Does Outsourcing to Central and Eastern Europe really threaten manual workers' jobs in Germany?

May 2005

Abstract

This paper analyses how international outsourcing has affected the relative demand for manual workers in Germany during the 1990s. In contrast to previous empirical work, we combine trade and input output data to disentangle international outsourcing and trade in final goods more accurately and differentiate between the effects of outsourcing in different geographic regions. Accounting for endogeneity of international outsourcing by applying GMM techniques we find a significant negative effect of international outsourcing towards Central and Eastern Europe that in its magnitude is comparable to the skill biased effect of technological progress.

Keywords: international outsourcing, skill-bias, Central and Eastern Europe, GMM

JEL classification: F20, J31, J23

I Introduction

This paper is concerned with the impact of international outsourcing on the relative demand for manual workers in Germany during the 1990s. Germany 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 labour market. Furthermore political and economic transition in the former communist Central and Eastern European countries during the 1990's now allows for intensive production sharing with these economies at Germany's doorstep. Particularly against the backdrop of eastern enlargement of the European Union this has raised widespread public concern about potential negative labour market implications in Germany especially for manual workers. However, the current public debate under flashy headlines[1] can at best be described as uninformed since despite the strong public interest surprisingly little academic research has been directed towards the systematic analysis of the outsourcing phenomenon and its implications for the German labour market.

The paper aims at contributing to a more scientific facts based debate by providing the, to the best knowledge of the author, first empirical assessment of the impact of international outsourcing differentiated by geographic regions on the demand for manual workers during the 1990's.

Section II starts off by presenting some stylised facts on the skill upgrading within German manufacturing industries. Section III discusses measurement and the development of international outsourcing in German manufacturing differentiated by geographic region and industry. Section IV introduces some previous empirical work mainly on the effects of outsourcing during the 1980's. In the following Section V the empirical model is developed. Section VI presents the empirical findings and discusses the economic relevance of international outsourcing during the 1990's. Section VII summarises and draws some conclusions.

[1] such as "Deutschland Exportweltmeister (von Arbeitsplätzen)" *Germany, the export champion (of jobs)*, Der Spiegel, 44/2004

II Stylised facts: skill upgrading in manufacturing

It is a well established fact that over the past decades a substantial skill upgrading of employment has occurred in Germany [see Reinberg and Hummel (2002)]. As can be seen in Table 2, employment of low-skilled workers decreased sharply by on average 3.6% per year between 1975 and 1990 and continued to fall all through the 1990s by on average 1.3% per year. In contrast employment of the high- and medium skilled increased by on average 4.3% and 2.1% per year between 1975 and 1990 and continued to rise during the 1990s with average yearly growth rates of 3.6% and 0.2%. At the same time relative wages of low-skilled workers remained fairly stable as Fitzenberger (1999) and Christensen and Schimmelpfennig (1998) demonstrate.

On the basis of aggregate employment and wage data for production and non-production workers, we analyse the process of skill upgrading in more detail.[2] For the whole manufacturing industry[3], the cost share of low-skilled workers in the total wage bill decreased by 23 percentage points between 1991 and 2000. Decomposing this overall change shows that only 2 percentage points of it can be attributed to decreased relative wages but 21 percentage points to decreased relative employment of low-skilled workers.[4] Thus the findings by

[2]The distinction between low- and high-skilled workers based on the broad categories production- and non-production work may be not clear cut. However this approximation is fairly common in the literature as the correlation between high-skilled and non-production workers is very high (e.g. Berman, Bound and Griliches (1994), Berman, Bound and Machin (1998), Machin and Reenen (1998), Head and Ries (2002) Egger and Stehrer (2003)).

