

Offshoring, Wages and Job Security of Temporary Workers

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Abstract

Temporary contracts have become an important mode of employment in many countries. We investigate the impact of offshoring on individual level wages and unemployment probabilities and pay particular attention to the question if workers with temporary contracts are affected differently than workers with permanent contracts. Data are taken from the German Socio-Economic Panel (SOEP), linked with industry-level data on offshoring. We do not find systematic differences between temporary and permanent workers with respect to the effects of offshoring for wages. We find, however, that offshoring increases the unemployment risk of low-skilled workers, and more so for temporary than permanent workers. Also, offshoring reduces the unemployment risk for all high- and medium-skilled workers.

Keywords: Offshoring, imported value added, temporary contracts, wages, job security

JEL Classification: F14, F16, J31

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1 Introduction

An important facet of today's world economy is that trade is no longer mostly in final goods. Instead, the recent wave of globalization is characterized by the strong emergence of vertical specialization and the offshoring of parts of the production (see Yi, 2003). The labour market consequences of this offshoring of production are debated in the media as well as among policy makers and academic economists.

At least since Feenstra and Hanson (1999) trade economists have concerned themselves with investigating the impact of offshoring on labour markets. While Feenstra and Hanson (1999) and many papers since investigate this issue using industry or country level data (e.g. Foster-McGregor et al. 2013), recent research tends to use individual level data in order to examine whether offshoring has any impact on an individual's job security or wage. Using micro data has the advantage that it allows to focus on the level of the individual where one can control for observable and unobservable characteristics that may play a role for transitions in employment status or wages, but that cannot be controlled for in firm or industry data (e.g., age, tenure or marital status of a worker). It also provides information on the various aspects of skills of an individual, which can be exploited in the estimations. Moreover, unobserved time-invariant characteristics can be controlled for by using panel data methods.

A number of recent studies have investigated the effects of offshoring using individual level data. Baumgarten et al. (2013), Ebenstein et al. (2014), Liu and Trefler (2008) and Geishecker and Görg (2008, 2013) use individual level data for the US, Germany and the UK, respectively, to study the impact of offshoring on individual wages. Liu and Trefler (2008), Geishecker (2008), Bachmann and Braun (2011) and Egger et al. (2007) also use individual level data for the US, Germany and Austria, respectively, to investigate whether offshoring has any implications for job security, measured in terms of whether an individual switches jobs or moves into unemployment. Overall, it seems from this literature that, in

general, offshoring may have some effects on employment and wages in line with expectations, where low skilled workers may be more likely to lose and high skilled workers more likely to benefit in terms of job security and wages.

What has, to the best of our knowledge, been neglected in this literature thus far is the question as to how workers with different types of contracts fare in this wave of offshoring. This is the focus of this paper, where we particularly consider whether workers on temporary contracts experience different labour market effects of offshoring than their peers on permanent contracts. This is an important issue, given that temporary contracts are an important mode of employment today (see table 1).

[Table 1 here]

In Germany, the country studied in this paper, the share of temporary contracts in the group of workers aged 25 to 49 years increased slightly from 7.4% in 1999 to 9.8% in 2011 (according to Eurostat statistics, not shown).¹ Having been well below the European average, Germany has now almost caught up with the European average (see Figure 1).

[Figure 1 here]

The share of temporary contracts is particularly high among younger workers and low-skilled workers (see table 2). According to Eurostat data in table 2, almost one-third of workers with primary education hold a temporary contract in 2007 (up from one-fourth in 1999). Among workers with secondary or tertiary education, only 10 or 8 per cent hold a temporary contract, respectively.

[Table 2 here]

Negative economic shocks such as a recession with many jobs being shed, can cause high levels of unemployment among groups with a high prevalence of temporary contracts

¹ Note, however, that this increase may be overstated due to a change in the statistical methodology in 2004.

(cf. Blanchard and Landier, 2002; Cahuc and Postel-Vinay, 2002; Boeri and Garibaldi, 2007). Yet, the possibility to use temporary contracts should also increase overall employment as employers may be more willing to create jobs given the lower cost of eliminating jobs. Moreover, the use of temporary contracts by employers also enhances employment stability for regular core employees who hold permanent contracts (Gramm & Schnell, 2001).

While, in principle, all workers in an industry are equally likely to be affected by the pressures on labour brought about by offshoring, there are several reasons to believe that workers on temporary contracts are affected differently than workers on permanent contracts. Booth et al. (2002a) characterize temporary labour under fixed-term contracts as “a buffer stock that allows firms to adjust to changes in the business environment due to seasonal or other transitory causes” (p. F182). Accordingly, if firms and industries adjust to offshoring, this may lead to a stronger adjustment among temporary workers; both positively and negatively.

In terms of wages, temporary workers might be particularly affected because they supposedly have a weaker bargaining position than permanent workers. They might also be represented less well in collective wage bargaining processes. Moreover, they have possibly obtained less on-the-job training or job-specific human capital, making their bargaining position even weaker. Hence, they might incur stronger wage reductions in case employers adjust to globalization pressure at the intensive margin.

In terms of job security, temporary workers might, on the one hand, have a stronger propensity to lose their job due to international competition because their contracts have a natural termination date after which employers might not renew it. Moreover, they have typically obtained less firm-specific human capital, making them less attractive for employers to keep them. On the other hand, when firms expand due to offshoring-induced cost savings or productivity improvements, temporary workers might benefit from renewed contracts or conversion to a permanent contract. Indeed, there is some evidence that temporary contracts

can serve as a stepping-stone to regular employment (e.g. Holmlund & Storrie, 2002; Booth et al., 2002b).

We address the question of whether employees on temporary contracts are differently affected by offshoring by looking at individual wages and the risk of becoming unemployed. The sample consists of workers between 18 and 64 years in manufacturing industries between 1999 and 2007. Data are taken from the German Socio-Economic Panel (SOEP), an annual, representative, and widely used individual level panel data set for Germany (see Wagner et al., 2007, for a description of the SOEP). In order to integrate offshoring into the data, we link the SOEP with industry-level data on offshoring, specifically the share of imported value added in industry production, which we calculate from the World Input Output Database (WIOD). In the regressions, we interact offshoring intensities with contract type and can thus infer the potentially differential impact of offshoring on permanent and temporary workers.

The remainder of the paper is structured as follows. Section 2 describes our measure for offshoring and gives an overview about the evolution of offshoring. Section 3 introduces the other data and presents our methodological approach. In Section 4 we discuss our empirical results. Section 5 concludes.

