. A closer inspection reveals that the effect is even stability-reducing for low degrees of non-routineness and interactivity. The results are consistent with the hypothesis that international outsourcing of services leads to a specialization towards non-routine and interactive tasks in the service sector. Only occupations that use these tasks intensively become more stable, which might again be attributable to productivity enhancements.

The result that international service outsourcing is overall not associated with negative effects for the domestic labour market is in line with the results of Amiti and Wei (2005b) and Hijzen, Pisu, Upward, and Wright (2007). Whereas the former find positive effects on industry-level productivity and no negative effects on industry-level employment in the US, the latter analyze firm-level employment and worker turnover in the UK – without finding negative effects, either. As far as increases in productivity induced by international (service) outsourcing are concerned, Amiti and Wei (2006) suggest four channels through which these can occur. These are (1) static efficiency gains due to the relocation of the least efficient parts of the production abroad, (2) efficiency gains achieved through firm restructuring, (3) learning externalities arising from importing and (4) positive effects due to the use of new material or service input varieties.

6 Extensions and robustness checks

As the qualitative results obtained with the three different task specifications do not differ, I restrict the following robustness checks and extensions to my preferred specification, which is based on the combined measure (Models 5 and 6).

6.1 Discretization of the task intensity measure

So far I have assumed that the impact of international outsourcing on the occupational hazard rate depends on the continuous task measure in a linear way, which might be too restrictive. Hence, instead of inserting the continuous task intensity measure directly, I categorize the occupations according to their position in the task intensity distribution. I differentiate between 'low non-routine/interactive' (lower quartile), 'medium non-routine/interactive' (second and third quartile) and 'high non-routine/interactive' (upper quartile) occupations. The results of both the baseline and the interacted model remain fairly stable (cf. Table 4). International material outsourcing still has a very limited effect on the occupational hazard rate in the manufacturing sector with only individuals in 'low non-routine/interactive' occupations experiencing a statistically significant increase. Even for this group, however, the marginal effect amounts to just 1.4 percent on average. In contrast, international service outsourcing significantly reduces the risk of leaving the occupation for the three occupational groups. The Wald test rejects the hypothesis of a uniform impact across occupational groups for material outsourcing but not for service outsourcing.[24]

In the service sector the impact of international service outsourcing on the hazard rate is significantly positive for 'low non-routine/interactive' occupations and significantly negative for the others. Again, the Wald test rejects the hypothesis of an equal impact.

6.2 Task intensity versus production or service orientation of occupations

A closer inspection of the occupations and the task measures reveals that production-oriented occupations are predominant among the low scores of the latter and service-oriented among the high scores.[25] To ensure that the interaction of 'non-routiness/interactivity' with international outsourcing does not only capture a (much simpler) heterogeneous impact of the latter with respect to these two broad occupational groups, I add two further specifications. In the first one I let outsourcing vary only with a dummy variable for production-oriented occupations. In the second one I include interaction terms for both, the task measure and the dummy variable. For the manufacturing sector I find in both specifications that the impact of both international material and service outsourcing on the hazard rate does not differ for production- as opposed to service-oriented occupations (cf. Table 5). Moreover, in the second specification the coefficient of the interaction term of material outsourcing with the task measure remains negative and significant.

In the service sector the picture is slightly different. Here, international service outsourcing has a highly adverse effect on individuals employed in production-oriented occupations. This result is surprising at first sight because the import of services should rather be a substitute for service-oriented occupations. One possible interpretation is that in this sector

[24]Since I use clustered standard errors, the Wald test is preferred over the likelihood ratio test.
[25]The division into these two broad occupational groups follows a classification of the IAB.

service outsourcing increases the productivity of service-occupations and leads to a greater focus on core competencies and activities within the sector. Moreover, the impact is again the more (less) favorable the higher (lower) the degree of non-routineness/interactivity. The respective interaction term remains strongly significant.

Therefore I conclude that only differentiating between production- and service-oriented occupations is not sufficient to obtain a clear picture of the effects of international outsourcing on occupational stability.

6.3 Task intensity versus educational attainment

As has been argued in the introduction, the intensity of non-routine and interactive tasks of the occupation is not necessarily informative about the skill level of the individual. However, several occupations that are characterized by a high degree of both non-routineness and interactivity, such as physicians, managers and engineers, are typically filled by high-educated workers, so that empirically it is an open question whether the task measures indeed capture important aspects that are not accounted for by the skill level and vice versa. The instability of the coefficient on the high-education dummy with respect to the task measure used, as documented before for the manufacturing sector, casts some doubt on this issue. For a first inspection I estimate the pairwise correlation coefficients between the three task measures and each of the four educational categories.[26] Results are tabulated in Table 6. The following points stand out. First, the most pronounced (and positive) associations can be observed for the high-education dummy. Second, the high-education dummy correlates more strongly with the measure of non-routineness than with the one of interactivity. Third, in general correlations are lower (in absolute terms) in the service sector than in manufacturing. Against this background, I apply the same strategy as in the previous subsection and estimate two additional specifications: one where the effect of international outsourcing is allowed to vary only with the skill level of the individual and another one where the outsourcing indicators are interacted with the educational dummies as well as the degree of non-routineness/interactivity.