[3]Excluding the industries: oil refining, printing and publishing, recycling

[4]The formula for the decomposition is:

$$\Delta\left(\frac{w^{LS}\times L^{LS}}{w^{HS}\times L^{HS}}\right)=\Delta\left(\frac{w^{LS}}{w^{HS}}\right)\times\frac{\frac{L_t^{LS}}{L_t^{HS}}+\frac{L_{t-n}^{LS}}{L_{t-n}^{HS}}}{2}+\Delta\left(\frac{L^{LS}}{L^{HS}}\right)\times\frac{\frac{w_t^{LS}}{w_t^{HS}}+\frac{w_{t-n}^{LS}}{w_{t-n}^{HS}}}{2}$$

With $w^{LS,HS}$ denoting the wage for low- and high skilled workers and $L^{LS,HS}$ the employment of low- and high-skilled workers.

Fitzenberger et al. (2001) and Reinberg and Hummel (2002) that are derived from micro data are confirmed.

An important detail is that most of the observed skill upgrading occurred within industries. Using micro data from the German Socio-Economic Panel study, Schimmelpfennig (1998) reports that while the share of high-skilled labour in total employment increased by 6.5 percentage points between 1984/86 and 1994/96, around 5.5 percentage points of this change can be attributed to skill upgrading within industries.[5] These findings for Germany are in line with empirical evidence on skill upgrading during the 1980s for many OECD-countries as reported in Berman et al. (1998).

For our analysis we use a panel of 20 manufacturing industries over the more recent period 1991 to 2000 (see SectionA). On this basis our calculations show that the overall change in the relative employment of high-skilled workers in the manufacturing industry was +3.2 percentage points, of which +3.9 percentage points can be attributed to within-industry skill upgrading while -0.7 percentage points can be attributed to skill upgrading across industries. Thus there is evidence for a substantial skill upgrading within industries which to a small extent was counteracted by a shift towards industries with lower skill intensity.[6]

An important question immediately arises: what is the driving force behind the observed skill upgrading in manufacturing? In the literature, two explanations have been discussed. One focuses on increased international trade and the other on skill-biased technological change as the main reason for skill upgrading. However, the fact that most skill upgrading occurs within and not across industries has led many authors [e.g. Berman et al. (1994)

[5] Schimmelpfennig (1998) uses data for broad categories of the primary, secondary and tertiary sector.

[6] Note that low-skilled relative employment is now expressed as the share in total employment:

$$\Delta S^{LS} = \sum_i \Delta S_i^{LS} \times \bar{E}_i + \sum_i \Delta E_i \times \bar{S}_i^{LS}$$

with $\Delta S^{LS} = \Delta\left(\frac{L^{LS}}{E}\right)$ denoting the overall change in the share of low-skilled labour (L^{LS}) in total employment (E).

and Berman et al. (1998)] to conclude that skill-biased technological change rather than international trade is the driving force behind the negative demand shift for low-skilled labour. It may, however, be misleading to focus solely on skill-biased technological change. First, skill upgrading within industry does not necessarily violate the predictions of standard trade theory if rigid wages are assumed. A lack of wage flexibility prevents the substitution of low-skilled workers, who are then driven out of the market. Second, while standard trade theory mainly focuses on trade with final goods, the analysis of trade with intermediate goods or international outsourcing may yield quite different results, as this paper shows.

III International Outsourcing

International outsourcing accompanied by trade with intermediate goods has become increasingly important over the past decades. This reflects an

> "[...] increasing interconnectedness of production processes in a vertical trading chain that stretches across many countries, with each country specialising in particular stages of a good's production sequence" [Hummels, Ishii and Yi (2001), p. 76].

Anecdotal evidence on firms shifting production stages abroad by subcontracting legally independent suppliers or establishing foreign production sites is manifold. However measuring this process of international outsourcing presents a challenge. In general two approaches to measure international outsourcing activities have been pursued in the literature. Authors such as Yeats (1998) seek to measure international outsourcing by directly quantifying trade with intermediate goods, assessing the intermediate character of the traded goods on the basis of disaggregated goods classifications. Imported parts and components are assumed to be intermediate goods imports of the respective broader industry that produces such parts and components. This procedure abstracts from the possibility that parts and components

from one industry can be also used by other industries or by final consumers which may bias the measurement outcome.