2 Measuring offshoring

Empirical work in international trade generally gauges the importance of offshoring by looking at imports of intermediate goods from the respective industry abroad. Following Feenstra and Hanson (1999), many studies use input-output tables to estimate the importance of intermediate goods trade for certain industries. In this study, we measure offshoring by the share of foreign value added contained in domestic production. Similar indicators have been derived by Hummels et al. (2001), Daudin et al. (2011), Johnson und Noguera (2012) und

Koopman et al. (2014), and have been calculated with various data sets. Our offshoring measure is calculated using the World Input Output Database (WIOD).²

The WIOD contains detailed information about the production structure, imports and exports of 40 countries, which jointly represent 85 per cent of world GDP. Moreover, the WIOD distinguished 35 industries, of which 14 are manufacturing industries. A list of industries in the WIOD and their NACE equivalents can be found in Appendix A. Note that the industries Textiles and Leather had to be aggregated because of some missing values in the WIOD. The world input-output tables are available on an annual basis between 1995 and 2009, and they are comparable across countries and time.

We employ the concept of narrow offshoring here. Narrow offshoring describes the share of imported value added, which the worker's industry imports from the same industry abroad. Changes in narrow offshoring are expected to affect the worker's wage and job loss probability because the measure captures imported tasks, which could as well be carried out by the domestic worker. For example, an increase in narrow offshoring could be due to the relocation of production steps which were previously carried out domestically. The formal derivation of our offshoring measure can be found in Appendix B. We are using the expressions offshoring and imported value added interchangeably throughout the text.

Figure 2 shows the evolution of narrow offshoring, i.e. the share of imported own-industry value added, across German manufacturing industries between 1999 and 2007. It is clear that there are differences in the *level* of imported value added, with the food/beverage industry showing a ratio of material imports to output of between 0.5 and 1 per cent, while industries such as basic and fabricated metals import between 5 and 10 per cent of value added. However, in most industries there is also a clear and upward trend over time.

² The WIOD is available at <http://www.wiod.org/database/index.htm>. See Timmer (2012) for a detailed description of the construction of the world input-output tables.

[Figure 2 here]

Table 3 shows that the share of imported value added increased by a bit more than one percentage point between 1999 and 2007 in manufacturing industries. This increase is mostly driven by an increase in offshoring to low-wage countries, which include Central and Eastern European countries.

[Table 3 here]

3 Other Data and Methodology

The aim of our analysis is to investigate the effect of offshoring on individual wages and unemployment probabilities and to see whether temporary work arrangements affect these outcomes. Such labour market effects may strongly depend on individual level characteristics, such as education, age, employment duration with the employer etc. In order to be able to abstract from such confounding effects we therefore turn to an econometric analysis where we use individual level data combined with the industry level measures for imported value added (i.e., offshoring).

The analysis relies on individual level data from Samples A to E, as well as Samples H and I of the German Socio-Economic Panel (SOEP; see Appendix C for variable descriptions and summary statistics of the individual level variables). Using the industry identifier we combine the individual level data with the industry level data on offshoring described in Section 2. Our sample includes all regular full-time employees as well as employees with atypical employment relationships, which include temporary contracts, part-time employment, marginal or irregular employment, and employment by temporary work agencies. We restrict our sample to male workers that are between 18 and 64 years old and

that are employed in manufacturing industries (NACE 15-36) in West Germany.³ Moreover, we exclude apprentices and self-employed from our estimation sample. Apprentices have a rather specific and special status on the German labour market because of the German dual apprenticeship system. In particular, they hold temporary contracts but, due to their special status, they cannot be regarded as regular labour market participants. The analysis spans the period 1999 to 2007. The starting date of our time period is set because information about the workers' contract types is only available since 1999. We concentrate on the period up to 2007 only in order to avoid results, which are driven by the financial crisis.

The first part of the analysis looks at wages. To investigate the relationship between offshoring and individuals' wages, we estimate variants of the following Mincerian wage regression:⁴

$$(1) \ln WAGE_{ijt} = \beta X_{it} + \gamma_1 OFF_{jt} + \gamma_2 TEMP_{it} + \gamma_3 (OFF_{jt} * TEMP_{it}) + Y_{jt} + d_j + d_t + d_i + v_{it}$$

where *WAGE* is the hourly gross wage for individual *I* in industry *j* in year *t*. Wage data are derived from the SOEP Cross-national equivalent file (CNEF) and include bonuses, premia, and other extra payments. Hourly wages are calculated by dividing gross yearly labour earnings by yearly working hours.⁵

As explanatory variables we include a vector *X* of individual specific characteristics (including marital status, employment duration with the employer, work experience, education, size of the firm where the individual works, and a dummy for individuals living in East Germany, in addition to gender and age in case of the unemployment risk regressions).⁶ Dummies *d* for industry *j*, time *t* and individual fixed effects *d_i* control for unobserved effects

³ We exclude workers from East Germany, as wages in the East are to a large extent shaped by the structural change of the economy that has been taking place since the fall of the wall and that most likely dominates the impact of other changing structural factors. We also exclude female workers since, as is well known, female workers have substantially different labour market outcomes than males. Hence, our sample is similar to that used in Geishecker and Görg (2008), though we have a more up-to-date time period.

⁴ This approach is similar to Geishecker and Görg (2008, 2013) and Liu and Trefler (2008). However, these papers do not allow for differential effects depending on the type of employment contract and use a different offshoring measure.

⁵ Imputed wages are dropped throughout the analysis.

⁶ A definition of the explanatory variables is given in Appendix C.

at these levels. We also include a vector Y with measures of industry-level R&D (relative to the output of industry j) in order to control for technical change that is specific to an industry, and of industry-level production in order to control for activity. Industry-level R&D data are taken from the ANBERD database provided by the OECD. Production data are taken from the WIOD.

The main variables of interest are the vector OFF which is our measure of narrow offshoring as described in Section 3 and $TEMP$, which is an indicator variable equal to one if the individual holds a temporary contract and zero if the contract is permanent. The interaction term $OFF * TEMP$ captures the differential effect (if any) of offshoring on wages for workers with temporary contracts.

The incidence of temporary contracts differs by the educational attainment of the worker (see table 2 above): low-skilled workers are more likely to hold a temporary contract than the other skill groups. Hence, estimates may partly capture the effects of education. Therefore, we split the sample by educational group, in order to derive within group estimates of the differential offshoring effects of temporary contracts and atypical employment relationships.