Interestingly, for the manufacturing sector I fail to reject the null hypothesis of a uniform impact across educational levels in both specifications, as both the Wald test on joint significance as well as the individual coefficients – with the exception of the interaction between service outsourcing and the low-education dummy – indicate (cf. Table 7). Furthermore, in the second specification the coefficient of the interaction term of material

[26]Note that these are correlations between continuous (task) variables on one side and dichotomous (education) variables on the other. The appropriate measure in this case is the point-biserial correlation coefficient, which however is mathematically equivalent to the traditional Pearson (product moment) correlation coefficient (cf. Tate, 1954).

outsourcing with the task measure remains strongly significant. In contrast, in the service sector the effect does vary with education. The overall effect of outsourcing is significantly stability-increasing for individuals with medium and high education and stability-reducing for individuals with low education. Still, in the second specification the coefficient of the interaction term of service outsourcing with the task measure remains strongly significant. I conclude that although there is a positive correlation between the skill level of an individual and the intensity of non-routine and interactive tasks performed in the occupation, the latter has an additional effect that should not be omitted.

6.4 Definition of a failure

Despite the loss of specific human capital, occupational changes might also characterize voluntary (stepping-stone) mobility in the line of Jovanovic and Nyarko (1997). Hence, to ensure that I indeed capture worker vulnerability, I redefine a failure to only include transitions into non-employment, whereas direct transitions to a new occupation are right-censored. Reporting results for the outsoucing variables only, the previous findings are largely confirmed (cf. Table 8). Both, the stability-reducing effect of material outsourcing and the stability-increasing effect of service outsourcing are even more pronounced.

6.5 Unobserved heterogeneity

Even though I control for duration dependence in a flexible way and for much of observed individual heterogeneity, there might be unobservables influencing the results. Hence, as a robustness check I include an individual random effect, which is assumed to follow a normal distribution and to be uncorrelated with the explanatory variables. The results for the simple and the interacted model are displayed in Table 9. As can be seen, coefficients change very little. For the manufacturing sector the likelihood ratio test even rejects the null hypothesis of the presence of unobservable effects at the five percent level of significance.

7 Concluding remarks

By means of a hazard model in discrete time this study has analyzed the impact of international outsourcing on occupational stability in Germany. It has been argued that the role of occupations is of particular interest in this context as they best capture relevant characteristics in a world of ever more fragmented production processes (trade in tasks, as suggested by Grossman and Rossi-Hansberg, 2006).

Data of a large survey on, among others, workplace-related tools and performed tasks on the job has been used to differentiate occupations along the dimensions non-routineness and interactivity as well as a combination of both measures. As far as international outsourcing is concerned, separate measures for services and material outsourcing have been constructed at the industry-level with data from German input-output tables.

In the manufacturing sector, the impact of international material outsourcing on occupational stability has been found to be the more unfavourable the lower the degree of non-routineness and interactivity of the occupation, though the quantitative importance is very limited. In contrast, international service outsourcing is associated with a statistically as well as economically significant *increase* in occupational stability. This result is consistent with the notion that service outsourcing leads to an increase in productivity that more than compensates for the relocation of certain tasks abroad. In the service sector this result is less clear-cut. Whereas the overall effect is positive, workers employed in occupations characterized by a low degree of non-routineness and interactivity suffer from greater instability.

The results for both sectors are robust to several different specifications. In particular, the effect found for the intensity of non-routine and interactive tasks goes beyond a simple distinction between production- and service-oriented occupations and is not accounted for by the individual level of educational attainment and unobserved heterogeneity, either.

Regarding the positive effects found for international service outsourcing, one has to bear in mind that its importance is still rather limited in Germany. Hence, the results do not rule out adverse effects in the future, although the pace of international outsourcing has slowed down a bit lately. Furthermore, while this study has added new insights to the discussion on the labour market effects of international outsourcing, it does certainly not capture all relevant adjustment channels. First, it has only focused on occupational stability of employed workers. Adjustments in the form of lower or higher job creation in certain occupations – with direct consequences for unemployed workers – have not been considered. Second, unfortunately adjustments within two-digit occupations cannot be identified, either. Spitz-Oener (2006) documents considerable changes in task usage within occupations for the time period 1979 to 1998/99. It is quite likely that this trend has continued and that it can at least partly be attributed to the increased international fragmentation of production processes. From a policy perspective, this study highlights once more the importance of being able to adapt to changing conditions and requirements at the workplace. Measures directed at increasing the transferability of accumulated human capital from one employment relationship to the next, e.g. through further education or further training on the job, are probably best suited to minimize adjustments costs while reaping the benefits brought about by globalization.

