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**WINNERS AND LOSERS: A MICRO-LEVEL ANALYSIS OF INTERNATIONAL OUTSOURCING AND WAGES**

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# WINNERS AND LOSERS: A MICRO-LEVEL ANALYSIS OF INTERNATIONAL OUTSOURCING AND WAGES

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## ABSTRACT

# Winners and losers: A Micro-level Analysis of International Outsourcing and Wages

Our paper investigates the link between international outsourcing and wages utilizing a large household panel and combining it with industry level information on industries' outsourcing activities from input-output tables. This approach avoids problems such as aggregation bias, potential endogeneity bias and poor skill definitions that commonly hamper industry-level studies. We find that outsourcing has had a marked impact on wages. Applying two alternative skill classifications we find evidence that a one percentage point increase in outsourcing reduced the wage for workers in the lowest skill categories by up to 1.5% while it increased wages for high-skilled workers by up to 2.6%. This result is robust to a number of different specifications.

JEL Classification: F16 and J31
Keywords: international outsourcing, offshoring, skills and wages

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# 1 Introduction

International outsourcing is a growing phenomenon in world trade and has sparked a lot of interest in the recent academic literature and business press.[1] Hummels, Ishii and Yi (2001) provide evidence for the worldwide importance of outsourcing from data collected for 10 OECD and four emerging market countries. They find that trade in outsourced components in the vertical production chain accounts for around 21 percent of these countries' exports. Moreover, international outsourcing grew very strongly by approximately 30 percent between 1970 and 1990.[2]

Given that the increase in international outsourcing coincided with deteriorating relative wages and employment chances for low skilled workers in many developed countries, much research has been devoted to assessing the impact of this disintegration of production on domestic labor markets. Most of these studies, as reviewed by Feenstra and Hanson (2001), investigate the impact of international outsourcing by estimating the relative demand for skilled labor derived from a cost function, or mandated wage regressions using aggregate industry-level data. However, outsourcing has implications for micro units (firms or workers) which should arguably be studied using micro level data in order to take into account individual heterogeneity.[3]

Our paper pays particular attention to the role of individual heterogeneity for the impact of international outsourcing on workers. In particular, we investigate the link between outsourcing and wages utilizing a large household panel and combining it with industry level information on industries' outsourcing activities measured as imported material inputs constructed from input-output tables.[4] Hence, we directly assess the effects of international outsourcing on wages at the level of the individual, controlling for observable and unobservable worker characteristics. In particular, our attention focuses on the role of individual skill levels for the effect of outsourcing on wages. To the best of our knowledge this is the first study to do so using micro-level data.

One of the main contributions of our study is that the use of micro-level data enables us to identify winners and losers from international outsourcing among workers with different skills in absolute terms. This is a highly policy relevant issue, which cannot be addressed by merely analyzing relative demand changes as in e.g., Feenstra and Hanson (1996b, 1999). Also, we extend the literature by employing more accurate definitions of workers' skill levels than the commonly used production vs. non-production workers differentiation (see, e.g., Feenstra and Hanson, 1996b and Berman, Bound and Machin, 1998.) In addition, we can overcome the potential aggregation bias inherent in industry-level studies by directly controlling for individual observed and unobserved heterogeneity.[5]

Our empirical analysis uses data from the large German Socio-Economic Panel Study (GSOEP), which is described in some detail below, combined with industry level data for the period 1991 to 2000.[6] Germany is an interesting case to analyze, as there is a general consensus that relative wages of high- vs. low-skilled workers have remained virtually unchanged since the 1980s, even though outsourcing of activities has increased substantially during the 1990s, probably aided by the opening up of low-wage Eastern and Central European markets which provided potential for outsourcing.[7] Still, Germany is a highly regulated labor market, both in terms of price of labor (through unionization) and quantity (through high levels of employment protection) and therefore adjustment may go through either, both or none channel. However, international outsourcing may give particular rise to wage moderation in bargaining between firms and unions if, for example, it corresponds to improved outside options for employers. This may be especially true for Germany where employment is highly protected. Thus, even if wages are relatively rigid in Germany they may still adjust if faced with increasing outsourcing pressure.

Against the background of nearly constant relative wages on aggregate, we find from our individual level data that international outsourcing has, nevertheless, had a marked impact on wages. Distinguishing three skill categories that comply with the International Standard Classification of Education (ISCED) we find evidence that outsourcing reduced the real wage for workers in the lowest skill categories; the results are similar in terms of magnitude and statistical significance, when instead applying a skill grouping that is based on required on the job skills rather than educational attainment. Furthermore, we find evidence that high-skilled workers experienced increased wages due to international outsourcing.

The remainder of the paper is structured as follows. Section 2 reviews briefly the theoretical and empirical literature on international outsourcing and labor markets. Section 3 highlights recent labor market trends and motivates our empirical study. Section 4 introduces the empirical model and Section 5 discusses the data set. Section 6 presents the empirical findings and Section 7 considers some robustness checks. Section 8 evaluates the economic significance of our estimates and Section 9 concludes.

## 2 International outsourcing and wages

The causes and consequences of international outsourcing have attracted considerable interest in the theoretical literature. While papers like Feenstra and Hanson (1996b) and Kohler (2004b) stress the importance of international differences in relative prices as driving force of outsourcing, Jones and Kierzkowski (2001) and Harris (2001), for example, focus on the role of exogenous reductions in general services and telecommunications costs for allowing outsourcing to occur. The consequences of outsourcing for local labor markets are not clear cut in theory, however. For example, Feenstra and Hanson (1996a) formulate a model of international outsourcing that is a specific form of a Heckscher-Ohlin type model with only one final good and two countries, North and South. By changing relative unit costs of production, for instance through Hicks-neutral technological progress in the South, production fragments with lower skill intensity are shifted from the North to the South, thereby raising the average skill intensity of production in both countries. As a results, relative demand for skilled labor increases in both the North and the South. By contrast, Arndt (1997, 1999), develops a model of international outsourcing that is also based on a HO framework but makes less restrictive assumptions.

In particular, he considers trade between a small price-taking economy and the rest of the world, allowing for two factors of production and two final goods. In this model, if the low skill intensive industry shifts some fragments of production abroad, this results in a productivity improvement in the low skill intensive industry and with given world prices, ultimately in higher relative wages for skilled workers. Hence, depending on the models and assumptions chosen, outsourcing of the low skill intensive part of production can lead to decreases or increases in the wage of (unskilled) labor in the outsourcing economy.[8] Whether workers in practice gain or lose from international outsourcing is, therefore, essentially an empirical question.

One of the first systematic empirical studies on the labor market impact of international outsourcing is Feenstra and Hanson (1996a). In their study for the United States they estimate a factor share equation for an industry panel of more than 400 industries. In the model international outsourcing, approximated by the industries' import penetration ratios, is implemented as a shift parameter similar to technological progress. Following this procedure, the authors report that approximately 15% to 33% of the increase in the cost share of non-production labor over the period 1979-1987 can be explained by international outsourcing. An extension to this study is Feenstra and Hanson (1996b) which uses a more precise outsourcing definition based on imported intermediate inputs and calculates that approximately 31% to 51% of the increase of the cost share of non-production labor over the same period can be explained by international outsourcing. In a follow-up study Feenstra and Hanson (1999) apply a narrower definition of international outsourcing by focusing on imported intermediate inputs of an industry from the same industry abroad. According to this study, international outsourcing can explain between 11% and 15% of the observed decline in the cost share of production labor in U.S. manufacturing between 1979 and 1990. Morrison-Paul and Siegel (2001) extend the above studies by simultaneously incorporating several trade and technology related measures that can shift relative labor demand in a system of factor demand equations. Their results suggest that international outsourcing as well as trade and technological change significantly lowered relative demand for low-skilled labor.

Falk and Koebel (2002) present an analysis of the effect of outsourcing on wages using industry level data for Germany. They use a Box-Cox cost function, which nests the normalized quadratic as well as the translog functional form, and estimate elasticities of substitution from a system of input-output equations. International outsourcing is implemented in the model as a flexible choice variable captured by relative prices for imported intermediate goods and purchased services. Their findings suggest that between 1978 and 1990 neither imported material inputs nor purchased services substitute for unskilled labor in German manufacturing industries.[9]

Our approach differs significantly from the previous empirical studies and may be considered suitable to overcome some of the shortcomings associated with using industry level data. Utilizing a large household panel, we incorporate the industry's international outsourcing activity as a shift parameter in a Mincerian (Mincer, 1974) wage model. This approach has substantial advantages over an industry level analysis, as it allows controlling for individual observed and unobserved heterogeneity thereby avoiding aggregation bias. In addition, changes in relative earnings can now be decomposed into wage gains and losses for different skill groups. Furthermore, since the industry's outsourcing activities may be largely considered exogenous to the individual, endogeneity bias due to simultaneous determination of labor demand and international outsourcing at the industry level may arguably be to some extent reduced.

Given the nature of our econometric estimation our results should be interpreted as the short run effects of international outsourcing on wages of individuals within industries. Hence, we can think of our approach as essentially partial equilibrium, in line with the theoretical one sector setting of, e.g., Feenstra and Hanson (1996a). This is consistent with a short run view of the economy such that labor is immobile between industries. Many previous industry-level studies implicitly or explicitly make the same assumption (e.g., Feenstra and Hanson, 1996a; Morrison-Paul and Siegel, 2001; Hsieh and Woo, 2005).Clearly, this assumption is only plausible in the short run. To get an idea of how restrictive this assumption is we calculated the number of respondents in our sample that indeed moved between industries, these are reported in Table 4. As is apparent, the number of switchers is low. Between 1991 and 2000 only 253 individuals left manufacturing and of those respondents who stayed in manufacturing only 207 changed industry. Thus, even for a period of 10 years the short-run assumption arguably is not too problematic.