An important assumption implicit in our estimation is that of exogeneity of regressors. This may be questionable in particular with respect to the offshoring variables. These may be endogenous due to reverse causality – e.g. industries with many unskilled, low-wage workers may also be those that are more likely to offshore. However, given that there is substantial heterogeneity in individual wages it is unlikely that reverse causality is an issue. Also, we control for industry-level fixed effects, which would control for time invariant characteristics, such as production technology at the industry level. Another potential source of correlation between the offshoring variable and the error term is measurement error, which is, however, hard to correct as alternative measures are not available.

The second part of the analysis looks at employment probabilities. To investigate the link between an individual's probability of losing her job and offshoring we estimate the probability of job loss conditional on individual and industry characteristics:

$$(2) \Pr(\text{job loss})_{ijt} = \beta X_{it} + \lambda_1 \text{OFF}_{jt} + \lambda_2 \text{TEMP}_{it} + \lambda_3 (\text{OFF}_{jt} * \text{TEMP}_{it}) + Y_{jt} + d_j + d_i + d_t + e_{it}$$

where *job loss* is defined as a dummy variable equal to one in period *t* if the individual *I* moves from full-time employment in period *t* into unemployment in period *t+1*, and zero otherwise.⁷ The explanatory variables are identical to those in equation (1), except that we add age and, in a separate regression, replace the linear measure of employment duration (tenure) by several dummies for relevant groups of employment duration in order to limit potential collinearity between the temp contract indicator and employment duration. Given the binary nature of the dependent variable the model is estimated using probit techniques.⁸ Since a fixed effects estimation of the unemployment risk equation would require dropping a large number of observations, we revert to random effects estimations. It is assumed that the individual specific effect *d_i* is uncorrelated with the other independent variables.

4 Results

This section discusses the results of our econometric estimations. We first discuss the impact of offshoring on wages and then the impact on the probability to become unemployed.

4.1 Wage effects

The results of the wage regressions are shown in table 4. The coefficients on the control variables have generally the expected signs but are mostly statistically insignificant.

⁷ There are, of course, also other possibilities of employment exits in our data, e.g., workers may move into maternity leave, non-participation or new jobs. These options are not considered here. Moves into maternity leave or non-participation are set to missing (right-censored) while moves into new jobs are considered as stayers.

⁸ This approach is similar to Geishecker (2008) and Bachmann and Braun (2011) who, however, only consider the period 1991 to 2000. Also, they do not distinguish temporary and permanent work arrangements.

This is not too surprising as the equation includes individual fixed effects and, hence, only exploits the within variation in the data.

The full sample regression (column 1 in table 4) shows that there is no statistically significant relationship between offshoring and wages. The interaction of offshoring with the dummy for temporary contracts is also not statistically significant.

[Table 4 here]

In columns 2, 3, and 4, we split the sample by educational attainment in order to obtain within-group estimates. Column 2 shows the result for the sample of low-skilled workers, i.e. unqualified workers without vocational or tertiary education (ISCED 1 & 2). Column 3 shows results for medium-skilled workers with vocational education and Abitur (A-levels; ISCED 3 & 4), and column 4 for high-skilled workers with tertiary education (ISCED 5 & 6). Distinguishing the effects by educational attainment may be important as the coefficients for holding a temporary contract may mask an education effect in the full sample as less skilled workers are more likely to hold temp contracts (32% among low-skilled vs. 10% and 6% among medium- and high-skilled, respectively).

However, we still do not find any strong statistically significant effects in the estimations. The coefficients on the offshoring variable return a negative coefficient for low-skilled and positive coefficients for medium and high skilled workers, though these are statistically insignificant at standard levels of confidence. Still, these coefficients are in line with Geishecker and Görg (2008) and suggest that low skilled workers tend to lose from offshoring, while high and medium skilled workers are more likely to gain in terms of wages. The interactions of offshoring and temporary contracts are also statistically significant, though the signs suggest that the negative effect for low skilled and positive for high and medium skilled are somewhat dampened for temporary workers.

Overall, our results suggest that there is no strong evidence for systematic differences between temporary and permanent workers with respect to the effects of offshoring on wages.

Given that we only observe workers who *remain* in manufacturing after any effects of offshoring played out, these results may not be too surprising as the remaining workers are likely to be more productive than workers who drop out of manufacturing employment (Autor et al., 2012). In order to gain more insights on the relationship between offshoring and employment, we now turn to look at effects on the extensive margin.

4.2 Unemployment risk

This section reports results for the estimations of the risk to become unemployed. A priori, it is not clear what to expect. On the one hand, it is likely that workers holding temporary contracts are the first to be shed when firms adjust to offshoring on the extensive margin. After all, their contracts have a natural termination date, employment protection is weaker, and the workers have probably built up less firm-specific human capital. On the other hand, offshoring may make firms more productive, leading to increased production and, thus, a higher demand for labour. This may play out to the benefit of workers with temporary contracts whose contracts may be extended or converted into permanent ones.

We estimate the model of unemployment risk in equation (2) using a random-effects probit regression. As this is a non-linear estimator, interaction terms are inherently difficult to interpret. Hence, we report here the marginal effects of offshoring for workers with temporary and permanent contracts (table 5) while the full regression results are relegated to appendix D. In the estimations presented in table D1, duration dependence is modeled through the variable “employment duration”, which is a continuous variable including the years of current tenure with the employer. In table D2, we use a more flexible modeling approach where we define dummy variables for different stages of employment duration. The definition of these dummies follows Geishecker (2008). The regression results are very similar. The marginal effects presented in table 5 are based on the regressions in table D2.

[Table 5 here]

The full sample regression in column (1) shows that offshoring is negatively associated with the probability of job loss for permanent contracts, i.e. the risk to become unemployed in the next period is reduced as the share of imported value added rises. This is in line with an earlier study by Bachmann and Braun (2011) who, however, use different data and another time period. Workers with a temporary contract also face a lower risk to become unemployed as offshoring rises, and the effect appears to be of a similar magnitude as that for permanent workers. The finding of a lower unemployment risk is in line with the following argument: As offshoring makes firms more productive (see e.g. Grossman and Rossi-Hansberg, 2008), labour demand increases and existing workers may keep their jobs, despite potential pressure from abroad. However, the aggregate picture hides some important heterogeneity between education groups.