Other authors such as Campa and Goldberg (1997) and Feenstra and Hanson (1999) quantify international outsourcing by combining input coefficients found in input-output tables and trade data. The estimated value of imported intermediate inputs of an industry thereby largely depends on whether one applies a narrow or wide definition of international outsourcing. Campa and Goldberg (1997) and others assume that the total sum of imported intermediate goods in each industry represents a reasonable indicator for international outsourcing. But according to Feenstra and Hanson (1999) this "definition" might be too broad if one understands international outsourcing as the result of a make-or-buy decision. Following this approach, not the total sum of imported intermediate inputs but only the part that could be produced within the respective domestic industry corresponds to international outsourcing. However depending on the aggregational level, the range of products that an industry can produce varies. Accordingly, the more highly aggregated the industries are, the broader the definition of international outsourcing becomes.

In this paper we construct two different measures of international outsourcing. We define narrow outsourcing as the shift of a two-digit industry's *core activities* abroad represented by the value of the industry's imported intermediate inputs from the same industry abroad as a share of the domestic industries production value. The challenge is now to measure the respective industries imports of intermediate goods. A simple but equally distorting procedure would be to assume that all imports from a certain industry abroad are directed towards the respective domestic industry and nowhere else. Essentially this amounts to the construction of industry level import penetration ratios which are however rather poor measures of industries' outsourcing activities. Instead we utilise input-output data in order to allocate imports according to their usage as input factors across industries:

$$OUTS_{it}^{narrow} = \frac{IMP_{it} * S_{it}}{Y_{it}} \tag{1}$$

with Imp_{it} denoting imported intermediate inputs and Y_{it} the production value of industry i at time t. S_{it} denotes the share of imports from industry i abroad that is consumed by the domestic industry i in t with $\sum_{i=1}^{I} S_{it} \times IMP_{it}$ =total imports from industry i that is used in agriculture, manufacturing, services, private and public consumption, investment and exports in t.

Loosening the concept of an industries *core activities*, we somewhat less conservatively define wide outsourcing as a two-digit industries purchase of intermediate goods from abroad represented by the respective industries sum of imported intermediate goods from all manufacturing industries abroad as a share of the domestic industries production value:

$$OUTS_{it}^{wide} = \frac{\sum_{j=1}^{J} IMP_{ijt} * S_{ijt}}{Y_{it}} \tag{2}$$

Figure 1 shows the development of outsourcing in the whole manufacturing sector over time applying the narrow and wide concept respectively. In general international outsourcing has grown substantially over the last years. Naturally wide outsourcing has a higher level than narrow outsourcing but the development of both appears to by fairly parallel. If one looks at the development of outsourcing in specific industries a diverse picture emerges. Figure 2 shows that international outsourcing is of fairly different importance across industries. While the computer industry has an outsourcing intensity of up to 34% respectively 50%, the outsourcing intensity in the Glas and Ceramics industry is with 2% respectively 8% much lower. However, despite the differences in the extent of international outsourcing a significant increase in the outsourcing activity during the 1990's is common to most industries.

By differentiating imports one can construct outsourcing measures for different geographic regions. Equations 3 and 4 show the decomposition of the outsourcing measure by geographic

regions which is simply additive since the denominator is always the same and the weight is assumed to be constant:

$$OUTS_{it}^{narrow} = \frac{IMP_{it} * S_{it}}{Y_{it}} = \frac{\sum_{c=1}^{C} IMP_{ict} * S_{it}}{Y_{it}} \quad (3)$$

$$OUTS_{it}^{wide} = \frac{\sum_{j=1}^{J} IMP_{it} * S_{it}}{Y_{it}} = \frac{\sum_{c=1}^{C} \sum_{j=1}^{J} IMP_{ict} * S_{it}}{Y_{it}} \quad (4)$$