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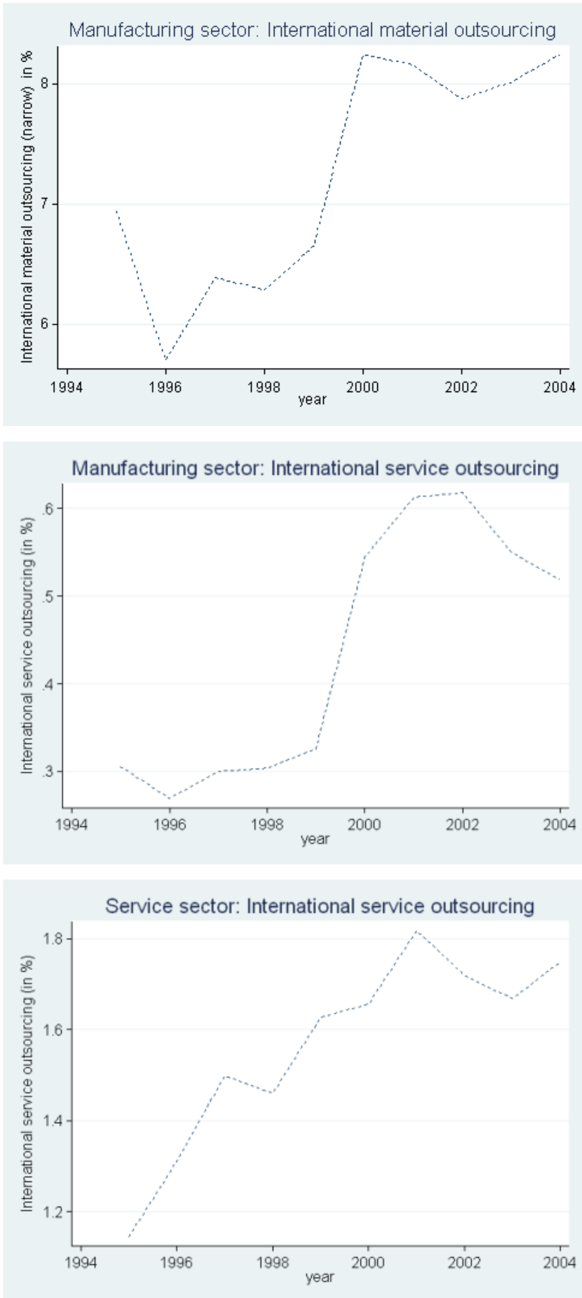
Appendix

Figure 1: Development of international outsourcing intensity over time



Notes: Author's calculations. Intensities calculated according to the formulae given in equations (1) and (2) with data from German input-output tables. Averages over two-digit industries weighted by the respective production values.

Table 1: Summary statistics

	Manufacturing		Services	
	mean	std. dev.	mean	std. dev.
End of occupational spell: yes	0.121	0.327	0.181	0.385
Occupational tenure: (0; 1] years	0.117	0.321	0.189	0.391
Occupational tenure: (1; 2] years	0.087	0.282	0.114	0.318
Occupational tenure: (2; 3] years	0.070	0.255	0.085	0.279
Occupational tenure: (3; 4] years	0.061	0.239	0.067	0.251
Occupational tenure: (4; 5] years	0.053	0.224	0.055	0.227
Occupational tenure: (5; 7] years	0.089	0.285	0.091	0.288
Age: 25–29	0.084	0.278	0.111	0.314
Age: 30–34	0.150	0.357	0.173	0.379
Age: 35–39	0.183	0.387	0.179	0.384
Age: 40–44	0.168	0.374	0.154	0.361
Age: 45–49	0.143	0.350	0.130	0.336
Age: 50–54	0.119	0.323	0.105	0.306
Age: 55–59	0.069	0.254	0.059	0.235
Age: 60–65	0.037	0.188	0.030	0.170
Gender: Female	0.216	0.411	0.366	0.482
Education: Missing	0.013	0.113	0.026	0.158
Education: Low	0.150	0.357	0.083	0.276
Education: High	0.107	0.309	0.128	0.335
Nationality: Foreign	0.099	0.298	0.068	0.251
Non-routineness	0.404	0.215	0.399	0.210
Interactivity	0.403	0.157	0.493	0.129
Non-routineness/interactivity	0.499	0.180	0.546	0.150
Occupation: production-oriented	0.559	0.497	0.136	0.342
Occupation: low non-routine/interactive	0.247	0.431	0.121	0.327
Occupation: high non-routine/interactive	0.224	0.417	0.226	0.418
Material Outsourcing	6.834	5.123		
Service outsourcing	0.436	0.469	1.670	2.080
Net exports (in billion euros)	16.769	24.199	0.437	2.591
Output (in billion euros)	97.198	62.631	139.940	75.899
Capital-output ratio	0.803	0.232	1.522	2.694
Regional unemployment rate	9.810	3.913	10.769	4.409
Firm size: 20–99	0.210	0.408	0.303	0.459
Firm size: 100–499	0.315	0.464	0.234	0.424
Firm size: 500–999	0.115	0.319	0.063	0.244
Firm size: >1000	0.253	0.435	0.090	0.287
Observations (person × year)	579334		635537	