**[Table 4 about here]**

Similar to Feenstra and Hanson (1996b) and Feenstra and Hanson (1999) we construct outsourcing on the basis of input-output data. Specifically, we apply a narrow and a wide definition such that:

$$OUT_{jt}^{narrow} = \frac{IMP_{jt}}{Y_{jt}} \quad (1)$$

$$OUT_{jt}^{wide} = \frac{\sum_{j=1}^{J} IMP_{jt}}{Y_{jt}} \quad (2)$$

with j denoting the respective two-digit manufacturing industry ($j \epsilon J$), $IMP$ the value of imported intermediate inputs from a foreign industry and $Y$ the industry's output value. Hence, narrowly defined outsourcing only captures an industry's imported intermediate inputs from the same industry abroad while broadly defined outsourcing incorporates all imported intermediate manufacturing goods of an industry.

In comparison to Feenstra and Hanson we can directly differentiate between imported and domestic inputs in the German input-output tables rather than having to rely on aggregated input-use data. However, this advantage of our data also comes with a disadvantage. We are only able to calculate this measure for 21 two-digit industries, while Feenstra and Hanson identify intermediate inputs for over 400 four-digit industries, albeit not differentiating between domestic and imported inputs. It is, however, important to stress that our more aggregated data do not result in a different concept of narrow and wide outsourcing as in Feenstra and Hanson (1999) such differentiation also only takes place at the two-digit level.[10]

A further difference to Feenstra and Hanson (1996b) and Feenstra and Hanson (1999) refers to the denominator in Equations 1 and 2. While, Feenstra and Hanson express industry-level intermediate imports as a share of total non-energy input purchases we normalize by industry-level output instead. Thus, in addition to non-energy input purchases our denominator includes value added and energy purchases. Our main motivation is to separate domestic and international outsourcing. A trend towards domestic outsourcing, i.e. increased purchases of intermediate goods from domestic suppliers, ceteris paribus lowers the international outsourcing intensity in the formulae employed by Feenstra and Hanson (1996b) and Feenstra and Hanson (1999). Our measures are better suited to corrects for this problem as, abstracting from overall efficiency gains, increasing industry-level domestic purchases are countered by decreasing industry-level value added.

# 3 Recent labor market trends and international outsourcing

It is well established that relative earnings of low skilled workers have decreased in most OECD countries during the last two decades. However, wage trends are far from uniform across countries with the US and Great Britain experiencing very strong increases in the wage dispersion, and countries such as Australia, Canada, Japan and Spain only experiencing modest decreases in the relative earnings of low skilled workers (see Freeman and Katz, 1995; OECD, 1994 for a detailed discussion).

In this study we focus on the German labor market which is an interesting case since it is not only the largest economy in Europe, but it is also far more open to international trade than for instance the U.S. and has a fairly rigid labor market. Furthermore, political and economic transition in the former communist Central and Eastern European countries (CEEC's) during the 1990's now allows for intensive production sharing with these economies at Germany's doorstep with potentially large implications for the German labor market. Nonetheless, considering the wage distribution in Germany, abundant empirical evidence suggests that relative wages of the low skilled have virtually not changed or have even increased since the 1980's (see Fitzenberger, 1999; Prasad, 2004; Beaudry and Green, 2003).

Our own analysis on the basis of our sample from the German Socio-Economic Panel (which will be discussed in more detail in Section 5) for the years 1991-2000 also fails to identify significant changes in the earnings distribution between different skill groups, which is in line with the literature. Figure 1 shows median wages and wages of the 10th and 90th percentile for low, medium and high skill workers. As becomes apparent, there is considerable variation in wages across the three skill categories. In addition, while we observe some wage variation within skill groups over time there is no general upward or downward trend.

[**Figure 1 about here**]

Against this background, international outsourcing in German manufacturing has grown substantially. Figure 2 shows the development of international outsourcing during the 1990's for the manufacturing industry as a whole. As can be seen, narrowly defined international outsourcing (as in Equation 1) increased by around 60 percent between 1991 and 2000 while broadly defined outsourcing grew somewhat slower by 45 percent over the same period. Table 1 shows the differences in levels and growth rates of international outsourcing by two digit NACE industries. Even though international outsourcing is of very different importance for the separate industries and the dynamic patterns vary considerably, almost every industry shows significant growth in the outsourcing activity.

[**Figure 2 and Table 1 about here**]

Thus, constant relative earnings for low-skilled workers coincide with pronounced increases in international outsourcing which at first sight casts doubt on a connection between relative earnings and outsourcing. However, relative earnings can be determined by a whole range of demand and supply factors that might cancel each other out. A thorough analysis of the impact of international outsourcing on the wage distribution therefore requires simultaneous controlling for other important determinants of the wage structure.

# 4 The Empirical Model

In order to analyze more rigorously the impact of international outsourcing on wages we estimate variants of the following log wage equation:

$$\begin{aligned} ln\, WAGE_{ijt} &= \alpha + \beta\ DEMOG_{it} + \gamma\ WORK_{it} + \delta\ EDUC_{it} \\ &+ \theta\ IND_{jt} + \lambda\ OUT_{jt} + \tau_j + \mu_t + \iota_i + \epsilon_{it} \end{aligned} \quad (3)$$

where $WAGE_{ijt}$ denotes individual i's hourly wages in industry j, which are defined in the next section below.

We apply control variables that are standard in such wage regressions, see for example Mincer (1974), Brown and Medoff (1989), Schmidt and Zimmermann (1991). $DEMOG$ denotes the demographic control variables for age, marital status, geographic region. The second set of control variables ($WORK$) contains characteristics related to the workplace such as size and ownership of the firm and tenure. A third set of control variables ($EDUC$) contains educational dummies for high education ($ISCED : high$) and medium ($ISCED : low$) education, low education ($ISCED : low$) is the omitted category. We also control for time changing industry characteristics ($IND$) by including the size of the industry (measured in terms of output) and two types of capital (plant and equipment).

We subsequently incorporate a narrow and a wide definition of international outsourcing ($OUT$) as in Equations 1 and 2. The error term is decomposed into general industry specific effects ($\tau_j$) and general time specific effects ($\mu_t$) which we estimate with a full set of industry dummies and time dummies respectively. This also enables us to control extensively for time invariant industry level wage determinants other than those captured by our outsourcing variable ($OUT$) and the additional time varying industry variables.

One key challenge for our analysis is to distinguish the effects of international outsourcing from the effects of technological change. In addition to the general time dummies that capture manufacturing wide technological progress and business cycles we make full use of the three data dimensions and include a full set of industry specific time trend variables that capture industry level technological changes that depart from manufacturing wide trends.

Furthermore, we allow for individual fixed effects ($\iota_i$) that take account of unchanging observable and unobservable individual characteristics.[11] The remaining error term ($\epsilon_{it}$) is assumed to be normally distributed. All regressions are weighted using the standard GSOEP cross-sectional sampling weights to adjust for different individual sampling probabilities.[12]

Combining individual and industry level data could give rise to contemporaneous correlation that results in distorted standard errors as discussed in Moulton (1990). As has become standard in the literature we therefore adjust the standard errors to allow for an unspecified correlation of error terms across individuals within the same industry. One further potential problem casting doubt on the validity of our results could arise from sample selection. We expect outsourcing not only to affect wages but also employment. As workers become unemployed we cannot observe their wages, thus our sample potentially is incidentally truncated. Within the context of our fixed effects estimation sample selection bias should, however, only be a problem if selection and the idiosyncratic errors are correlated. We apply a sample selection test that is suggested by Wooldridge (1995) and which extends Heckman (1976) to the fixed effects context. In a first step we estimate a reduced form selection equation by pooled weighted probit including all explanatory variables plus the mean of the respective explanatory variables. In a second step we estimate the fixed effects wage equation including the inverted mills ratio from the selection equation. Selection bias is only an issue if the inverse mills ratio is statistically significant. We, however, can reject this in all model specifications as the t-statistics in Tables 5-7 indicate. Accordingly, we do not have to correct for selection bias and all specifications reported in Tables 5-9 exclude the inverted mills ratio.

In addition, the estimated coefficients potentially could be biased if wages and international outsourcing were determined simultaneously. Particularly for industry level studies this is a common concern. However, for our analysis we utilize micro level data. While it is true that in Germany wages are generally bargained collectively, collective bargaining merely sets a wage floor. Individual earnings can differ significantly from these *minimum wages*. As a result there is substantial variation of hourly earnings at the individual level. Arguably the industry level outsourcing intensity can therefore be considered as largely exogenous to the individual wage. Nevertheless, we formally test for the exogeneity of outsourcing using lagged values of outsourcing as instruments. As becomes apparent from Table 5, while our instruments prove to be valid a C-test cannot reject the exogeneity of international outsourcing within reasonable confidence bounds.

## 5 Data

The analysis is based on data from Sample A, B, C, D and E from the German Socio Economic Panel (GSOEP) for the years 1991 to 2000.[13] We exclude respondents who report to work in East Germany as wages in the East are to a large extent shaped by the dramatic 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 such as outsourcing.

We restrict our sample to prime age (18 to 65 years) male blue and white collar workers in full time employment over the whole period in the manufacturing industry (NACE 15-36). As is well known, female workers have substantially different labor market outcomes than males and, hence, as is common in the literature we focus exclusively on males.