where c indicates the geographic region. Figures 3 and 4 show the development of international outsourcing towards Central and Eastern European Countries (CEC), the European Union (EU15) and in total for the whole manufacturing sector.[7] From the figures it is evident that by far most outsourcing takes place within the European Union (EU15).[8] In comparison outsourcing towards Central and Eastern Europe is of much lower magnitude no matter whether one follows the narrow or wide concept. From Figures 5 and 6 it is evident that this pattern holds not only for the aggregated level but for most industries. This is interesting, since evidently most outsourcing does indeed not occur in the direction of low wage countries but takes place among countries with reasonably similar productivity and wages indicating the importance of other factors such as economies of scale or tax breaks that trigger outsourcing.

However, the comparably low level of outsourcing towards Central and Eastern Europe in Figures 3 and 4 is not to belie the strong growth of outsourcing activities in these countries. Starting almost at zero narrow and wide outsourcing towards Central and Eastern Europe grew between 1991 and 2000 by about 623% and 462% respectively. Expressed in levels this

[7] Outsourcing in CEC and EU15 does not ad up to total outsourcing.

[8] A result that still holds if one includes other country groups such as Asia or North America in the picture.

increase amounted, however, to only 0.64 and 1.12 percentage points. Nevertheless, if this trend continues Central and Eastern European Countries could soon become very important as outsourcing partners, particularly for industries such as clothing, electrical equipment, motor vehicles or furniture and wood. As for today, perhaps somewhat calming down some of the hysteric voices that see German jobs rapidly fleeing the country towards the East, this is not the case.

IV Reviewing the literature

How can international outsourcing affect domestic labour markets and can it explain the observed skill upgrading in German manufacturing industries? In recent years the theoretical literature regarding the labour market impact of international outsourcing has been much advanced by a number of general equilibrium models (see Kohler (2004), Kohler (2001), Jones and Kierzkowski (2001), Arndt (1999), Arndt (1997). However, the implications of international outsourcing for the labour market are ambiguous. Depending on the models' assumptions and set up low-skilled workers might gain or loose from international outsourcing.

In our analysis we focus on the within industry skill upgrading effect of international outsourcing which essentially amounts to a partial equilibrium analysis. One model that is particularly intuitive in this context is Feenstra and Hanson (1996). Their one sector model rests on the assumption of different relative factor prices for low- and high-skilled labour in two regions (North and South). The North is assumed to have a lower relative wage for high-skilled labour and thus an absolute cost advantage in the production of skill-intensive intermediate goods. According to the model, capital growth or Hicks-neutral technological progress in the South relative to the North results in a cost advantage of the South in production stages with a higher skill intensity in which the North initially had a cost advantage. As a result the North has to specialise in increasingly skill-intensive production stages in

order to maintain a cost advantage, which leads to decreased relative demand for low-skilled labour. It should be stressed, however, that the above model only assumes one final goods sector. Applying the model to a whole economy with many sectors as we do in this paper abstracts from the possibility of factor movements between sectors, which is only plausible in the short run. Explicitly or implicitly most existing empirical studies on the labour market impact of international outsourcing make this assumption.

Feenstra and Hanson (1996) provide one of the first empirical assessments of the impact of international outsourcing on the relative demand for low-skilled workers. In their study on the United States they approximate international outsourcing by the share of imports from a particular industry abroad in total domestic demand for that industry's products. Their empirical model is based on a translog cost function with capital as quasi fixed input. From this cost function, a cost share equation for non-production workers is derived. In order to assess the impact of outsourcing, Feenstra and Hanson extend the cost share equation to include the calculated industry's outsourcing intensity. Following this procedure, the authors report that approximately 15% to 33% of the increase of the cost share of non-production labour over the period 1979-1987 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 labour in U.S. manufacturing between 1979 and 1990.