Table 2: Estimation results for the manufacturing sector

Dependent variable: End of occupational spell (0/1)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Occupational tenure: (0; 1] year	1.378*** (0.011)	1.378*** (0.011)	1.385*** (0.011)	1.385*** (0.011)	1.380*** (0.011)	1.381*** (0.011)
Occupational tenure: (1; 2] years	0.899*** (0.013)	0.899*** (0.013)	0.904*** (0.013)	0.905*** (0.013)	0.900*** (0.013)	0.901*** (0.013)
Occupational tenure: (2; 3] years	0.514*** (0.016)	0.515*** (0.016)	0.520*** (0.016)	0.519*** (0.016)	0.516*** (0.016)	0.516*** (0.016)
Occupational tenure: (3; 4] years	0.461*** (0.017)	0.461*** (0.017)	0.465*** (0.017)	0.465*** (0.017)	0.462*** (0.017)	0.462*** (0.017)
Occupational tenure: (4; 5] years	0.333*** (0.019)	0.333*** (0.019)	0.338*** (0.019)	0.338*** (0.019)	0.334*** (0.019)	0.334*** (0.019)
Occupational tenure: (5; 7] years	0.204*** (0.016)	0.204*** (0.016)	0.209*** (0.016)	0.209*** (0.016)	0.205*** (0.016)	0.205*** (0.016)
Age: 25–29	−0.230*** (0.017)	−0.230*** (0.017)	−0.232*** (0.017)	−0.232*** (0.017)	−0.231*** (0.017)	−0.231*** (0.017)
Age: 30–34	−0.325*** (0.016)	−0.325*** (0.016)	−0.331*** (0.016)	−0.331*** (0.016)	−0.327*** (0.016)	−0.327*** (0.016)
Age: 35–39	−0.403*** (0.016)	−0.403*** (0.016)	−0.408*** (0.016)	−0.408*** (0.016)	−0.405*** (0.016)	−0.405*** (0.016)
Age: 40–44	−0.505*** (0.017)	−0.505*** (0.017)	−0.508*** (0.017)	−0.508*** (0.017)	−0.506*** (0.017)	−0.506*** (0.017)
Age: 45–49	−0.520*** (0.018)	−0.520*** (0.018)	−0.524*** (0.018)	−0.523*** (0.018)	−0.522*** (0.018)	−0.522*** (0.018)
Age: 50–54	−0.527*** (0.019)	−0.527*** (0.019)	−0.531*** (0.019)	−0.531*** (0.019)	−0.528*** (0.019)	−0.528*** (0.019)
Age: 55–59	−0.152*** (0.021)	−0.153*** (0.021)	−0.159*** (0.021)	−0.159*** (0.021)	−0.153*** (0.021)	−0.154*** (0.021)
Age: 60–65	1.192*** (0.019)	1.191*** (0.019)	1.181*** (0.019)	1.181*** (0.019)	1.190*** (0.019)	1.189*** (0.019)
Gender: Female	0.137*** (0.009)	0.135*** (0.009)	0.137*** (0.009)	0.134*** (0.009)	0.132*** (0.009)	0.130*** (0.009)
Education: Missing	−0.003 (0.031)	−0.002 (0.031)	0.007 (0.031)	0.009 (0.031)	−0.003 (0.031)	−0.001 (0.031)
Education: Low	0.086*** (0.011)	0.086*** (0.011)	0.105*** (0.012)	0.106*** (0.012)	0.086*** (0.011)	0.087*** (0.011)
Education: High	0.044** (0.015)	0.046** (0.015)	−0.069*** (0.014)	−0.063*** (0.014)	0.013 (0.015)	0.016 (0.015)
Nationality: Foreign	0.090*** (0.013)	0.090*** (0.013)	0.099*** (0.013)	0.099*** (0.013)	0.091*** (0.013)	0.091*** (0.013)
Non-routineness	−0.589*** (0.023)	−0.485*** (0.037)				
Interactivity			−0.342*** (0.028)	−0.064 (0.047)		
Non-routineness/interactivity					−0.575*** (0.027)	−0.381*** (0.043)
Material Outsourcing	0.006* (0.003)	0.011*** (0.003)	0.006* (0.003)	0.022*** (0.003)	0.006* (0.003)	0.018*** (0.004)
Material Outsourcing × non-routineness		−0.012** (0.004)				
Material Outsourcing × interactivity				−0.040*** (0.005)		
Material Outsourcing × non-routineness/interactivity						−0.023*** (0.004)
Service outsourcing	−0.194*** (0.038)	−0.173*** (0.044)	−0.190*** (0.038)	−0.179*** (0.048)	−0.193*** (0.038)	−0.156*** (0.049)
Service outsourcing × non-routineness		−0.045 (0.049)				
Service outsourcing × interactivity				−0.030 (0.072)		
Service outsourcing × non-routineness/interactivity						−0.069 (0.058)
Net exports (in billion euros)	0.004 (0.003)	0.004 (0.003)	0.004 (0.003)	0.004 (0.003)	0.004 (0.003)	0.004 (0.003)
Output (in billion euros)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Capital-output ratio	0.928*** (0.121)	0.930*** (0.121)	0.923*** (0.121)	0.936*** (0.121)	0.928*** (0.121)	0.933*** (0.121)
Regional unemployment rate	0.000 (0.012)	0.001 (0.012)	0.000 (0.012)	0.001 (0.012)	0.000 (0.012)	0.001 (0.012)
Firm size: 20–99	−0.301*** (0.012)	−0.301*** (0.012)	−0.314*** (0.012)	−0.311*** (0.012)	−0.309*** (0.012)	−0.309*** (0.012)
Firm size: 100–499	−0.510*** (0.012)	−0.511*** (0.012)	−0.532*** (0.012)	−0.529*** (0.012)	−0.525*** (0.012)	−0.525*** (0.012)
Firm size: 500–999	−0.632*** (0.017)	−0.633*** (0.017)	−0.657*** (0.017)	−0.656*** (0.017)	−0.649*** (0.017)	−0.650*** (0.017)
Firm size: >1000	−0.425*** (0.015)	−0.424*** (0.015)	−0.451*** (0.015)	−0.447*** (0.015)	−0.440*** (0.015)	−0.438*** (0.015)
Constant	−2.802*** (0.370)	−2.848*** (0.371)	−2.777*** (0.370)	−2.929*** (0.371)	−2.678*** (0.370)	−2.795*** (0.371)
log pseudo-likelihood	-194258.92	-194251.720	-194528.1	-194491.37	-194362.22	-194343.7
Observations (person × year)	579334	579334	579334	579334	579334	579334

* p<0.05, ** p<0.01, *** p<0.001

Standard errors (in parentheses) are clustered at the level of the individual.