In order to maximize the number of observations, we choose an unbalanced design of the sample. The sample therefore covers 1754 individuals yielding a total number of 7624 observations. In order to avoid selection bias with respect to item non-response that might be not completely at random each explanatory variable was supplemented with a dummy for missing values. Subsequently, missing values where recoded to zero and the generated dummies for missing values also act as regressors in the model.[14]

Wages are defined as average hourly gross labor earnings including bonuses, premiums and other extra payments over the year preceding the respective interview month. Gross yearly wages and yearly working hours are derived from the cross national equivalent files (CNEF). Observations with missing wage information were excluded from the sample, hence we disregard observations with imputed wage information in the subsequent analysis.[15]

We apply two different skill definitions that only partly overlap. A description of the alternative skill groupings can be found in Table 2. Firstly, we utilize internationally comparable information following the International Standard Classification of Education (ISCED)[16]. Secondly, we apply an alternative skill grouping based on the respondents information on the qualification that their current job actually requires. Applying this alternative skill grouping is an interesting extension since it takes account of the actually demanded qualification by employers as opposed to the supplied qualification by employees.

[**Table 2 about here**]

Table 3 shows the skill structure, based on the ISCED classification, within each manufacturing industry and the employment share of the respective industry.

Industry level data on international outsourcing were obtained from imported input use tables provided by the German Federal Statistical Office. Intermediate inputs corresponding to narrowly defined international outsourcing are represented by the main diagonal of the input-matrix for imports. Intermediate inputs corresponding to the wide definition are represented by the column sum of imported intermediate inputs from manufacturing industries. Data on industry output and plant and equipment were obtained from the German Federal Statistical Office.

**[Table 3 about here]**

## 6 Results

The results of estimating different specifications of Equation 3 using a fixed effects estimator to allow for time invariant individual specific effects and applying the ISCED skill definition are reported in Tables 5-6. The regressions include full sets of industry and time dummies.

Table 5 presents the results from pooled estimations over all individuals. The coefficients on the individual and firm-level control variables generally have the expected sign but only age (in a non-linear fashion) and education are found to be significant. One potential explanation for the lack of significant coefficients is that there are differences in the effects across different types of workers. [17] Another is that the individual fixed effects wipe out most of the variation in variables. This may, for example, explain the statistically insignificant result on tenure which for most individuals in our sample is just a linear trend.

The variable of interest to us is, of course, the measure of international outsourcing, while all other variables are merely included to control for individual heterogeneity. Column (a) in Table 5 reports results for the narrow measure of outsourcing as defined in Equation 1, while column (d) is for the wide measure as in Equation 2. As can be seen, in these regressions we find statistically significant negative effects of international outsourcing on wages. However, when allowing for different coefficients across skill groups by interacting outsourcing and education, we find a small but statistically significant negative effect of outsourcing on wages for medium (at the 10% level) and low-skilled workers while for high skilled workers the effect is rendered insignificant (Columns (b) and (e)).

In a further specification we test the robustness of these findings by more thoroughly controlling for time changing industry characteristics such as technological change. Arguably, technological change is an important determinant of labor demand but, however, is difficult to control for empirically since measures such as research and development expenditure constitute only crude proxies. In the specifications reported in Column (c) and (f) we make use of all panel dimensions and include industry specific time trends in an effort to allow for industry specific technological change that departs from the common pattern as captured by the set of time dummies. Both, time dummies and industry specific time trends are jointly significant in all specifications. With respect to international outsourcing, we now only find a statistically significant effect for low-skilled workers when applying the wide definition of international outsourcing (see Column (f)).

**[Table 5 about here]**

We now relax the assumption of equal coefficients on all covariates across different skill groups by estimating the model separately for each skill group. Hence, we allow for differences in the wage determination for different skill groups as well as skill specific unobserved industry characteristics.

Again, we incorporate a full set of year and industry dummies and also include industry specific time trends. Table 6 depicts the estimation results with narrowly and broadly defined outsourcing for each skill group. Notably, the coefficients on the individual and firm level variables differ significantly between the estimations for the different skill groups. Constraining the coefficients to be uniform across skill groups therefore indeed seems not appropriate.[18]

With regard to the impact of outsourcing the coefficients also differ substantially from the previous specification (compare Table 5 and Table 6). For high-skilled workers the coefficient of narrowly defined outsourcing is now found to be statistically significant and positive with a one percentage point increase in the outsourcing intensity ceteris paribus yielding a positive wage premium of about 2.6 percent. For broadly defined outsourcing the effect is somewhat smaller but still statistically significant (see Table 6 Column a and d). Hence, international outsourcing appears to raise the wage for high skilled workers, a finding that is in line with the idea that firms outsource the low skill intensive parts of production and, hence, increase the relative demand for skilled workers. For medium- and low-skilled workers we find negative coefficients on the outsourcing intensity, which is also in line with this reasoning. However, these coefficients are only statistically significant for low skilled workers. A one percentage point increase in the industries outsourcing intensity lowers wages for low-skilled workers by 1.5 and 1.3 percent for narrowly and broadly defined outsourcing respectively.[19]

**[Table 6 about here]**

## 7 Robustness checks

This section briefly considers some extensions of the empirical model in order to check the robustness of our results.

Firstly, in order to check how robust our results thus far are to different skill definitions, we apply an alternative skill measures based on self reported required qualifications for the respondents current job (See Section 5 and Table 2) and estimate the impact of narrow and wide outsourcing for each skill group.

The results for this skill definition support our findings. International outsourcing, both narrow and wide, has a statistically significant positive impact on workers who report that their job requires a college or technical school training. For example, a one percentage point increase in the narrow outsourcing intensity ceteris paribus raising wages by about 2 percent. For workers with lower required qualifications we find a statistically significant negative effect of outsourcing with a one percentage point increase in narrow outsourcing yielding a wage loss of around 1.2 percent, all other things equal (see Table 7).

**[Table 7 about here]**

Secondly, we consider the impact of domestic outsourcing as well as international outsourcing in our model context. We construct a measure of narrow domestic outsourcing similar to the international outsourcing variable in Equations 1, however instead using domestic intermediate inputs from input-output use tables.

$$DOMOUT_{jt}^{narrow} = \frac{DOM_{jt}}{Y_{jt}} \quad (4)$$

with j again denoting the respective two-digit manufacturing industry ($j \epsilon J$), $DOM$ the value of domestic intermediate inputs and $Y$ the industry's output value.

We then proceed to estimate two specifications of the model, one with domestic outsourcing only and one controlling for domestic and international outsourcing simultaneously. For this analysis we use the ISCED skill classification. The results are reported in Table 8.

As is apparent, domestic outsourcing is always rendered insignificant for all skill groups. Furthermore, in the model controlling for domestic and international outsourcing simultaneously, the point estimates on the coefficient on international outsourcing are not significantly altered, supporting our findings reported above. However, for high-skilled workers the formerly weakly statistically significant coefficient on international outsourcing is now insignificant pointing to some multicollinearity issue.

[**Table 8 about here**]

A last robustness check considers the impact of technological change on our estimates. As pointed out above, we are confident that the inclusion of time and year dummies, as well as industry specific time trends provide comprehensive controls to capture technological change. Still, as a robustness check we also include industry level research and development spending in order to capture non-linear industry specific technological change.

Before reporting the results of this exercise it is, however, important to mention that data on research and development expenditure for German industries are notoriously sketchy. The OECD publishes annual R&D data at the two digit industry level starting in 1995. However, research and development data for Germany is collected only biannually by the *Stifterverband für die deutsche Wissenschaft.* Thus, the published yearly OECD data already involves some imputations.[20] Clearly, this is already somewhat unsatisfactory and casts doubt on whether much is gained by including R&D intensity as an additional control variable to our model with industry specific time trends.

Nevertheless, Columns (a) to (c) of Table 9 report the estimated coefficients for high, medium and low-skilled workers in the augmented model. R&D intensity, measured as industry research and development expenditure over industry output is always rendered statistically insignificant. Furthermore, although the outsourcing coefficients are somewhat smaller (particularly for high-skilled workers) than before our general findings still hold: high skilled workers experience significant wage gains while low-skilled workers suffer wage losses due to outsourcing.

In a further model specification reported in Columns (d) to (f), we re-estimate the augmented model but exclude industry-specific time trends. Again, R&D intensity is always rendered insignificant indicating the weak predictive power of the variable. Hence, the inclusion of this variable does not improve our estimates - possibly due to the low quality of the data - and hence we prefer our previous estimations which capture manufacturing wide technological progress in a nonlinear fashion via time dummies and industry specific technological progress at least in a linear way.[21]

**[Table 9 about here]**

# 8 Economic significance

In order to get a better idea of the true impact of international outsourcing we calculate cumulative marginal effects based on the statistically significant results in Table 6 and the change in the intensity of international outsourcing over the years 1991 to 2000. Basically this amounts to multiplying the percentage point change in the outsourcing intensity starting from the basis year 1991 with the point estimate of the outsourcing variable from the wage regression and the average wage for each respective skill group in 1991. Overall the narrowly defined outsourcing intensity increased by 3 percentage points between 1991 and 2000. Applying the wide outsourcing definition the increase was about 5 percentage points.[22]

For low skilled workers, applying the ISCED definition, we calculate that between 1991 and 2000 increased outsourcing accounts for a reduction in hourly earnings by 0.66 Euro and 0.86 Euro for narrowly and broadly defined outsourcing respectively. For an average low-skilled worker with, lets say, 1600 working hours per year this amounts to a earnings loss of respectively 1055 Euro and 1376 Euro due to increased outsourcing (see Figure 3).