In the group of low-skilled workers (column 2), an increase in offshoring is associated with an increase in the unemployment risk for both types of workers. The effect appears much stronger for workers holding a temporary contract, however. For those workers, a one percentage point increase in offshoring is associated with a 0.12 percent increase in the unemployment risk. Given that our offshoring measure rose by 1.2 percentage points over our sample period (1999 and 2007), the implied effect is that the unemployment risk for low skilled temporary workers would have been 0.148 percent lower in the absence of offshoring.⁹ Hence, low skilled workers, especially those with temporary contract, may be more likely to be driven into unemployment as offshoring increases.

In the groups of medium-skilled and high-skilled workers, offshoring is associated with a *decrease* in the unemployment risk for both permanent and temporary contracts. For medium-skilled workers there appears to be no difference between temporary and permanent

⁹ Calculated as the rise in offshoring (1.2 percent) multiplied with the marginal effect for low skilled temporary workers (0.00124). The average overall risk of being unemployed in period t+1 was 3.46 percent for low skilled workers.

workers. However, for high-skilled workers the marginal effect is significantly higher for workers with temporary contracts compared to their peers on permanent contracts. The marginal effect suggests that the rise in offshoring over our sample period reduced the risk of unemployment by 3.66 percent for high skilled workers on temporary contracts.¹⁰ Hence, offshoring may, through reallocation of activities lead to more employment opportunities for high skilled workers and in particular benefit workers on temporary contracts.

5 Conclusions

In our empirical analysis based on individual level data for Germany, we do not find systematic differences between temporary and permanent workers with respect to the effects of offshoring for wages. In other words, the contract type does not appear to matter for wage effects of offshoring. We also find that, on the one hand, offshoring is associated with an *increase* in the unemployment risk for all low-skilled workers, and more so for those with temporary contracts than for permanent workers. On the other hand, offshoring is associated with a *decrease* in the unemployment risk for high-skilled workers with both temporary and permanent contracts, as well as for all medium-skilled workers.

The results for offshoring effects on unemployment risk fit well into the literature. Autor et al. (2013) argue that only the most productive workers remain in a firm while the less productive leave. If low skilled workers may be considered less productive than high skilled workers, this is in line with our finding of different effects on unemployment risk of for these two skill groups. We add to the literature by also estimating different effects for workers with temporary and permanent contracts, however.

Our findings provide some evidence for the policy debate on whether globalization and employment insecurity are linked (cf. Rodrik, 1998, Scheve and Slaughter, 2004) by

¹⁰ The average overall risk of being unemployed in period t+1 is 0.96 percent for high skilled workers.

investigating whether the nature of employment contracts matters. While a full answer to this issue would clearly need further research, we take our paper as providing a first step in this direction.

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Appendix A: List of manufacturing industries contained in the WIOD

No.	NACE	Description
1	15t16	Food, Beverages and Tobacco
2	{ 17t18	Textiles and Textile Products
	19	Leather, Leather and Footwear
3	20	Wood and Products of Wood and Cork
4	21t22	Pulp, Paper, Paper , Printing and Publishing
5	23	Coke, Refined Petroleum and Nuclear Fuel
6	24	Chemicals and Chemical Products
7	25	Rubber and Plastics
8	26	Other Non-Metallic Mineral
9	27t28	Basic Metals and Fabricated Metal
10	29	Machinery, Nec
11	30t33	Electrical and Optical Equipment
12	34t35	Transport Equipment
13	36t37	Manufacturing, Nec; Recycling

Note: Textiles (17t18) and Leather (19) had to be combined for calculation of imported value added.

Appendix B: Derivation of offshoring measure – share of imported value added

Our indicator for offshoring should describe the value of imported value added, i.e. value added purchased abroad, relative to the total value of industry's production. The difference between 1 and the indicator's value should thus be the share of value which is added domestically. The indicator should also account for the cases in which imported intermediate goods (e.g. German motor imports from the Czech Republic) contain parts which were previously produced domestically (e.g. the crankshaft produced in Germany). These parts should be classified as domestic and not as foreign value added.

The indicator is derived from the World Input-Output Database (WIOD). The WIOD assumes that each industry ($s, r = 1, \dots, S$) in each country ($I, j, k = 1, \dots, L$) produces a single, homogenous good, which is different from the same industry's goods produced in other countries. Hence, there are LS different goods produced in the world.

The input-output tables of the WIOD consist of four components. (i) The intermediate inputs matrix, W , of dimension $(LS \times LS)$, describes the values of bilateral trade in intermediate goods between all countries of the world. The element in row is and column jr describes the value of intermediate goods which industry r in country j purchases from industry s in country i . (ii) The final use matrix, C , of dimension $(LS \times L)$, describes the value of all LS goods sold to final users (private households, investors, the government, and changes in inventories) in all L countries. (iii) The vector Y of dimension $(I \times LS)$ describes the value added input of each industry, and (iv) the $(I \times LS)$ vector of total production, P , describes the total output of each industry.

An industry's total production (P) can be formally described as

$$p_{is} = \sum_{j=1}^L \sum_{r=1}^S w_{is,jr} + \sum_{j=1}^L c_{is,j}, \quad (1)$$

where p_{is} is the sum of a product's intermediate use and final use. Note that a matrix' cell is denoted by a small letter here. Alternatively, total production can be written as

$$p_{is} = \sum_{j=1}^L \sum_{r=1}^S w_{jr,is} + y_{is}, \quad (2)$$

where p_{is} is the sum of intermediate inputs and the industry's value added.

Equations 1 and 2 can be combined using matrix notation:

$$P = AP + Cl_L \quad (3)$$

$$= W'l_{LS} + Y. \quad (4)$$

where $P = (P_{11}, \dots, P_{1S}, P_{21}, \dots, P_{2S}, \dots, P_{L1}, \dots, P_{LS})$ is the $(LS \times I)$ vector of all production values and $Y = (Y_{11}, \dots, Y_{1S}, Y_{21}, \dots, Y_{2S}, \dots, Y_{L1}, \dots, Y_{LS})$ is the $(LS \times I)$ vector of value added in all industries. In equation 3, matrix C is multiplied by the identity vector (l_L) in order to

aggregate across all countries that consume the respective good. The $(LS \times LS)$ matrix of input coefficients, A , is constructed by dividing each element of the W matrix along the vertical by the total output of that industry:

$$A = W * diag(P^{-1}), \quad (5)$$

Its elements $a_{is,jr} = w_{is,jr} / p_{jr}$ denote how many Cents industry r in country j purchases from country I in order to produce one unit of output.