A similar study was undertaken by Anderton and Brenton (1999) for the UK. They estimate the impact of outsourcing, which is approximated by import penetration ratios, for a panel of eleven disaggregated textile and mechanical engineering industries. In contrast to Feenstra and Hanson (1996), they do, however, distinguish between imports from low- and high-wage countries. As might be expected, only the coefficient of import penetration from

low-wage countries is statistically significant.[9] Furthermore, the impact differs between high-skill-intensive mechanical engineering and the low-skill-intensive textiles industry. While the coefficient of the import penetration variable is, in general, not statistically significant for the mechanical engineering industries, in the textiles industry up to 40% of the observed rise in the cost share and up to 33% of the rise in the employment share of skilled workers between 1970 and 1983 can be explained by import penetration from low-wage countries.

Another study on the effects of international outsourcing on the UK labour market includes Hijzen, Görg and Hine (2004). Instead of using import penetration ratios as in Anderton and Brenton (1999) the authors construct a narrower more accurate outsourcing measure on the basis of UK input-output tables. Their results suggest a strong negative effect of international outsourcing on the demand for low-skilled workers.

Morrison-Paul and Siegel (2001) extend the above studies by simultaneously incorporating several trade and technology related measures that can shift relative labour 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 labour in the U.S.

Falk and Koebel (2000) use a similar approach, applying a fairly wide definition of international outsourcing. Using a Box Cox cost function, which nests the normalised quadratic as well as the translog functional form, they estimate elasticities of substitution between the variable input factors: high-, medium- and low skilled labour as well as imported intermediate materials, domestic non-energy intermediate materials, energy and intermediate services. However their findings for Germany suggest that neither imported material inputs nor intermediate services substitute for unskilled labour. In a second step Falk and Koebel (2000) compare their results with those of Feenstra and Hanson (1999), applying a similar translog cost function. Again outsourcing is found to be statistically insignificant for the

[9]The assumption is that low-skill activities are typically outsourced to low-wage countries.

cost share of unskilled labour.

The above studies look at the impact of outsourcing on labour markets in *sending* respectively developed countries. One of the few studies taking the perspective of *receiving* countries is Egger and Stehrer (2003) who analyse the labour market impact of international outsourcing in the Czech Republic, Poland and Hungary. Approximating international outsourcing with trade in intermediate goods the authors find that outsourcing has a significant positive effect on the low-skilled workers wage bill share. Thus, while for *sending* countries many of the empirical studies have found significant negative effects of outsourcing on the relative demand for low-skilled workers in *receiving* Central and Eastern European countries outsourcing is found to have the opposite effect.

In the following section we develop the empirical model which in its general outline is similar to the specification proposed in Berman et al. (1994) and Feenstra and Hanson (1996). However, instead of using first differences which potentially could exacerbate measurement errors in the data (see Grilliches and Hausman (1986)), we estimate in levels with fixed effects and account for the endogeneity of some regressors. Furthermore we will differentiate between the effects of international outsourcing in different geographic regions.

V The Empirical Model and Estimation

The starting point for the econometric model is an arbitrary production function for each industry i. If firms are profit maximizing and if isoquants of the production function are convex, there exists a dual variable unit cost function for each industry:

$$cv_i = cv\left(W_i^{HS}, W_i^{LS}, Y_i, \frac{K_i}{Y_i}, Outs_i, T_i\right) \tag{5}$$

with W_i^{HS} and W_i^{LS} representing the respective wage rates for high- and low-skilled labor in industry i,

Y_i industry output[10],

$\frac{K_i}{Y_i}$ the quasi fixed capital input expressed as capital intensity,

$Outs_i$ the share of imported intermediates as defined in equations 1 and 2 and

T_i technology.

Both $Outs_i$ and T_i are parameters that represent a shift in the production technology either due to international outsourcing or due to technological progress. Assuming that capital is quasi fixed takes account of the fact that it may differ from its long-run equilibrium, implicitly incorporating adjustment costs.