**[Figure 3 about here]**

On the other hand high skilled workers significantly gained from increased outsourcing. On average their hourly wages increased by about 1.98 Euro and 2.21 Euro in 2000 as compared to 1991 due to outsourcing. Again, with assumed 1600 working hours per year this amounts to a earnings gain of 3168 Euro and 3536 Euro for narrow and wide outsourcing respectively (Figure 4).

**[Figure 4 about here]**

Figures 5 and 6 show similar calculations for our alternative skill definition based on actual on the job skill requirements. Again, comparing hourly wages of low skilled workers in 1991 and 2000, increased international outsourcing accounts for a hourly wage reduction of 0.57 Euro and 0.86 Euro. High skilled workers, however, significantly gained, with increased outsourcing raising hourly wages by 1.58 Euro to 2.1 Euro.

**[Figures 5 and 6 about here]**

# 9 Conclusion

This paper adds to the literature on the implications of outsourcing for labor markets by investigating the effect of international outsourcing, measured in terms of imports of intermediates, on wages for different skill groups. To the best of our knowledge, this is the first paper to look at this issue by using individual level data which makes it possible to control for compositional changes of the workforce and to estimate the gains and losses for accurately defined skill groups in absolute terms.

Our results show that outsourcing has a marked impact on wages. We find evidence of a negative effect of outsourcing on the real wage for low-skilled workers. We also find evidence that high-skilled workers gain from outsourcing in terms of receiving higher wages. These results are robust to a number of different specifications and definitions of outsourcing.

This suggests that low-skilled workers are the losers from this form of globalization of production, while high-skilled workers are, on average, the group that may be able to gain. This may have implications for policy makers, who need to debate whether losers should be compensated or in any other way be the focus of policies aimed at easing the adjustment cost of globalization.[23]

Our results of course raise the question as to how the relative wages of skilled to unskilled workers could have remained relatively unchanged if outsourcing has had this opposing effect? While a thorough investigation of this issue is beyond the scope of this paper, recent research has brought up two possible explanations. Firstly, Krueger and Pischke (1997) find that the returns to skills in Germany fell over the 1980s and this would thus have had a mediating effect on increases in wages for skilled workers. Secondly, Beaudry and Green (2003) argue that Germany has been able to avoid increases in wage inequality by following a path of balanced growth in the ratio of physical to human capital as opposed to the US where the accumulation of physical capital was too slow. Evaluating these explanations in the context of our findings is a priority for further research.

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## Notes

[1]For example, Jones and Kierzkowski (2001) provide examples from IT, car manufacturing, sport shoe manufacturing etc.

[2]See Chen, Kondratowicz and Yi (2005) for further discussions of the growth of international outsourcing.

[3]There are a few exceptions in the literature which have used micro level data. See, for example, Head and Ries (2002) and Görg and Hanley (2005) using firm level data for Japan and Ireland, respectively, to investigate the impact of outsourcing on labor demand in a firm and Egger, Pfaffermayr and Weber (2007) and Geishecker (2007) analyzing the impact of industry-level international outsourcing on individual employment transitions.

[4]A related issue is outsourcing of services which has attracted some interest in the case of the US and the UK but which is beyond the scope of

our study. Interested readers are referred to Amiti and Wei (2005).

[5]Furthermore, combining individual-level and industry-level data arguably also helps to reduce the potential endogeneity of the outsourcing measure as the assumption that individual heterogenous wages are unlikely to affect industry-level aggregates is less heroic than the assumption necessary in the literature using aggregate data that industry level relative wages are not affecting industry-level outsourcing measures.

[6]See, for example, Hunt (2001) and Krueger and Pischke (1995) for analyses using this data set in different contexts.

[7]See, for example, Geishecker (2006).

[8]See also Jones and Kierzkowski (2001) and Kohler (2004a) for other related theoretical papers.

[9]Their approach can be criticized since the impact of international outsourcing is only captured by relative price changes for imported intermediate inputs. However, intensified international outsourcing is consistent with unchanging or even increasing observed relative prices for imported intermediate inputs. Factors such as trade liberalization, the opening up of former communist states or new advances in communication technologies reduce the costs of outsourcing. These developments are not necessarily reflected in relative prices for intermediate goods if previously outsourcing costs were prohibitive.

[10]Recent studies by Hsieh and Woo (2005) and Hijzen, Görg and Hine (2005) also use outsourcing measures calculated at levels of aggregation similar to ours.

[11]Random effects were rejected in a Hausman specification test.

[12]A detailed description of the rather complex construction of the GSOEP sampling weights is provided in Haisken-DeNew and Frick (2003). However, person related characteristics that are used to construct the GSOEP sampling weights can be considered exogenous to our analysis and include gender and age of the household head and the individual as well as individual marital status and occupational placement. Weights for the foreigner sample (Sample B) in addition are based on nationality of the household head and the individual while weights for the East German sample (Sample C) only involve individual gender and age.

[13]See Haisken-DeNew and Frick, 2003 for a detailed description of the panel. The data used in this paper was extracted from the 2003 GSOEP Database provided by the DIW Berlin (http://www.diw.de/soep) using the Add-On package SOEPMENU for Stata(TM). SOEPMENU was written by Dr. John P. Haisken-DeNew (Haisken-DeNew, 2005) and is now available in an updated version under http://www.panelwhiz.eu. The SOEPMENU generated DO file to retrieve the GSOEP data used here is available from us upon request. Any data or computational errors in this paper are our own.

[14]These coefficients are only reported if statistically significant. As a robustness check we also run regressions dropping observations with item non-responses. Overall, we drop 176 observations. The results, which are not reported here to save space are, however, robust to this amendment.

[15]Frick and Grabka (2003) describe the imputation procedure for missing wage information. Since the procedure does not use industry level information, heterogeneity in the wage distribution with respect to industry level

variables, particularly outsourcing, is reduced preventing the use of imputed data for our analysis.

[16]See UNESCO (1997).

[17]In fact, as we show in table 6 this seems to be the case. When we allow for coefficients to differ across skill groups more variables are statistically significant.

[18]This is also confirmed more formally by an F-test that rejects the parameter constraints.

[19]As a means of comparison we have also estimated our model including industries' import penetration calculated as imports from OECD countries and imports from non-OECD countries over gross production. As Anderton and Brenton (1999) state, particularly import penetration from non-OECD countries may be considered as measuring the outsourcing of low-skill intensive production to low-wage locations. However, in our regressions the coefficients of import penetration are always statistically insignificant casting doubt on this assertion. Results are available from the authors.

[20]To estimate our model with R&D intensity we further impute missing information for the years 1991 to 1995 with a industry specific trend.

[21]In a final robustness check we also estimate our empirical model excluding industry output. In a sense this regression is less restrictive as it allows for wage effects of outsourcing through output effects. Our results, however, show, that this does not alter our general findings. The estimations are not reported here to save space.

[22]Accordingly, using the point estimates from Table 6 our calculations

indicate that the average hourly wage for low-skilled workers decreased by 4.5% and 6.5% respectively between 1991 and 2000. The same calculations can be made for each year between 1991 and 2000 and are plotted in Figures 3 to 6.

[23]Our estimates relate, however, to the immediate short run effects of international outsourcing. With regard to the long run effects of international outsourcing the theoretical literature is not conclusive (see Section 2). At what point long run effects, however, materialize, essentially depends on the interindustry mobility of labor which, arguably, is in itself a function of labor market policies.

# A Tables

Table 1: Outsourcing intensity and growth rate in percent

| industry | Narrow 1991 | 2000 | Growth | Wide 1991 | 2000 | Growth |
|---|---|---|---|---|---|---|
| (15,16) Food,Beverages | 2.73 | 3.40 | 24.26 | 4.28 | 5.47 | 28.00 |
| (17) Textiles | 4.82 | 9.51 | 97.14 | 12.50 | 20.40 | 63.19 |
| (18) Clothing | 9.23 | 23.27 | 152.06 | 20.38 | 39.14 | 92.05 |
| (19) Leather | 10.47 | 25.75 | 145.90 | 16.79 | 32.16 | 91.60 |
| (20) Wood | 4.21 | 4.66 | 10.62 | 7.24 | 8.72 | 20.50 |
| (21) Pulp,Paper | 7.65 | 10.48 | 36.93 | 17.66 | 22.32 | 26.42 |
| (22) Printing,Publish | 0.16 | 0.13 | -21.71 | 6.42 | 7.52 | 17.10 |
| (23) Coke,Petroleum | 5.21 | 4.98 | -4.26 | 7.52 | 5.73 | -23.77 |
| (24) Chemicals | 7.07 | 12.94 | 82.94 | 12.47 | 19.42 | 55.73 |
| (25) Rubber,Plastic | 0.45 | 0.95 | 114.16 | 14.78 | 19.52 | 32.10 |
| (26) Non-Metal.Minerals | 2.01 | 2.27 | 12.95 | 3.94 | 4.66 | 18.29 |
| (27) Basic Metals | 10.78 | 16.33 | 51.45 | 14.14 | 21.15 | 49.51 |
| (28) Metal Products | 1.04 | 1.53 | 48.10 | 7.77 | 10.03 | 29.06 |
| (29) Machinery, Equ. | 4.48 | 5.83 | 30.21 | 10.21 | 13.31 | 30.42 |
| (30) Computers | 8.61 | 23.28 | 170.58 | 17.37 | 34.87 | 100.70 |
| (31) Electr. Machinery | 3.67 | 6.59 | 79.66 | 7.34 | 12.06 | 64.23 |
| (32) Radio,TV | 13.01 | 21.42 | 64.69 | 17.82 | 26.87 | 50.73 |
| (33) Instruments | 3.51 | 4.22 | 20.47 | 8.30 | 11.37 | 36.93 |
| (34) Motor Vehicles | 6.76 | 9.79 | 44.88 | 13.56 | 19.17 | 41.35 |
| (35) Transport Equip. | 18.91 | 37.34 | 97.47 | 23.33 | 41.50 | 77.84 |
| (36) Furniture, n.e.c. | 4.72 | 8.54 | 80.84 | 14.02 | 19.02 | 35.66 |
| Total Manufacturing | 5.05 | 8.19 | 62.02 | 10.63 | 15.43 | 45.21 |