Matrix A contains input coefficients for a representative step in production. However, the production of many goods requires more than one production step, so that we have attribute the value added contributions of all intermediate inputs to their countries of origin as well. Ultimately, we would like to derive how many Cents of value added each industry in each country contributes to one Dollar of each final good. To that end, equations 3 and 4 are rewritten so that the relationships between output and final use, and between output and value added can be used to derive a direct relationship between final use and value added:

$$P = (I_{LS} - A)^{-1} * C * l_L, \quad (6)$$

$$Y = [diag(I_{LS} - A' * l_L)] * P, \quad (7)$$

$$Y = V * P, \quad (8)$$

where $V = diag(I_{LS} - A' * l_L)$.

Equation 6 describes the relationship between final use and output. Matrix $B = (I_{LS} - A)^{-1}$ is the Leontief inverse; its elements $b_{is,jr}$ describe by how much of the output of industry s in country I contributes to each Dollar of the final good of industry r from country j .

Equation 7, which is presented in a simplified way in equation 8, describes the relationship between value added and output. The diagonal elements of the $(LS \times LS)$ matrix V , $v_{ir} = y_{ir} / p_{ir}$, denote the fraction of value added in total output of industry jr .¹¹ Substituting equation 6 into equation 8 results in:

$$Y = [V * (I_{LS} - A)^{-1}] * C * l_L, \quad (9)$$

$$Y = M * C * l_L, \quad (10)$$

Matrix $M = V * (I_{LS} - A)^{-1}$ contains all the information needed for the estimations. It describes the contribution of value added by all industries in all countries to one Dollar of final good production. Its elements $m_{is,jr}$ denote how many Cents industry is contributes to each Dollar of the final good produced by industry jr .

¹¹ In equation 7, this is expressed as 1 minus the share of intermediates in total output. It can be shown that $W'l_{LS} = diag(A' l_{LS})P$.

For our estimations, we calculate a measure of narrow offshoring, OFF , for each German industry, i.e. the share of value added in industry production, which is imported from the same industry in all other countries. Specifically, we sum over the relevant elements of \mathbf{M} :

$$OFF = \sum_{i \neq j} m_{is, js} ,$$

where s is the respective industry, I is the country where the imported value added stems from, and j denotes Germany.

Appendix C: Variable definitions and summary statistics

The econometric analysis is based on the German Socio-Economic Panel (SOEP), waves 1999 to 2007. We use all SOEP samples for the analysis. Yearly industry-level information about trade and offshoring is merged with the SOEP on basis of industry classification provided in the SOEP (NACE 1.1). Variables are defined as follows (SOEP variable names are mentioned in brackets).

Variable	SOEP variable and modifications
Log hourly wage	<p>The log hourly wage is calculated using two variables from the SOEP Cross-national equivalent file: Annual individual labour earnings (i11110\$\$) and Annual work hours of the individual (e11101\$\$).</p> <p>Annual labor earnings include wages and salary from all employment including training, primary and secondary jobs, and self-employment, plus income from bonuses, overtime, and profit-sharing.</p> <p>Annual work hours are constructed using information on employment status in the survey year, average number of hours worked per week, and the number of months worked (see Grabka, 2011, p. 24 for details).</p> <p>Imputed incomes and hours are <i>not</i> used.</p>
Job loss	<p>Dummy for job loss is set to 1 in period t if person is unemployed in t (LFSS) and was working full time in t-1 (EMPLST\$). For unemployed persons, no industry information is provided in period t. We replace the missing value in t by the values in t-1.</p>
Female	Dummy = 1 if person is female
Age	Age at time of survey
Married	Dummy = 1 if person is married (\$FAMSTD)
Employment duration (1)	Number of years with employer (\$ERWZEIT)
Employment duration (2)	<p>Derived from employment biography.</p> <ol style="list-style-type: none"> 1. 1-6 months 2. 6-12 months 3. 13-36 months 4. 37-96 months 5. more than 96 months
Public ownership	Dummy = 1 if employer is public service (OEFFD\$)

(Continued on next page)

Variable	SOEP variable and modifications
Firm size	Firm size categories (ALLBET\$): <ol style="list-style-type: none"> 1. less than 20 employees (omitted category) 2. greater/equal 20 and less than 200 employees 3. greater/equal 200 and less than 2000 employees 4. greater/equal 2000 employees
Education	Highest educational level obtained (ISCED\$): <ol style="list-style-type: none"> 1. unqualified labour, up to secondary education (ISCED 1 & 2) 2. skilled labour, apprenticeship, vocational education (ISCED 3 & 4) 3. high-skilled labour, tertiary education (ISCED 5 & 6)
Experience	Years of work experience; one year of full-time work (EXPFT\$) counts as 1 year, one year of part-time work (EXPPT\$) counts as 0.5 year.
East Germany	Dummy for Eastern federal state (BULA\$)
Industry production	Taken from WIOD Supply and Use tables. See discussion of offshoring measures.
R&D expenditure	Taken from the Analytical Business Enterprise Research and Development (ANBERD) database provided by the OECD. Series runs until 2008. Values for 2009 are extrapolated.

Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Real hourly wage	6074	17.858	6.504	1.514	37.603
Job loss between t and t+1	6074	0.0201		0	1
<i>Educational attainment:</i>					
Low-skilled	6074	0.167		0	1
Medium-skilled	6074	0.584		0	1
High-skilled	6074	0.249		0	1
Age	6074	40.848	9.644	18	64
Married	6074	0.743		0	1
Employment duration	6074	12.092	9.545	0	46.4
<i>Employment duration:</i>					
1-6 months	6074	0.044		0	1
7-12 months	6074	0.037		0	1
13-36 months	6074	0.114		0	1
37-96 months	6074	0.229		0	1
> 96 months	6074	0.576		0	1
Public employer	6074	0.0092		0	1
<i>Firm size:</i>					
< 20 employees	6074	0.105		0	1
20-199 employees	6074	0.269		0	1
200-1999 employees	6074	0.325		0	1
> 2000 employees	6074	0.301		0	1
Work experience	6074	18.935	10.301	0	48
Work experience ²	6074	464.642	437.556	0	2304
Industry output	6074	177886.5	90995.5	3260.3	480661.7
R&D expenditure	6074	4547.48	4754.93	3.4	15609.9

Note: Full sample used in wage regressions.