All regressions include industry dummies, year dummies and region dummies. Reference category: Occupational tenure: >7 years; Age: < 25; Gender: Male; Education: Medium; Establishment size: 0–19.

Table 3: Estimation results for the service sector

Dependent variable: End of occupational spell (0/1)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Occupational tenure: (0; 1] years	1.563*** (0.009)	1.556*** (0.009)	1.566*** (0.009)	1.563*** (0.009)	1.560*** (0.009)	1.556*** (0.009)
Occupational tenure: (1; 2] years	1.018*** (0.011)	1.014*** (0.011)	1.018*** (0.011)	1.016*** (0.011)	1.015*** (0.011)	1.012*** (0.011)
Occupational tenure: (2; 3] years	0.704*** (0.013)	0.701*** (0.013)	0.702*** (0.013)	0.702*** (0.013)	0.700*** (0.013)	0.698*** (0.013)
Occupational tenure: (3; 4] years	0.580*** (0.014)	0.577*** (0.014)	0.579*** (0.014)	0.578*** (0.014)	0.576*** (0.014)	0.575*** (0.014)
Occupational tenure: (4; 5] years	0.424*** (0.016)	0.420*** (0.016)	0.423*** (0.016)	0.422*** (0.016)	0.420*** (0.016)	0.418*** (0.016)
Occupational tenure: (5; 7] years	0.263*** (0.014)	0.260*** (0.014)	0.261*** (0.014)	0.261*** (0.014)	0.260*** (0.014)	0.259*** (0.014)
Age: 25–29	−0.172*** (0.012)	−0.169*** (0.012)	−0.178*** (0.012)	−0.176*** (0.012)	−0.174*** (0.012)	−0.171*** (0.012)
Age: 30–34	−0.186*** (0.012)	−0.183*** (0.012)	−0.194*** (0.012)	−0.191*** (0.012)	−0.189*** (0.012)	−0.186*** (0.012)
Age: 35–39	−0.254*** (0.012)	−0.252*** (0.012)	−0.259*** (0.012)	−0.257*** (0.012)	−0.256*** (0.012)	−0.254*** (0.012)
Age: 40–44	−0.342*** (0.013)	−0.341*** (0.013)	−0.346*** (0.013)	−0.344*** (0.013)	−0.345*** (0.013)	−0.343*** (0.013)
Age: 45–49	−0.377*** (0.014)	−0.377*** (0.014)	−0.380*** (0.014)	−0.379*** (0.014)	−0.381*** (0.014)	−0.380*** (0.014)
Age: 50–54	−0.354*** (0.015)	−0.355*** (0.015)	−0.358*** (0.015)	−0.357*** (0.015)	−0.358*** (0.015)	−0.359*** (0.015)
Age: 55–59	−0.110*** (0.017)	−0.112*** (0.017)	−0.114*** (0.017)	−0.114*** (0.017)	−0.116*** (0.017)	−0.116*** (0.017)
Age: 60–65	0.970*** (0.018)	0.969*** (0.018)	0.963*** (0.018)	0.964*** (0.018)	0.965*** (0.018)	0.965*** (0.018)
Gender: Female	−0.043*** (0.007)	−0.049*** (0.007)	−0.063*** (0.007)	−0.064*** (0.007)	−0.057*** (0.007)	−0.061*** (0.007)
Education: Missing	0.027 (0.017)	0.028 (0.017)	0.027 (0.017)	0.027 (0.017)	0.024 (0.017)	0.025 (0.017)
Education: Low	0.208*** (0.010)	0.204*** (0.010)	0.221*** (0.010)	0.217*** (0.010)	0.203*** (0.010)	0.201*** (0.010)
Education: High	−0.120*** (0.011)	−0.105*** (0.011)	−0.202*** (0.011)	−0.189*** (0.011)	−0.143*** (0.011)	−0.126*** (0.011)
Nationality: Foreign	0.155*** (0.011)	0.153*** (0.011)	0.169*** (0.011)	0.166*** (0.011)	0.158*** (0.011)	0.154*** (0.011)
Non-routineness	−0.715*** (0.018)	−0.410*** (0.025)				
Interactivity			−0.755*** (0.025)	−0.414*** (0.035)		
Non-routineness/interactivity					−0.805*** (0.022)	−0.404*** (0.032)
Service outsourcing	−0.024** (0.009)	0.056*** (0.010)	−0.026** (0.009)	0.072*** (0.011)	−0.025** (0.009)	0.102*** (0.011)
Service outsourcing × non-routineness		−0.174*** (0.011)				
Service outsourcing × interactivity				−0.205*** (0.015)		
Service outsourcing × non-routineness/interactivity						−0.224*** (0.014)
Net exports (in billion euros)	−0.003 (0.003)	−0.003 (0.003)	−0.003 (0.003)	−0.002 (0.003)	−0.003 (0.003)	−0.002 (0.003)
Output (in billion euros)	0.002* (0.001)	0.002* (0.001)	0.002* (0.001)	0.002* (0.001)	0.002* (0.001)	0.002* (0.001)
Capital-output ratio	−0.051 (0.038)	−0.033 (0.038)	−0.055 (0.038)	−0.049 (0.038)	−0.054 (0.038)	−0.044 (0.038)
Regional unemployment rate	−0.032*** (0.008)	−0.032*** (0.008)	−0.031*** (0.008)	−0.031*** (0.008)	−0.032*** (0.008)	−0.032*** (0.008)
Firm size: 20–99	−0.153*** (0.008)	−0.157*** (0.008)	−0.150*** (0.008)	−0.152*** (0.008)	−0.156*** (0.008)	−0.159*** (0.008)
Firm size: 100–499	−0.260*** (0.009)	−0.267*** (0.009)	−0.268*** (0.009)	−0.268*** (0.009)	−0.273*** (0.009)	−0.276*** (0.009)
Firm size: 500–999	−0.419*** (0.016)	−0.425*** (0.016)	−0.435*** (0.016)	−0.433*** (0.016)	−0.437*** (0.016)	−0.438*** (0.016)
Firm size: >1000	0.208*** (0.013)	0.202*** (0.013)	0.198*** (0.013)	0.197*** (0.013)	0.196*** (0.013)	0.193*** (0.013)
Constant	−1.556*** (0.109)	−1.671*** (0.109)	−1.444*** (0.109)	−1.605*** (0.110)	−1.387*** (0.109)	−1.591*** (0.110)
log pseudo-likelihood	-263002.31	-262849.4	-263354.2	-263246.46	-263132.08	-262979.7
Observations (person × year)	635537	635537	635537	524328	635537	635537