Table 2: Alternative skill classifications

| | |
|---|---|
| **1) International Standard Classification of Education (ISCED)** | |
| low skill | Lower secondary education, Second stage of basic education |
| medium skill | Upper secondary education, Post-secondary non tertiary education, first stage of tertiary education |
| high skill | Second stage of tertiary education |
| **2) Required Qualification** | |
| low skill | work requires less than technical college or university degree |
| high skill | work requires technical college or university degree |

Table 3: Employment shares and skill* structure of industries in %

| | Employment Share of industry | High-skilled | Medium-skilled within industry | Low-skilled |
|---|---|---|---|---|
| Food products, beverages, tobacco | 6.08 | 10.61 | 21.22 | 68.16 |
| Textiles | 2.53 | 2.94 | 11.76 | 85.29 |
| Wearing apparel | 0.22 | 0.00 | 27.78 | 72.22 |
| Tanning,dressing of leather | 0.47 | 21.05 | 0.00 | 78.95 |
| Wood products, except furniture | 1.87 | 0.00 | 7.28 | 92.72 |
| Pulp, paper and paper products | 1.84 | 6.08 | 7.43 | 86.49 |
| Publishing, printing and reproduction | 2.69 | 18.89 | 13.82 | 67.28 |
| Coke, refined petroleum | 0.55 | 15.91 | 4.55 | 79.55 |
| Chemicals and chemical products | 11.31 | 20.75 | 14.16 | 65.09 |
| Rubber and plastic products | 3.84 | 3.24 | 10.03 | 86.73 |
| Other non-metallic mineral products | 3.41 | 0.36 | 15.64 | 84.00 |
| Basic metals | 3.49 | 9.61 | 9.61 | 80.78 |
| Fabricated metal products | 21.54 | 7.72 | 12.62 | 79.65 |
| Machinery and equipment | 11.67 | 20.96 | 16.70 | 62.34 |
| Office machinery and computer | 0.19 | 60.00 | 0.00 | 40.00 |
| Electrical machinery and apparatus | 7.80 | 29.14 | 22.45 | 48.41 |
| Radio, television and communication | 1.40 | 30.97 | 23.89 | 45.13 |
| Medical, precision and optical instruments | 3.09 | 18.07 | 31.73 | 50.20 |
| Motor vehicles, trailers | 12.46 | 16.63 | 13.45 | 69.92 |
| Other transport equipment | 1.68 | 22.96 | 15.56 | 61.48 |
| Furniture; manufacturing n.e.c. | 1.87 | 5.96 | 7.95 | 86.09 |

*applying the first skill definition from Table 2

Table 4: Inter-Industry Mobility between 1991 and 2000

| | Number | in percent of | Total sample |
|---|---|---|---|
| Respondents who left manufacturing | 253 | 1.66 | 15235 |
| Respondents who stayed in manufacturing but changed industry | 207 | 2.84 | 7294 |

Sample is constrained according to the criteria discussed in Section 5.

Table 5: Fixed Effects Log Wage Regression

| | Narrow Outsourcing | | | Wide Outsourcing | | |
|---|---|---|---|---|---|---|
| | (a) | (b) | (c) | (d) | (e) | (f) |
| Age: 18-24 | 0.027 | 0.025 | 0.031 | 0.027 | 0.023 | 0.028 |
| | [0.46] | [0.42] | [0.52] | [0.46] | [0.38] | [0.47] |
| Age: 25-34 | 0.051 | 0.051 | 0.053 | 0.052 | 0.051 | 0.053 |
| | [1.15] | [1.12] | [1.19] | [1.16] | [1.12] | [1.18] |
| Age: 35-44 | 0.054 | 0.054 | 0.056 | 0.054 | 0.054 | 0.055 |
| | [1.55] | [1.52] | [1.56] | [1.55] | [1.52] | [1.54] |
| Age: 45-54 | 0.035 | 0.035 | 0.039 | 0.035 | 0.035 | 0.039 |
| | [2.05]* | [2.10]** | [2.46]** | [2.06]* | [2.14]** | [2.50]** |
| Married | 0.019 | 0.018 | 0.008 | 0.019 | 0.017 | 0.008 |
| | [0.75] | [0.72] | [0.35] | [0.74] | [0.68] | [0.34] |
| Dummy: Respondent has children | 0.012 | 0.012 | 0.014 | 0.012 | 0.011 | 0.014 |
| | [1.06] | [1.02] | [1.39] | [1.05] | [0.99] | [1.35] |
| Firm size: $< 20$ | -0.065 | -0.065 | -0.065 | -0.063 | -0.064 | -0.064 |
| | [1.60] | [1.63] | [1.67] | [1.58] | [1.62] | [1.67] |
| Firm size: $< 200$ | -0.018 | -0.018 | -0.015 | -0.017 | -0.016 | -0.015 |
| | [0.59] | [0.59] | [0.53] | [0.55] | [0.54] | [0.52] |
| Firm size: $< 2000$ | -0.009 | -0.009 | -0.010 | -0.009 | -0.009 | -0.010 |
| | [0.52] | [0.54] | [0.61] | [0.51] | [0.53] | [0.61] |
| Firm:Public Owner | 0.018 | 0.019 | 0.023 | 0.018 | 0.019 | 0.024 |
| | [0.64] | [0.69] | [0.89] | [0.65] | [0.72] | [0.92] |
| Tenure | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [0.05] | [0.04] | [0.23] | [0.07] | [0.06] | [0.23] |
| ISCED: high | 0.035 | -0.016 | -0.013 | 0.035 | -0.092 | -0.083 |
| | [1.73]* | [0.46] | [0.38] | [1.75]* | [1.55] | [1.43] |
| ISCED: medium | 0.001 | -0.017 | -0.010 | 0.001 | -0.053 | -0.037 |
| | [0.03] | [0.29] | [0.17] | [0.04] | [0.68] | [0.48] |
| Industry: $Equipment/Y$ | 0.154 | 0.145 | -0.326 | 0.088 | 0.073 | -0.344 |
| | [0.45] | [0.43] | [0.87] | [0.27] | [0.23] | [0.93] |
| Industry: $Plant/Y$ | -0.895 | -0.827 | 0.336 | -0.731 | -0.643 | 0.428 |
| | [1.28] | [1.17] | [0.77] | [1.13] | [1.00] | [1.03] |
| Industry: Output Y (in 100 billion) | -0.098 | -0.098 | -0.037 | -0.091 | -0.093 | -0.034 |
| | [1.69] | [1.71] | [0.60] | [1.63] | [1.69] | [0.60] |
| $Out$ | -0.009 | | | -0.009 | | |
| | [2.53]** | | | [2.86]*** | | |
| $Out * ISCED: high$ | | -0.003 | -0.002 | | -0.002 | -0.001 |
| | | [0.99] | [0.30] | | [0.76] | [0.19] |
| $Out * ISCED: middle$ | | -0.008 | -0.007 | | -0.007 | -0.007 |
| | | [1.76]* | [0.95] | | [1.88]* | [1.06] |
| $Out * ISCED: low$ | | -0.011 | -0.010 | | -0.012 | -0.010 |
| | | [2.66]** | [1.46] | | [3.16]*** | [1.80]* |
| Constant | 2.964 | 2.880 | -84.848 | 3.067 | 3.133 | -82.320 |
| | [20.81]*** | [18.76]*** | [3.42]*** | [19.43]*** | [18.10]*** | [3.79]*** |
| Year dummies | YES | YES | YES | YES | YES | YES |
| Industry dummies | YES | YES | YES | YES | YES | YES |
| Industry specific time trends | NO | NO | YES | NO | NO | YES |
| Individual fixed effects | YES | YES | YES | YES | YES | YES |
| Region Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 7294 | 7294 | 7294 | 7294 | 7294 | 7294 |
| $R^2$ | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| Exogeneity test for $OUT$ | | | | | | |
| Shea-partial $R^2$ | 0.281 | | | 0.309 | | |
| Hansen J statistic: | 1.076 | | | 0.652 | | |
| p-val = | 0.584 | | | 0.722 | | |
| Hansen J statistic for unrestricted equation: | 0.540 | | | 0.238 | | |
| p-val = | 0.462 | | | 0.626 | | |
| C statistic for exogeneity test | 0.536 | | | 0.414 | | |
| p-val = | 0.464 | | | 0.520 | | |
| Excluded instruments | $OUT_{t-1}^{NARROW}$, $OUT_{t-2}^{NARROW}$ | | | $OUT_{t-1}^{WIDE}$, $OUT_{t-2}^{WIDE}$ | | |
| Inverted Mills-ratio from selection test | -0.219 | -0.210 | -0.229 | -0.228 | -0.208 | -0.226 |
| (separate regression) | [1.28] | [1.36] | [1.70] | [1.30] | [1.29] | [1.65] |

t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
not reported: full set of federal state dummies; default categories: Age:> 54; Firm size:> 2000; ISCED:Low