The unit cost function can be approximated by a general translog function with variable and quasi fixed input factors that was introduced by Brown and Christensen (1981). Differentiation of the variable cost function with respect to prices of the variable factors gives the respective factor demand equation. Since the cost function is in logarithmic form, differentiation yields the factor's share in total variable costs:

$$\frac{\partial \ln cv_i}{\partial \ln W_i^{HS}} = \frac{W_i^{HS}}{cv_i} \times \frac{\partial cv_i}{\partial W_i^{HS}} = \frac{W_i^{HS} L_i^{HS}}{cv_i} = S_i^{HS} \tag{6}$$

$$\frac{\partial \ln cv_i}{\partial \ln W_i^{LS}} = \frac{W_i^{LS}}{cv_i} \times \frac{\partial cv_i}{\partial W_i^{LS}} = \frac{W_i^{LS} L_i^{LS}}{cv_i} = S_i^{LS} \tag{7}$$

where S^{HS} and S^{LS} denote the cost share of high- and low-skilled labor in variable costs. Since high-skilled and low-skilled labor are the only variable inputs, both factor share equations have to add up to one and only one of them is linearly independent. The cost share can be understood as a composite expression of the relative demand for low-skilled labor that reflects not only relative employment but also relative factor prices. Imposing symmetry and homogeneity, the equation can be further simplified. The result is a linear equation expressed in the logarithmic of the relative wage for low-skilled labor, output, the quasi fixed input factor capital expressed as capital intensity, as well as the non-logarithmic technological shift parameters for each industry. Adding a time dimension and a stochastic error term u_i with

[10]Including output in the unit cost function allows for changing returns to scale.

$E(u_i) = 0$ and $Var(u_i) = \sigma^2$ yields a fully specified econometric model:

$$\begin{aligned} S_{it}^{LS} &= \beta_{LS} + \theta \ln (W_{it}^{HS}/W_{it}^{LS}) \\ &+ \varphi_Y \ln Y_{it} + \varphi_K \ln \frac{K_{it}}{Y_{it}} + \phi_O Outs_{it} + \eta_{RD} T_{it} + u_{it} \end{aligned} \tag{8}$$

In imposing the restriction that the coefficients of the independent variables are equal across industries, the estimation can be pooled, hence utilizing time and cross section variation. However, estimates are inconsistent if industry specific time invariant unobserved characteristics are present and correlated with the time varying explanatory variables. In the context of our industry panel it is reasonable to assume that industries are heterogeneous with respect to time invariant characteristics such as structure or average managerial quality. Furthermore a Hausman test rejects the hypothesis that industry specific unobserved characteristics are not systematically correlated with the time varying explanatory variables. We therefore control for industries' unobserved heterogeneity by including a set of industry dummies (fixed effects) ID_i.

One difficulty is how to control for technological progress. One common method is to use expenditure on research and development (r&d) as a proxy for technological progress. Since data on r&d at the two-digit industry level in Germany is only available since 1995 and is actually collected only biannually[11] following this approach is not an option.[12] One alternative is to use linear time trends to capture technological change. This procedure

[11]Data on research and development expenditure is collected by the German foundation *Stifterverband für die deutsche Wissenschaft* on a biannual basis. Data provided by the OECD as part of the ANBERD data base imputes missing years in an undocumented way.

[12]We do however also estimate our model specifications including r&d expenditure for the years 1995 to 2000. The variable is statistically insignificant in all specifications and the coefficient on our outsourcing variable is significantly higher. This, however, is not due to the inclusion of the r&d variable but also holds without r&d if the model is estimated from 1995 onwards.

is however fairly restrictive as technological change would be assumed to be linear and monotonous. Instead, we include a set of time dummies TD_t that captures technological progress and other macroeconomic shocks that are not explicitly dealt with. This assumes a common technological drift across all industries which may not be too problematic since technological diffusion is arguably very high within a country.