* p<0.05, ** p<0.01, *** p<0.001

All regressions include industry dummies, year dummies and region dummies. Reference category: Occupational tenure: >7 years; Age: < 25; Gender: Male; Education: Medium; Establishment size: 0–19.

Table 4: Discretization of the task measure

Dependent variable: End of occupational spell (0/1)	Manufacturing		Services	
Material Outsourcing	0.006*	0.003		
	(0.003)	(0.003)		
Material Outsourcing × low non-routine/interactive		0.011***		
		(0.002)		
Material Outsourcing × high non-routine/interactive		−0.002		
		(0.003)		
Service outsourcing	−0.193***	−0.190***	−0.025**	−0.022*
	(0.038)	(0.039)	(0.009)	(0.009)
Service outsourcing × low non-routine/interactive		0.027		0.132***
		(0.026)		(0.006)
Service outsourcing × high non-routine/interactive		−0.031		−0.034***
		(0.024)		(0.005)
log pseudo-likelihood	-194399.44	-194370.18	-263174.5	-262853.6
Wald test: Material Outsourcing equal (p-value)		0.000		
Wald test: Service outsourcing equal (p-value)		0.165		0.000
Observations (person × year)	579334	579334	635537	635537

* p<0.05, ** p<0.01, *** p<0.001

Standard errors (in parentheses) are clustered at the level of the individual.

In addition, regressions include the explanatory variables listed in tables 2 and 3 with the coefficients being very similar to the ones obtained in Model 5 and Model 6. Reference category: medium non-routine/interactive.

Table 5: Task intensity and differentiation between production and service-oriented occupations

Dependent variable: End of occupational spell (0/1)	Manufacturing		Services	
Material Outsourcing	0.005	0.020***		
	(0.003)	(0.004)		
Material Outsourcing × production-oriented occ.	0.002	−0.002		
	(0.002)	(0.002)		
Material Outsourcing × non-routineness/interactivity		−0.025***		
		(0.005)		
Service outsourcing	−0.197***	−0.148**	−0.033***	0.076***
	(0.040)	(0.053)	(0.009)	(0.012)
Service outsourcing × production-oriented occ.	0.010	0.003	0.100***	0.092***
	(0.021)	(0.019)	(0.005)	(0.006)
Service outsourcing × non-routineness/interactivity		−0.086		−0.190***
		(0.063)		(0.014)
log pseudo-likelihood	-194324.24	-194306.39	-262645.84	-262537.96
Observations (person × year)	579334	579334	635537	635537

* p<0.05, ** p<0.01, *** p<0.001

Standard errors (in parentheses) are clustered at the level of the individual.

In addition, regressions include the explanatory variables listed in tables 2 and 3 with the coefficients being very similar to the ones obtained in Model 5 and Model 6. Reference category: service-oriented occ.

Table 6: Pairwise correlation coefficients between the task measures and the education dummies

	Manufacturing			Services		
	NR	INTER	NR/INTER	NR	INTER	NR/INTER
Education: missing	-0.0508	-0.0410	-0.0484	-0.0612	-0.0401	-0.0465
Education: low	-0.2413	-0.2986	-0.2780	-0.2301	-0.2112	-0.2441
Education: medium (base)	-0.1364	-0.0027	-0.1026	-0.1671	0.0155	-0.1236
Education: High	0.4935	0.3639	0.4863	0.4310	0.1734	0.3803

The table displays the point-biserial correlation coefficients (mathematically equivalent to the traditional Pearson product moment correlation coefficient) between the education dummy variables and the intensities of non-routine tasks (NR), interactive tasks (INTER) as well as the maximum of the two (NR/INTER).