Table 6: Fixed Effects Log Wage Regression by ISCED Skill Groups

| | Narrow Outsourcing | | | Wide Outsourcing | | |
|---|---|---|---|---|---|---|
| | High (a) | Medium (b) | Low (c) | High (d) | Medium (e) | Low (f) |
| Age: 18-24 | 0.164 | 0.032 | 0.022 | 0.168 | 0.034 | 0.021 |
| | [1.08] | [0.26] | [0.28] | [1.09] | [0.28] | [0.26] |
| Age: 25-34 | 0.140 | 0.025 | 0.042 | 0.139 | 0.026 | 0.041 |
| | [1.08] | [0.24] | [0.70] | [1.06] | [0.25] | [0.69] |
| Age: 35-44 | 0.124 | 0.047 | 0.053 | 0.121 | 0.048 | 0.052 |
| | [1.09] | [0.45] | [1.06] | [1.05] | [0.46] | [1.04] |
| Age: 45-54 | 0.074 | 0.041 | 0.044 | 0.073 | 0.041 | 0.043 |
| | [0.79] | [0.42] | [1.50] | [0.78] | [0.43] | [1.47] |
| Married | 0.011 | -0.114 | 0.021 | 0.010 | -0.114 | 0.021 |
| | [0.44] | [3.19]*** | [0.70] | [0.42] | [3.19]*** | [0.73] |
| Dummy: Respondent has children | 0.037 | 0.054 | 0.006 | 0.038 | 0.054 | 0.006 |
| | [1.77]* | [3.81]*** | [0.58] | [1.82]* | [3.82]*** | [0.54] |
| Firm size: $< 20$ | -0.351 | 0.010 | -0.067 | -0.353 | 0.011 | -0.067 |
| | [3.22]*** | [0.16] | [1.33] | [3.29]*** | [0.17] | [1.34] |
| Firm size: $< 200$ | -0.024 | -0.044 | -0.022 | -0.024 | -0.044 | -0.022 |
| | [0.61] | [0.59] | [0.67] | [0.63] | [0.58] | [0.67] |
| Firm size: $< 2000$ | 0.037 | -0.021 | -0.017 | 0.039 | -0.020 | -0.017 |
| | [2.02]* | [0.58] | [0.76] | [2.18]** | [0.57] | [0.77] |
| Firm:Public Owner | 0.068 | 0.044 | 0.025 | 0.070 | 0.046 | 0.025 |
| | [0.41] | [1.18] | [0.71] | [0.42] | [1.25] | [0.71] |
| Tenure | 0.000 | 0.000 | -0.002 | 0.000 | 0.000 | -0.002 |
| | [0.07] | [0.08] | [0.97] | [0.09] | [0.09] | [0.95] |
| Industry: $Equipment/Y$ | -1.802 | -1.463 | 0.102 | -1.604 | -1.438 | 0.061 |
| | [1.12] | [1.52] | [0.22] | [1.03] | [1.51] | [0.14] |
| Industry: $Plant/Y$ | 3.834 | 2.255 | -0.496 | 3.109 | 2.282 | -0.334 |
| | [1.37] | [2.18]** | [0.80] | [1.18] | [2.39]** | [0.52] |
| Industry: Output Y (in 100 billion) | 0.093 | -0.057 | -0.067 | 0.024 | -0.069 | -0.050 |
| | [0.48] | [0.45] | [0.81] | [0.12] | [0.68] | [0.61] |
| $Out$ | 0.026 | -0.007 | -0.015 | 0.019 | -0.010 | -0.013 |
| | [2.15]** | [0.42] | [2.25]** | [2.22]** | [0.77] | [2.03]* |
| Constant | 4.013 | -199.050 | -48.608 | -8.450 | -198.570 | -57.096 |
| | [0.04] | [4.59]*** | [1.18] | [0.09] | [4.60]*** | [1.25] |
| Year dummies | YES | YES | YES | YES | YES | YES |
| Industry dummies | YES | YES | YES | YES | YES | YES |
| Industry specific time trends | YES | YES | YES | YES | YES | YES |
| Individual fixed effects | YES | YES | YES | YES | YES | YES |
| Region Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 1021 | 1085 | 5188 | 1021 | 1085 | 5188 |
| $R^2$ | 0.84 | 0.84 | 0.74 | 0.84 | 0.84 | 0.74 |
| Inverted Mills-ratio from selection test | 0.028 | -0.100 | -0.063 | 0.014 | -0.102 | -0.067 |
| (separate regression) | [0.18] | [1.03] | [0.76] | [0.09] | [1.07] | [0.77] |

t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
not reported: full set of federal state dummies; default categories: Age:> 54; Firm size:> 2000

Table 7: Fixed Effects Log Wage Regression by Required Skill

| | Narrow Outsourcing | | Wide Outsourcing | |
|---|---|---|---|---|
| | High | Low | High | Low |
| | (a) | (b) | (c) | (d) |
| Age: 18-24 | - | 0.038 | - | 0.036 |
| | - | [0.59] | - | [0.57] |
| Age: 25-34 | 0.020 | 0.051 | 0.022 | 0.051 |
| | [0.33] | [1.09] | [0.36] | [1.08] |
| Age: 35-44 | 0.041 | 0.050 | 0.042 | 0.050 |
| | [0.67] | [1.19] | [0.67] | [1.18] |
| Age: 45-54 | 0.003 | 0.041 | 0.004 | 0.041 |
| | [0.10] | [1.88]* | [0.11] | [1.86]* |
| Married | 0.011 | -0.012 | 0.010 | -0.011 |
| | [0.31] | [0.47] | [0.30] | [0.46] |
| Dummy: Respondent has children | 0.009 | 0.019 | 0.010 | 0.018 |
| | [0.47] | [1.89]* | [0.49] | [1.84]* |
| Firm size: < 20 | -0.390 | -0.053 | -0.390 | -0.053 |
| | [3.13]*** | [1.18] | [3.16]*** | [1.17] |
| Firm size: < 200 | -0.030 | -0.022 | -0.029 | -0.022 |
| | [0.64] | [0.71] | [0.62] | [0.71] |
| Firm size: < 2000 | 0.064 | -0.017 | 0.067 | -0.017 |
| | [2.12]** | [0.75] | [2.15]** | [0.74] |
| Firm:Public Owner | 0.102 | -0.009 | 0.103 | -0.009 |
| | [0.68] | [0.26] | [0.68] | [0.26] |
| Tenure | -0.002 | 0.000 | -0.002 | 0.000 |
| | [0.56] | [0.02] | [0.59] | [0.02] |
| Industry: $Equipment/Y$ | -0.901 | -0.426 | -0.808 | -0.437 |
| | [0.60] | [1.00] | [0.55] | [1.05] |
| Industry: $Plant/Y$ | 2.173 | 0.671 | 1.625 | 0.790 |
| | [0.71] | [0.68] | [0.56] | [0.83] |
| Industry: Output Y (in 100 billion) | -0.135 | -0.073 | -0.175 | -0.066 |
| | [0.52] | [1.01] | [0.64] | [1.00] |
| $Out$ | 0.020 | -0.012 | 0.017 | -0.012 |
| | [2.02]* | [1.82]* | [2.07]* | [2.12]** |
| Constant | -19.472 | -37.015 | -34.195 | -34.074 |
| | [0.33] | [1.46] | [0.53] | [1.42] |
| Year dummies | YES | YES | YES | YES |
| Industry dummies | YES | YES | YES | YES |
| Industry specific time trends | YES | YES | YES | YES |
| Individual fixed effects | YES | YES | YES | YES |
| Region Dummies | YES | YES | YES | YES |
| Observations | 900 | 6799 | 900 | 6799 |
| $R^2$ | 0.82 | 0.76 | 0.82 | 0.76 |
| Inverted Mills-ratio from selection test | -0.008 | -0.105 | -0.021 | -0.107 |
| (separate regression) | [0.12] | [1.07] | [0.30] | [1.07] |

t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
not reported: full set of federal state dummies; default categories: *Age* :> 54; Firm size:> 2000

Table 8: Fixed Effects Log Wage Regression by ISCED Skill Groups for Domestic and International Outsourcing