Appendix D: Results of the random effects probit models

Table D1 - Random effects probit regression on dummy for unemployment in next period, 1999-2007, linear measure for employment duration

	(1)	(2)	(3)	(4)
	Total ⁱ	Low-skilled ⁱⁱ	Medium-skilled ⁱⁱⁱ	High-skilled ^{iv}
Offshoring	-0.118*** (0.00186)	0.0800*** (0.00988)	-0.140*** (0.00226)	-0.656*** (0.00824)
Temp contract	0.393*** (0.00479)	-0.501*** (0.0271)	0.475*** (0.00629)	-0.220*** (0.0136)
Offshoring x Temp	0.0665*** (0.000963)	0.0453*** (0.00593)	0.0995*** (0.00124)	0.229*** (0.00296)
<i>Educational attainment</i>				
Medium-skilled	-0.113*** (0.00197)			
High-skilled	-0.665*** (0.00277)			
Age	0.0355*** (0.000211)	-0.0130*** (0.00127)	0.0532*** (0.000267)	0.0313*** (0.000532)
Married	-0.135*** (0.00181)	1.478*** (0.0161)	-0.395*** (0.00238)	0.187*** (0.00583)
Employment duration	-0.00812*** (0.0000927)	-0.00815*** (0.000521)	-0.00125*** (0.000119)	-0.0446*** (0.000256)
Public employer	-0.0550*** (0.00753)		-0.323*** (0.00842)	
<i>Firm size</i>				
20-199 employees	-0.00276 (0.00231)	0.204*** (0.0132)	0.0186*** (0.00290)	0.191*** (0.00600)
200-1999 employees	-0.185*** (0.00242)	-0.0624*** (0.0129)	-0.217*** (0.00305)	0.180*** (0.00639)
> 2000 employees	-0.333*** (0.00275)	-1.169*** (0.0154)	-0.150*** (0.00331)	-0.302*** (0.00738)
Work experience	-0.0559*** (0.000330)	-0.302*** (0.00308)	-0.0458*** (0.000407)	0.00775*** (0.000953)
Work experience^2	0.000942*** (5.52e-06)	0.00656*** (6.04e-05)	0.000389*** (6.85e-06)	2.10e-06 (1.78e-05)
Industry output	1.24e-06*** (4.86e-08)	-9.07e-06*** (2.68e-07)	4.04e-06*** (5.99e-08)	-1.34e-06*** (1.96e-07)
R&D expenditure	-6.67e-06*** (2.94e-06)	0.000568*** (1.66e-05)	-0.000186*** (3.72e-06)	0.000110*** (1.02e-05)
Constant	-2.967*** (0.0175)	0.451*** (0.0447)	-3.999*** (0.0207)	-3.341*** (0.0306)
<i>No. of observations</i>	7534	1008	4314	1473
<i>No. of groups</i>	1796	309	1156	384
<i>Log likelihood</i>	-2541379.3	-399688.3	-1656374.0	-295365.9

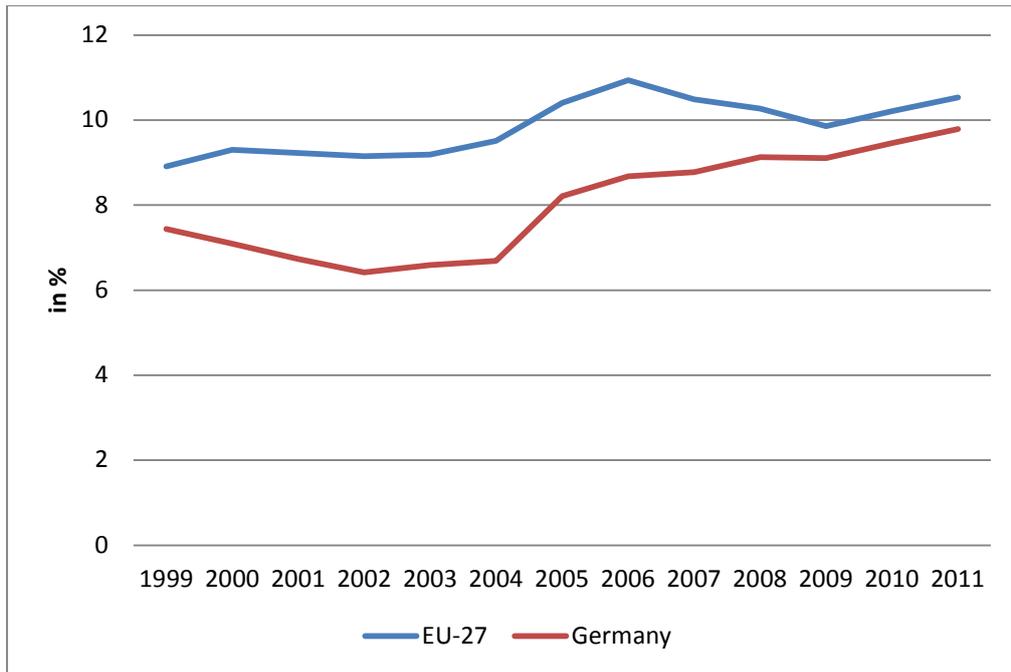
Notes: All specifications include industry and year dummies. Offshoring (narrow) is measured by the share of imported value-added from the same industry abroad. Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ — i: Industries NACE 19 and 23 are excluded as they predict failure perfectly (16 and 15 obs.) — ii: Public employer is excluded as it predicts failure perfectly (18 obs.). Industry NACE 20 is excluded as it predicts failure perfectly (17 obs.). Year 2000 is excluded as it predicts failure perfectly (168 obs.). — iii: Industries NACE 19 and 23 are excluded as they predict failure perfectly (14 and 14 obs.) — iv: Public employer is excluded as it predicts failure perfectly (2 obs.). Industries NACE 19, 20, 21, 23, 25, 26, 34, and 36 are excluded as they predict failure perfectly (2, 5, 99, 1, 32, 43, 334, and 13 obs.).