Table 7: Task versus education effects of international outsourcing

Dependent variable: End of occupational spell (0/1)	Manufacturing		Services	
Material Outsourcing	0.006*	0.020***		
	(0.003)	(0.004)		
Material Outsourcing × Education: missing	−0.007	−0.008		
	(0.006)	(0.006)		
Material Outsourcing × Education: low	0.001	−0.002		
	(0.002)	(0.002)		
Material Outsourcing × Education: high	−0.001	0.005		
	(0.003)	(0.003)		
Material Outsourcing × non-routineness/interactivity		−0.028***		
		(0.005)		
Service outsourcing	−0.200***	−0.182***	−0.033***	0.087***
	(0.039)	(0.051)	(0.009)	(0.012)
Service outsourcing × Education: missing	0.100	0.098	0.043***	0.035***
	(0.084)	(0.084)	(0.009)	(0.010)
Service outsourcing × Education: low	0.054*	0.049	0.061***	0.044***
	(0.026)	(0.027)	(0.006)	(0.006)
Service outsourcing × Education: high	−0.016	−0.011	0.005	0.023***
	(0.030)	(0.033)	(0.005)	(0.005)
Service outsourcing × non-routineness/interactivity		−0.033		−0.214***
		(0.065)		(0.014)
log pseudo-likelihood	-194357.77	-194338.63	-263064.46	-262937.87
Wald test: Material Outsourcing × Educ. equal (p-value)	0.591	0.097		
Wald test: Service outsourcing × Educ. equal (p-value)	0.099	0.204	0.000	0.000
Observations (person × year)	579334	579334	635537	635537

* p<0.05, ** p<0.01, *** p<0.001
Standard errors (in parentheses) are clustered at the level of the individual.
In addition, regressions include the explanatory variables listed in tables 2 and 3 with the coefficients being very similar to the ones obtained in Model 5 and Model 6. Reference category: Education: Medium

Table 8: Redefinition of a failure: only transitions into non-employment

Dependent variable: End of occupational spell (0/1)	Manufacturing		Services	
Material Outsourcing	0.011**	0.024***		
	(0.004)	(0.005)		
Material Outsourcing × non-routineness/interactivity		−0.027***		
		(0.006)		
Service outsourcing	−0.215***	−0.279***	−0.044***	0.051***
	(0.048)	(0.062)	(0.011)	(0.014)
Service outsourcing × non-routineness/interactivity		0.125		−0.170***
		(0.074)		(0.016)
log pseudo-likelihood	-137280.99	-137269.35	-207456.03	-207398.32
Observations (person × year)	579334	579334	635537	635537

* p<0.05, ** p<0.01, *** p<0.001
Standard errors (in parentheses) are clustered at the level of the individual.
In addition, regressions include the explanatory variables listed in tables 2 and 3.

Table 9: Random effects estimation results

	Manufacturing				Services			
Dependent variable: End of occupational spell (0/1)	Model 5		Model 6		Model 5		Model 6	
Occupational tenure: (0; 1] years	1.376***	(0.011)	1.377***	(0.011)	1.550***	(0.009)	1.545***	(0.009)
Occupational tenure: (1; 2] years	0.901***	(0.013)	0.901***	(0.013)	1.021***	(0.011)	1.017***	(0.011)
Occupational tenure: (2; 3] years	0.518***	(0.016)	0.518***	(0.016)	0.712***	(0.013)	0.709***	(0.013)
Occupational tenure: (3; 4] years	0.465***	(0.017)	0.465***	(0.017)	0.590***	(0.015)	0.587***	(0.015)
Occupational tenure: (4; 5] years	0.337***	(0.019)	0.337***	(0.019)	0.432***	(0.017)	0.430***	(0.017)
Occupational tenure: (5; 7] years	0.207***	(0.016)	0.207***	(0.016)	0.265***	(0.014)	0.264***	(0.014)
Age: 25–29	−0.233***	(0.017)	−0.233***	(0.017)	−0.179***	(0.012)	−0.176***	(0.012)
Age: 30–34	−0.331***	(0.016)	−0.330***	(0.016)	−0.196***	(0.012)	−0.192***	(0.012)
Age: 35–39	−0.408***	(0.016)	−0.409***	(0.016)	−0.265***	(0.012)	−0.262***	(0.012)
Age: 40–44	−0.510***	(0.017)	−0.511***	(0.017)	−0.355***	(0.013)	−0.353***	(0.013)
Age: 45–49	−0.526***	(0.018)	−0.526***	(0.018)	−0.392***	(0.014)	−0.391***	(0.014)
Age: 50–54	−0.532***	(0.019)	−0.532***	(0.019)	−0.369***	(0.015)	−0.369***	(0.015)
Age: 55–59	−0.156***	(0.021)	−0.157***	(0.021)	−0.122***	(0.017)	−0.122***	(0.017)
Age: 60–65	1.195***	(0.019)	1.194***	(0.019)	0.981***	(0.017)	0.980***	(0.017)
Gender: Female	0.133***	(0.009)	0.131***	(0.009)	−0.057***	(0.007)	−0.061***	(0.007)
Education: Missing	−0.002	(0.030)	0.000	(0.030)	0.028	(0.017)	0.029	(0.017)
Education: Low	0.087***	(0.011)	0.088***	(0.011)	0.210***	(0.010)	0.208***	(0.010)
Education: High	0.013	(0.015)	0.017	(0.015)	−0.145***	(0.011)	−0.128***	(0.011)
Nationality: Foreign	0.091***	(0.013)	0.091***	(0.013)	0.162***	(0.011)	0.158***	(0.011)
Non-routineness/interactivity	−0.578***	(0.026)	−0.384***	(0.042)	−0.822***	(0.022)	−0.416***	(0.032)
Material Outsourcing	0.006*	(0.003)	0.018***	(0.004)				
Material Outsourcing × non-routineness/interactivity			−0.023***	(0.004)				
Service outsourcing	−0.194***	(0.039)	−0.157**	(0.049)	−0.024**	(0.009)	0.103***	(0.011)
Service outsourcing × non-routineness/interactivity			−0.069	(0.058)			−0.226***	(0.013)
Net exports (in billion euros)	0.004	(0.003)	0.004	(0.003)	−0.003	(0.003)	−0.002	(0.003)
Output (in billion euros)	0.003	(0.002)	0.003	(0.002)	0.002*	(0.001)	0.002*	(0.001)
Capital-output ratio	0.929***	(0.120)	0.934***	(0.120)	−0.052	(0.039)	−0.042	(0.039)
Regional unemployment rate	0.001	(0.012)	0.001	(0.012)	−0.031***	(0.008)	−0.031***	(0.008)
Firm size: 20–99	−0.311***	(0.012)	−0.311***	(0.012)	−0.159***	(0.008)	−0.163***	(0.008)
Firm size: 100–499	−0.529***	(0.012)	−0.528***	(0.012)	−0.278***	(0.009)	−0.281***	(0.009)
Firm size: 500–999	−0.653***	(0.017)	−0.653***	(0.017)	−0.442***	(0.017)	−0.444***	(0.017)
Firm size: >1000	−0.443***	(0.015)	−0.441***	(0.015)	0.201***	(0.012)	0.198***	(0.012)
Constant	−2.675***	(0.365)	−2.792***	(0.366)	−1.396***	(0.110)	−1.601***	(0.110)
ρ	0.008	(0.006)	0.008	(0.006)	0.024***	(0.005)	0.023***	(0.005)
log likelihood	-194361.34		-194342.86		-263118.65		-262967.66	
Likelihood ratio test: $\rho = 0$ (p-value)	0.092		0.098		0.000		0.000	
Observations (person × year)	579334		579334		635537		635537	