| | Only Domestic | | | Domestic and International | | |
|---|---|---|---|---|---|---|
| | High | Medium | Low | High | Medium | Low |
| | (a) | (b) | (c) | (d) | (e) | (f) |
| Age: 18-24 | 0.178 | 0.010 | 0.017 | 0.173 | 0.025 | 0.018 |
| | [1.08] | [0.09] | [0.22] | [1.08] | [0.21] | [0.23] |
| Age: 25-34 | 0.144 | 0.011 | 0.035 | 0.145 | 0.019 | 0.034 |
| | [0.99] | [0.10] | [0.62] | [1.02] | [0.17] | [0.62] |
| Age: 35-44 | 0.118 | 0.043 | 0.048 | 0.125 | 0.048 | 0.048 |
| | [0.93] | [0.43] | [0.98] | [1.02] | [0.48] | [0.99] |
| Age: 45-54 | 0.079 | 0.033 | 0.040 | 0.079 | 0.035 | 0.039 |
| | [0.77] | [0.35] | [1.48] | [0.79] | [0.37] | [1.47] |
| Married | 0.004 | -0.089 | 0.017 | 0.009 | -0.090 | 0.020 |
| | [0.19] | [2.75]** | [0.59] | [0.40] | [2.77]** | [0.72] |
| Dummy: Respondent has children | 0.034 | 0.040 | 0.004 | 0.036 | 0.041 | 0.003 |
| | [1.61] | [2.10]** | [0.39] | [1.62] | [2.16]** | [0.28] |
| $Firmsize :< 20$ | -0.339 | 0.027 | -0.069 | -0.346 | 0.024 | -0.067 |
| | [3.43]*** | [0.35] | [1.32] | [3.49]*** | [0.30] | [1.29] |
| $Firmsize :< 200$ | -0.017 | -0.035 | -0.021 | -0.014 | -0.039 | -0.019 |
| | [0.51] | [0.51] | [0.63] | [0.41] | [0.54] | [0.57] |
| $Firmsize :< 2000$ | 0.030 | -0.017 | -0.015 | 0.025 | -0.018 | -0.012 |
| | [1.59] | [0.44] | [0.67] | [1.23] | [0.47] | [0.57] |
| Firm:Public Owner | 0.090 | 0.058 | 0.029 | 0.079 | 0.062 | 0.030 |
| | [0.55] | [1.58] | [0.85] | [0.47] | [1.67] | [0.87] |
| Tenure | -0.001 | 0.000 | -0.001 | -0.001 | 0.000 | -0.002 |
| | [0.38] | [0.06] | [0.89] | [0.43] | [0.07] | [0.97] |
| Industry: $Equipment/Y$ | -102.340 | -109.850 | -15.425 | -132.840 | -110.010 | 3.509 |
| | [1.04] | [1.62] | [0.37] | [1.21] | [1.69] | [0.11] |
| Industry: $Plant/Y$ | 162.010 | 195.870 | 4.052 | 275.100 | 171.000 | -46.436 |
| | [0.96] | [2.73]** | [0.07] | [1.34] | [2.04]* | [0.88] |
| Industry: Output Y (in 100 billion) | -0.053 | 0.020 | -0.007 | 0.057 | -0.002 | -0.040 |
| | [0.49] | [0.28] | [0.24] | [0.23] | [0.07] | [0.65] |
| $Out - Domestic$ | 0.001 | -0.005 | 0.002 | 0.015 | -0.013 | -0.008 |
| | [0.04] | [0.39] | [0.15] | [0.59] | [0.94] | [0.61] |
| $Out - International$ | | | | 0.028 | -0.015 | -0.019 |
| | | | | [1.44] | [0.78] | [2.22]** |
| Constant | -123.110 | -141.400 | -21.067 | -62.489 | -134.060 | -48.903 |
| | [0.73] | [3.03]*** | [0.49] | [0.34] | [2.95]*** | [1.19] |
| Year dummies | YES | YES | YES | YES | YES | YES |
| Industry dummies | YES | YES | YES | YES | YES | YES |
| Industry specific time trends | YES | YES | YES | YES | YES | YES |
| Individual fixed effects | YES | YES | YES | YES | YES | YES |
| Region Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 1021 | 1085 | 5188 | 1021 | 1085 | 5188 |
| $R^2$ | 0.850 | 0.850 | 0.740 | 0.850 | 0.850 | 0.740 |

t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
not reported: full set of federal state dummies; default categories: Age:> 54; Firm size:> 2000

Table 9: Fixed Effects Log Wage Regression by ISCED Skill Groups with R&D Intensity

| | Narrow Outsourcing | | | Wide Outsourcing | | |
|---|---|---|---|---|---|---|
| | High (a) | Medium (b) | Low (c) | High (d) | Medium (e) | Low (f) |
| Age: 18-24 | 0.167 | 0.030 | 0.020 | 0.076 | -0.041 | 0.027 |
| | [1.11] | [0.24] | [0.24] | [0.48] | [0.31] | [0.33] |
| Age: 25-34 | 0.142 | 0.024 | 0.039 | 0.068 | -0.062 | 0.054 |
| | [1.10] | [0.23] | [0.66] | [0.53] | [0.53] | [0.91] |
| Age: 35-44 | 0.126 | 0.047 | 0.051 | 0.066 | -0.013 | 0.063 |
| | [1.11] | [0.45] | [1.01] | [0.63] | [0.12] | [1.26] |
| Age: 45-54 | 0.076 | 0.040 | 0.043 | 0.034 | 0.000 | 0.045 |
| | [0.81] | [0.42] | [1.47] | [0.45] | [0.00] | [1.58] |
| Married | 0.007 | -0.115 | 0.021 | 0.035 | -0.093 | 0.035 |
| | [0.30] | [3.26]*** | [0.70] | [1.03] | [2.24]** | [1.11] |
| Dummy: Respondent has children | 0.037 | 0.053 | 0.006 | -0.016 | 0.048 | 0.005 |
| | [1.76]* | [3.81]*** | [0.57] | [0.30] | [2.76]** | [0.41] |
| $Firmsize :< 20$ | -0.352 | 0.012 | -0.067 | -0.352 | 0.032 | -0.064 |
| | [3.23]*** | [0.18] | [1.33] | [3.01]*** | [0.44] | [1.19] |
| $Firmsize :< 200$ | -0.024 | -0.044 | -0.021 | -0.018 | -0.041 | -0.023 |
| | [0.61] | [0.58] | [0.65] | [0.53] | [0.54] | [0.65] |
| $Firmsize :< 2000$ | 0.036 | -0.020 | -0.017 | 0.044 | -0.007 | -0.018 |
| | [2.00]* | [0.56] | [0.74] | [2.88]** | [0.21] | [0.75] |
| Firm:Public Owner | 0.069 | 0.042 | 0.025 | 0.084 | 0.046 | 0.022 |
| | [0.42] | [1.07] | [0.71] | [0.53] | [1.27] | [0.61] |
| Tenure | 0.000 | 0.000 | -0.002 | -0.003 | 0.003 | -0.001 |
| | [0.02] | [0.08] | [0.97] | [1.17] | [0.49] | [0.42] |
| Industry: $Equipment/Y$ | -1.735 | -1.469 | 0.152 | -0.790 | 0.802 | 0.117 |
| | [1.12] | [1.54] | [0.32] | [0.65] | [1.07] | [0.26] |
| Industry: $Plant/Y$ | 3.977 | 2.315 | -0.662 | 0.979 | -1.666 | -0.809 |
| | [1.41] | [2.33]** | [1.07] | [0.70] | [1.03] | [0.91] |
| Industry: Output Y (in 100 billion) | 0.042 | -0.080 | -0.003 | -0.117 | -0.194 | -0.105 |
| | [0.24] | [0.52] | [0.03] | [0.66] | [2.01]* | [1.57] |
| $Out$ | 0.023 | -0.008 | -0.014 | 0.005 | -0.021 | -0.012 |
| | [2.18]** | [0.45] | [2.14]** | [0.58] | [1.35] | [3.02]*** |
| $R\&D/Y$ | -1.742 | -0.770 | 1.881 | -0.433 | -0.862 | -0.489 |
| | [0.91] | [0.47] | [1.03] | [0.51] | [0.67] | [0.70] |
| Constant | 18.035 | -129.240 | 35.772 | 3.234 | 3.121 | 3.294 |
| | [0.18] | [3.05]*** | [0.87] | [9.79]*** | [11.45]*** | [15.94]*** |
| Year dummies | YES | YES | YES | YES | YES | YES |
| Industry dummies | YES | YES | YES | YES | YES | YES |
| Industry specific time trends | YES | YES | YES | NO | NO | NO |
| Individual fixed effects | YES | YES | YES | YES | YES | YES |
| Region Dummies | YES | YES | YES | YES | YES | YES |
| Observations | 1021 | 1085 | 5188 | 1021 | 1085 | 5188 |
| $R^2$ | 0.85 | 0.84 | 0.74 | 0.83 | 0.83 | 0.73 |

t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
not reported: full set of federal state dummies; default categories: Age:> 54; Firm size:> 2000