Table D2 - Random effects probit regression on dummy for unemployment in next period, 1999-2007, dummies for groups of employment duration

	(1)	(2)	(3)	(4)
	Total ⁱ	Low-skilled ⁱⁱ	Medium-skilled ⁱⁱⁱ	High-skilled ^{iv}
Offshoring	-0.109*** (0.00180)	0.0720*** (0.0129)	-0.125*** (0.00217)	-0.687*** (0.00884)
Temp contract	0.246*** (0.00469)	-0.599*** (0.0393)	0.299*** (0.00602)	-0.278*** (0.0146)
Offshoring x Temp	0.0667*** (0.000924)	0.0944*** (0.00856)	0.0921*** (0.00117)	0.220*** (0.00310)
<i>Educational attainment</i>				
Medium-skilled	-0.0991*** (0.00185)			
High-skilled	-0.647*** (0.00260)			
Age	0.0352*** (0.000201)	-0.0270*** (0.00181)	0.0512*** (0.000249)	0.0422*** (0.000535)
Married	-0.138*** (0.00170)	1.899*** (0.0218)	-0.371*** (0.00218)	0.109*** (0.00596)
<i>Employment duration:</i>				
7-12 months	0.333*** (0.00350)	1.708*** (0.0247)	0.357*** (0.00449)	0.188*** (0.00904)
13-36 months	0.0976*** (0.00320)	0.604*** (0.0224)	0.0813*** (0.00404)	0.108*** (0.00702)
37-96 months	-0.169*** (0.00323)	1.613*** (0.0284)	-0.227*** (0.00413)	-0.252*** (0.00661)
>96 months	-0.388*** (0.00326)	0.737*** (0.0283)	-0.358*** (0.00412)	-0.714*** (0.00684)
Public employer	-0.0494*** (0.00717)		-0.315*** (0.00795)	
<i>Firm size</i>				
20-199 employees	0.00443** (0.00220)	0.625*** (0.0190)	0.0294*** (0.00271)	0.202*** (0.00609)
200-1999 employees	-0.137*** (0.00231)	0.192*** (0.0174)	-0.168*** (0.00287)	0.197*** (0.00648)
> 2000 employees	-0.260*** (0.00257)	-1.365*** (0.0203)	-0.0728*** (0.00307)	-0.397*** (0.00744)
Work experience	-0.0412*** (0.000314)	-0.419*** (0.00439)	-0.0308*** (0.000383)	0.00572*** (0.000939)
Work experience ²	0.000673*** (5.20e-06)	0.00938*** (8.42e-05)	0.000191*** (6.38e-06)	-0.000286*** (1.74e-05)
Industry output	1.46e-06*** (4.71e-08)	-1.44e-05*** (3.48e-07)	4.01e-06*** (5.76e-08)	-3.50e-06*** (1.94e-07)
R&D expenditure	-7.01e-06** (2.86e-06)	0.000832*** (2.12e-05)	-0.000174*** (3.59e-06)	0.000131*** (1.02e-05)
Constant	-2.943*** (0.0169)	-0.287*** (0.0641)	-3.802*** (0.0199)	-3.335*** (0.0305)
<i>No. of observations</i>	7534	1008	4314	1473
<i>No. of groups</i>	1796	309	1156	384
<i>Log likelihood</i>	-2511469.9	-393186.6	-1636256.6	-299265.1

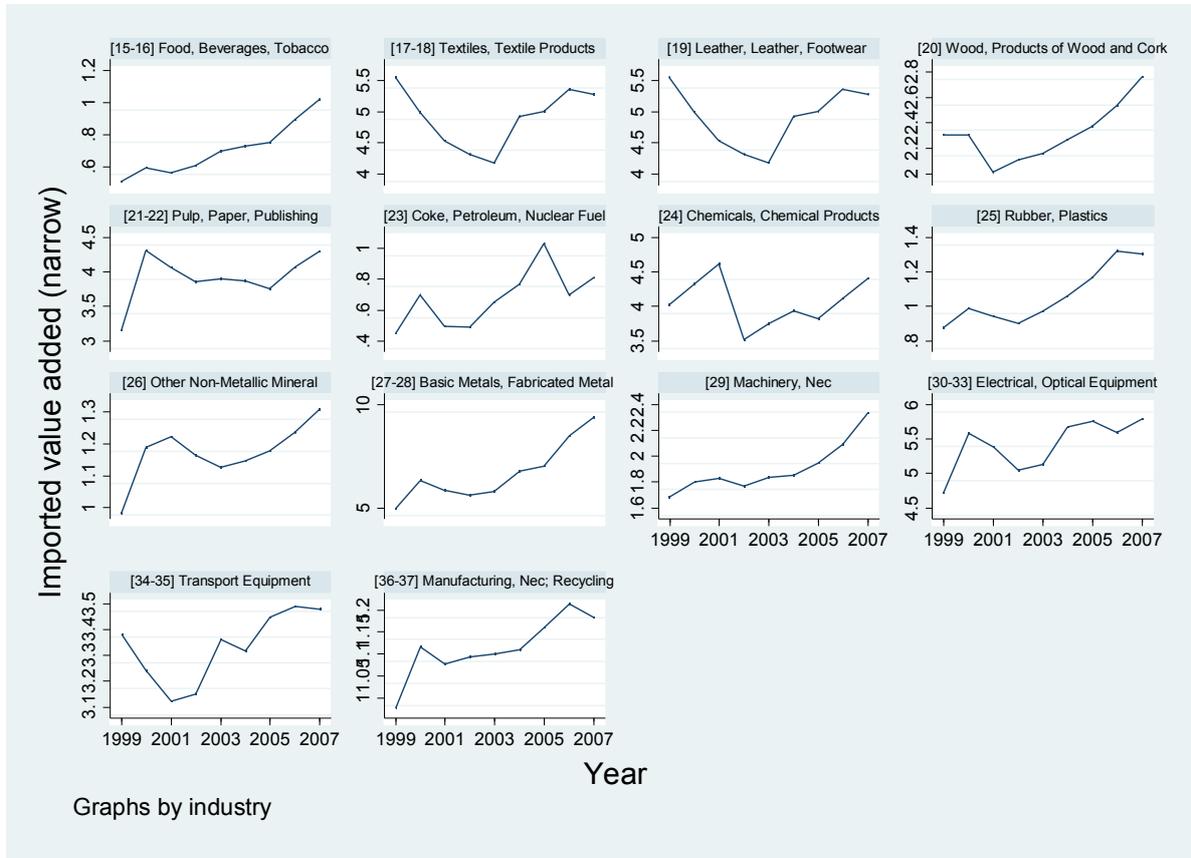
Notes: All specifications include industry and year dummies. Offshoring (narrow) is measured by the share of imported value-added from the same industry abroad. Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ — i: Industries NACE 19 and 23 are excluded as they predict failure perfectly (16 and 15 obs.) — ii: Public employer is excluded as it predicts failure perfectly (18 obs.). Industry NACE 20 is excluded as it predicts failure perfectly (17 obs.). Year 2000 is excluded as it predicts failure perfectly (168 obs.). — iii: Industries NACE 19 and 23 are excluded as they predict failure perfectly (14 and 14 obs.) — iv: Public employer is excluded as it predicts failure perfectly (2 obs.). Industries NACE 19, 20, 21, 23, 25, 26, 34, and 36 are excluded as they predict failure perfectly (2, 5, 99, 1, 32, 43, 334, and 13 obs.).