* p<0.05, ** p<0.01, *** p<0.001

All regressions include industry dummies, year dummies and region dummies. Reference category: Occupational tenure: >7 years; Age: < 25; Gender: Male; Education: Medium; Establishment size: 0–19.

Table 10: List of workplace-related tools and classification of non-routine and interactive tasks following Becker, Ekholm, and Muendler (2007)*

	Non-routine tasks	Interactive tasks: First component
Tools or devices		
Simple tools		
Precision-mechanical, special tools	x	
Power tools		
Other devices		
Soldering, welding devices		
Stove, oven, furnace		
Microwave oven		
Machinery or plants		
Hand-controlled machinery		
Automatic machinery		
Computer-controlled machinery		
Process plants		
Automatic filling plants		
Production plants		
Plants for power generation		
Automatic warehouse systems		
Other machinery, plants		
Instruments and diagnostic devices		
Simple measuring instruments		
Electronic measuring instruments		
Computer-controlled diagnosis		
Other measuring instruments, diagnosis		
Computers		
Personal or office computers		
Connection to internal network		
Internet, e-mail		
Portable computers (laptops)		
Scanner, plotter		
CNC machinery		
Other computers, EDP devices		
Office and communication equipment		
Simple writing material		
Typewriter		
Desktop calculator, pocket calculator		
Fixed telephone	x	
Telephone with ISDN connection	x	
Answering machine	x	
Mobile telephone, walkie-talkie, pager	x	
Fax device, telecopier		
Speech dictation device, microphone		x
Overhead projector, beamer, TV	x	x
Camera, video camera	x	x
Means of transport		
Bicycle, motorcycle		x
Automobile, taxi		x
Bus		x
Truck, conventional truck		x
Trucks for hazardous good, special vehicles		x
Railway		x
Ship		x
Aeroplane		x
Simple means of transport		x
Tractor, agricultural machine		
Excavating, road-building machine		x
Lifting-aids on vehicles		x
Forklift, lifting truck		
Lifting platform, goods lift		
Excavator		
Crane in workshops		
Erection crane		
Crane vehicle		
Handling system		
Other vehicles, lifting means		
Other tools and aids		
Therapeutic aids	x	x
Musical instruments	x	x
Weapons	x	x
Surveillance camera, radar device		
Fire extinguisher	x	x
Cash register		x
Scanner cash register, bar-code reader		x
Other devices, implements		
Software use by workers with computers		
Word processing program		
Spreadsheet program		
Graphics program	x	
Database program		
Special, scientific program	x	
Use of other software		
Computer handling by workers with computers		
Program development, systems analysis	x	
Device, plant, system support	x	
User support, training	x	x
Computer use by any worker		
Professional use: personal computer	x	
Machinery handling by workers with machinery		
Operation of program-controlled machinery		
Installation of program-controlled machinery	x	
Programming of program-controlled machinery	x	
Monitoring of program-controlled machinery	x	
Maintenance, repairs	x	x

* Source: Becker, Ekholm, and Muendler (2007). Items refer to the list of questioned tools in the German Qualification and Career Survey 1998/99. The authors' strict classification is used. Any non-intended deviations from the original classification are the fault of the author.

Table 11: List of job-related tasks and classification of (strictly) interpersonal activities*

Task	Interactive tasks: Second component
Training and teaching others	x
Consulting, informing others	
Measuring, testing, quality controlling	
Surveillance, operating machinery, plants, or processes	
Repairing, renovating	
Purchasing, procuring, selling	
Organizing, planning	
Advertising, public relations, marketing, promoting business	
Information acquisition and analysis, investigations	
Conducting negotiations	
Development, research	
Manufacture or production of merchandize	
Providing for, waiting on, caring for people	x

* Author's classification. Refers to the list of questioned job-related tasks in the German Qualification and Career Survey 1998/99. See section 3.2 for further details.