# B Graphs

Figure 1: Median, Top and Bottom Decile Wages by Skill

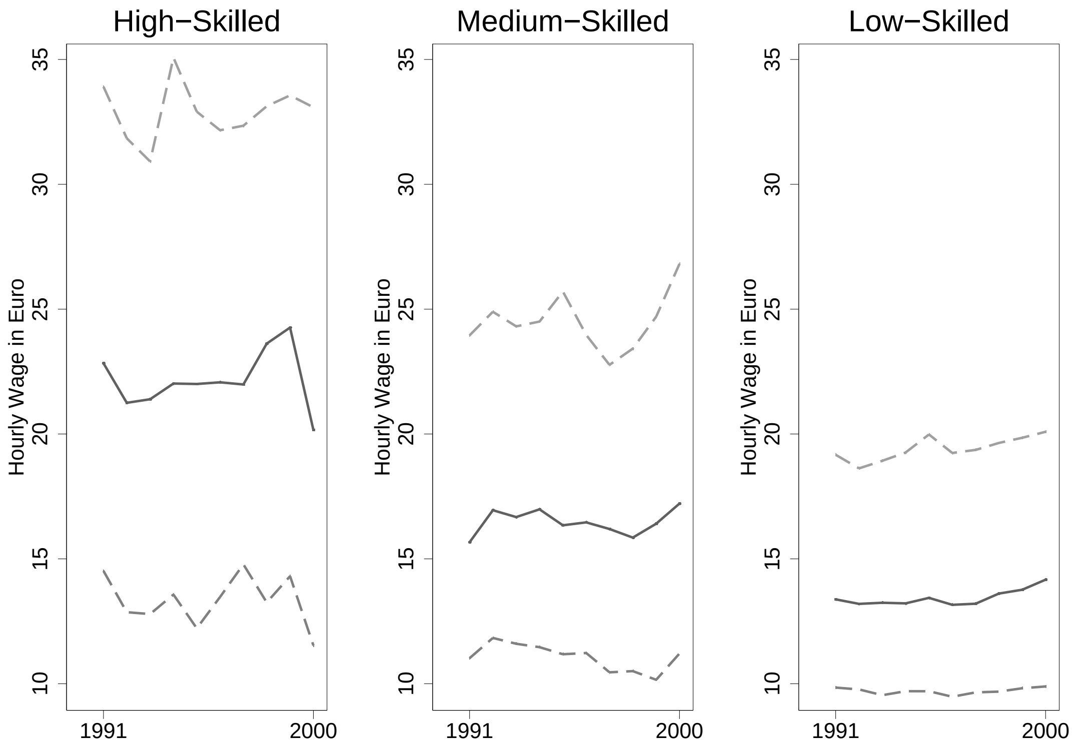

Figure 2: Outsourcing in German Manufacturing Industry

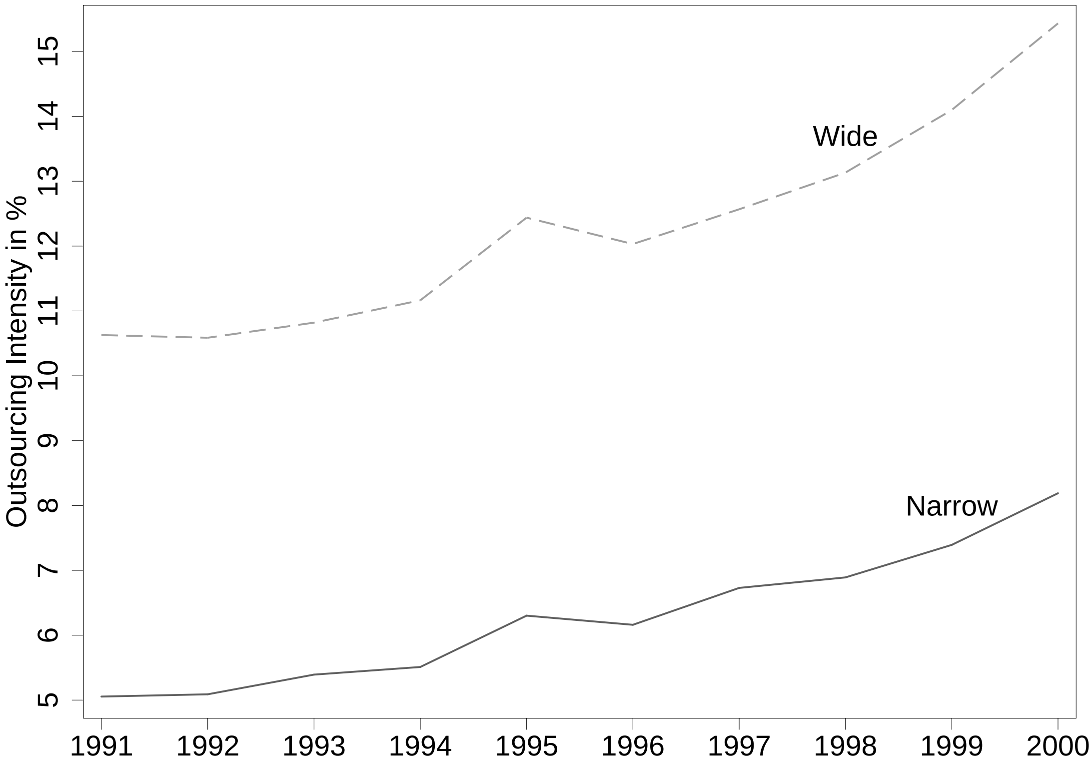

Figure 3: Cumulated marginal effects of outsourcing for ISCED low-skilled workers

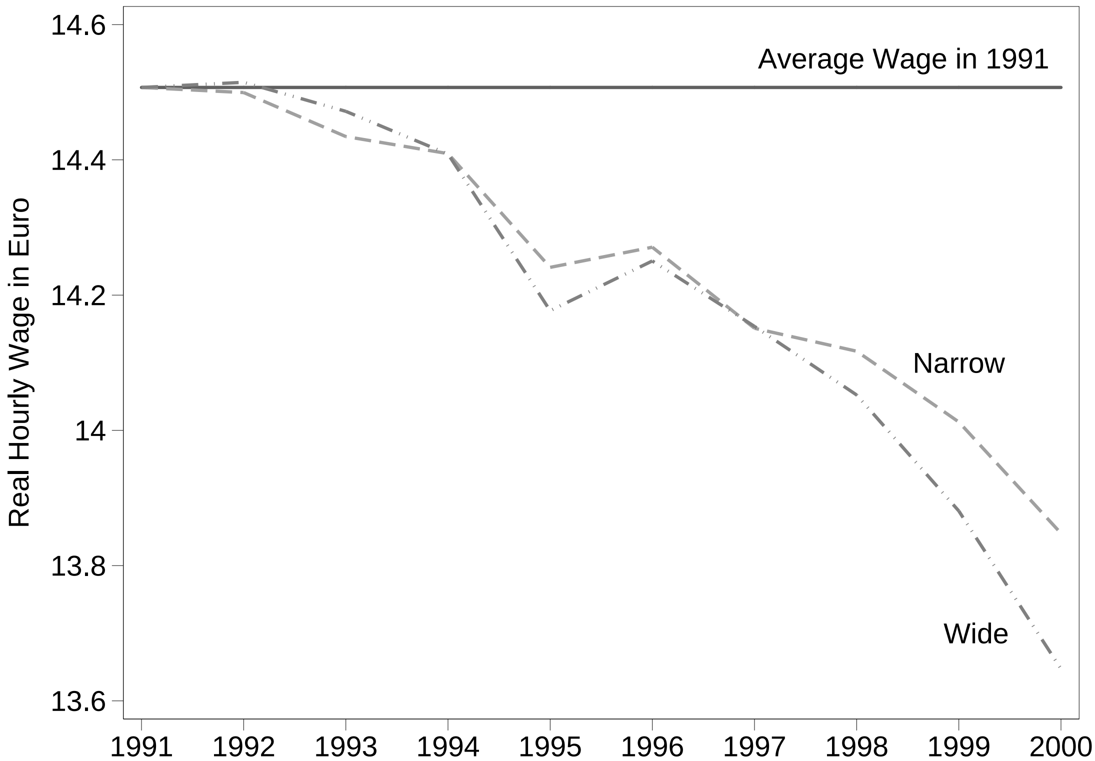

Figure 4: Cumulated marginal effects of outsourcing for ISCED high-skilled workers

Figure 5: Cumulated marginal effects of outsourcing for workers with low skill requirements

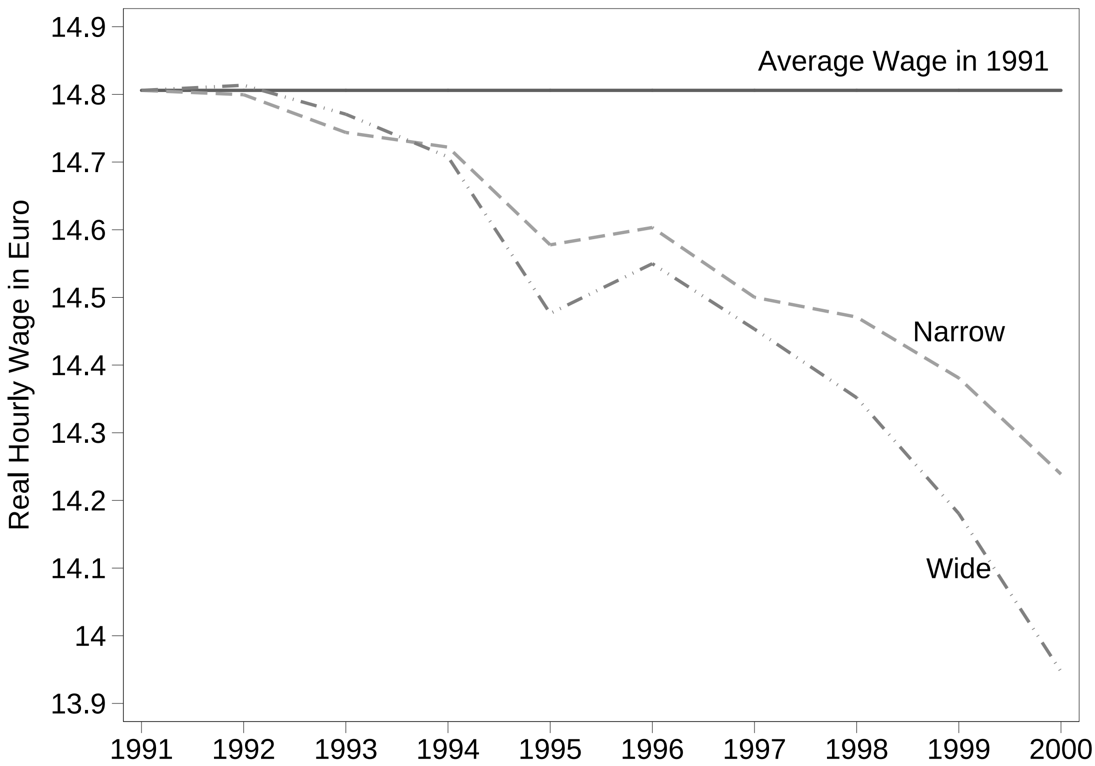

Figure 6: Cumulated marginal effects of outsourcing for workers with high skill requirements