Figure 1: Share of workers holding a temporary contract in total employment



Source: Eurostat

Figure 2: Offshoring, 1999 and 2007, by manufacturing industry, in percent of output



Source: WIOD, own calculations

Table 1 – Incidence of temporary contracts, by country, 15-64 year old persons

	1999	2000	2001	2002	2003	2004	2005	2006	2007
European Union	13.3	13.6	13.5	13.2	13.1	13.5	14.5	15.1	14.6
Germany	13.1	12.8	12.4	12.0	12.2	12.5	14.2	14.5	14.6
Denmark	10.1	10.2	9.4	8.9	9.5	9.8	9.8	8.9	8.6
Spain	32.8	32.4	32.1	32.1	31.8	32.1	33.4	34.1	31.7
France	13.9	15.4	14.9	14.1	13.4	13.0	14.1	14.9	15.2
Italy	9.8	10.1	9.6	9.9	9.5	11.9	12.3	13.1	13.2
United Kingdom	6.7	6.6	6.6	6.0	5.7	5.6	5.7	5.7	5.7
United States	4.5	.	4.0	.	.	.	4.2	.	.

Source: Eurostat (LFS), OECD Employment and Labour Market Statistics (for US)

Notes: European Union refers to EU15 until 2004, EU25 until 2006, and EU27 thereafter.

Table 2 – Incidence of temporary contracts by educational attainment, Germany, 15-64 year old persons

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Primary	26.8	27.5	27.8	27.9	29.2	29.8	30.4	30.4	31.9
Secondary	8.6	8.4	8.0	7.9	7.9	8.0	9.7	10.0	10.2
Tertiary	7.9	7.4	7.2	6.5	6.9	7.0	7.8	8.2	8.0

Source: Eurostat (LFS)

Notes: Primary education refers to ISCED levels 0-2, secondary refers to ISCED levels 3-4, tertiary refers to ISCED level 5-6.

Table 3 – Average share of imported value added (offshoring) in total production, manufacturing industries.

Year	Imported value added		
	Total	From high-wage countries	From low-wage countries
1999	3.60	2.70	0.91
2000	3.95	2.78	1.17
2001	3.83	2.68	1.14
2002	3.64	2.53	1.11
2003	3.77	2.53	1.23
2004	4.04	2.65	1.39
2005	4.12	2.69	1.43
2006	4.44	2.78	1.66
2007	4.79	2.92	1.87
Change 1999-2007	1.19	0.23	0.96

Notes: The WIOD countries are allocated as follows. High-wage countries include OECD countries (except Mexico, Turkey, and Middle and Eastern countries), as well as Taiwan. Low-wage countries include non-OECD countries (except Taiwan), Mexico, Turkey, Middle and Eastern European countries.

Table 4 – Fixed effects regression on log hourly wage, 1999 – 2007,

Dependent variable: log hourly wage (from CNEF, no imputed values, implausible values excluded (> 2 s.d.))

	(1)	(2)	(3)	(4)
	Total	Low-skilled	Medium-skilled	High-skilled
Offshoring	0.00909 (0.0104)	-0.0128 (0.0196)	0.00889 (0.0121)	0.0130 (0.0266)
Temp contract	0.00166 (0.0477)	-0.143 (0.106)	0.0141 (0.0531)	-0.0381 (0.0920)
Offshoring x Temp	-0.0157 (0.0100)	0.0349 (0.0234)	-0.0206* (0.0113)	-0.00648 (0.0158)
<i>Educational attainment</i>				
Medium-skilled	-0.00321 (0.0237)			
High-skilled	0.0728 (0.0446)			
Married	0.0303 (0.0316)	0.0793 (0.0625)	-0.0341 (0.0362)	0.117*** (0.0350)
Employment duration	-0.00118 (0.00253)	0.00685 (0.00796)	0.000142 (0.00315)	-0.00548 (0.00444)
Public employer	0.0459 (0.0417)	0.121 (0.0860)	0.0217 (0.0290)	-0.168** (0.0655)
<i>Firm size</i>				
20-199 employees	0.0169 (0.0408)	-0.0319 (0.0793)	0.0188 (0.0495)	-0.0128 (0.0616)
200-1999 employees	0.0724 (0.0447)	0.00768 (0.0831)	0.0979* (0.0576)	-0.00984 (0.0683)
> 2000 employees	0.0681 (0.0490)	-0.00735 (0.0899)	0.130** (0.0567)	-0.0307 (0.0807)
Work experience	0.113*** (0.0263)	0.122*** (0.0379)	0.0710* (0.0419)	0.207*** (0.0549)
Work experience ²	-0.000454*** (0.000122)	-0.000298 (0.000183)	-0.000255** (0.000127)	-0.00102** (0.000416)
Industry output	1.94e-07 (2.45e-07)	4.59e-07 (5.61e-07)	3.46e-07 (3.53e-07)	-3.63e-07 (5.09e-07)
R&D expenditure	4.16e-06 (1.30e-05)	-9.58e-06 (3.02e-05)	-8.20e-06 (2.00e-05)	2.52e-05 (1.97e-05)
Average fixed effect	0.717 (0.452)	0.262 (0.732)	1.365* (0.707)	0.329 (0.866)
<i>No. of observations</i>	6074	1012	3547	1515
<i>No. of groups</i>	1515	295	962	416
<i>R2 within</i>	0.116	0.190	0.0921	0.202

Notes: All specifications include industry and year dummies. Offshoring (narrow) is measured by the share of imported value-added from the same industry abroad. Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 –Marginal effects after random effects probit estimation, regression coefficient in Table D2

	(1)	(2)	(3)	(4)
Contract type	Total	Low-skilled	Medium-skilled	High-skilled
Permanent	-0.00276*** (0.0000466)	0.000696*** (0.000125)	-0.00365*** (0.0000650)	-0.0147*** (0.000195)
Temporary	-0.00284*** (0.000129)	0.00124*** (0.000115)	-0.00322*** (0.000234)	-0.0305*** (0.000658)
<i>N</i>	7534	1008	4314	1473

Notes: Average marginal effects, standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.