Futhermore, following Berman et al. (1994) capital is differentiated in production equipment and plant due to their potentially different implications for the skill structure of employment.

Finally, our aim is to differentiate between the labour market impact of outsourcing in different geographic regions particularly in Central and Eastern Europe. Following Equation 3 we therefore split our outsourcing measure up into outsourcing in Central and Eastern Europe and the rest of the world. After taking the above alterations of the model into account the specification to be estimated is:

$$\begin{aligned} S_{it}^{LS} &= \beta_{LS} + \theta \ln (W_i^{HS}/W_i^{LS})_t + \varphi_Y \ln Y_{it} \varphi_E \ln \frac{Equ_{it}}{Y_{it}} + \varphi_P \ln \frac{Plant_{it}}{Y_{it}} \\ &+ \phi_{CEC} Outs_{it}^{CEC} + \phi_{ROW} Outs_{it}^{ROW} + TD_t + ID_i + \epsilon_{it} \end{aligned} \tag{9}$$

As mentioned previously, the dependent variable is a composite measure of the demand for low-skilled labour that reflects relative employment and relative wages. The relative wage variable is therefore by definition correlated with the dependent variable. However including the relative wage variable is appropriate as it can control for some of the variation in the composite dependent variable leaving the remaining variation in relative employment to be explained by the other exogenous variables. It does seem questionable, however, whether or not the relative wage variable $\ln (W_i^{HS}/W_i^{LS})$ is indeed exogenous. If industry wages and the relative demand for low-skilled labour are simultaneously determined, which cannot be ruled out a priori even with high wage coordination across German manufacturing industries,

estimation of the model would deliver biased coefficients.

Similarly, it is questionable whether international outsourcing is indeed exogenous. Although various exogenous changes such as the political and economical opening of Eastern Europa after the fall of the iron curtain, advances in communication technologies or recent rounds of trade liberalisation have made international outsourcing much easier, whether or not to outsource and to what extend still essentially is a choice variable at the industry level that could be affected by wages.

Applying General Method of Moments (GMM) using one and two year lagged values, we can estimate the parameters of the above model in a consistent way. However, results produced by GMM are generally not efficient. It is therefore highly advisable to test for endogeneity first. We carry out a heteroscedasticity consistent C-test (see Baum, Schaffer and Stillman (2003)) for exogeneity of the relative wage variable and international outsourcing.[13] Table 1 reports the respective test statistics for the above model for wide and narrow outsourcing.

Table 1: Exogeneity tests

Outsourcing	Variable	Test statistic	Exogeneity
Narrow	$\ln \frac{W^{HS}}{W^{LS}}$	$Chi^2 = 0.264$	
		$P - value = 0.607$	not rejected
	$Outs^{CEC}$ and $Outs^{ROW}$	$Chi^2 = 7.333$	
		$P - value = 0.026$	rejected
Wide	$\ln \frac{W^{HS}}{W^{LS}}$	$Chi^2 = 0.490$	
		$P - value = 0.484$	not rejected
	$Outs^{CEC}$ and $Outs^{ROW}$	$Chi^2 = 8.489$	
		$P - value = 0.014$	rejected

[13] All GMM related estimations are carried out using the ivreg2 stata module by Baum et al. (2003).

Accordingly, including the relative wage in the model does not yield biased coefficients as exogeneity of the variable cannot be rejected within reasonable confidence bounds. However, the tests clearly indicate that international outsourcing can indeed not be taken as exogenous, we have to apply GMM to derive consistent parameter estimates. Valid instruments have to have predictive power for the variable and have to be orthogonal to the dependent variable. Using one and two years lagged values of international outsourcing as instruments fulfills these requirements as the test statistics documented in Table 3 indicate.

VI Empirical Results

The coefficient of the relative wage for low skilled labour is expected to take on a positive sign as the cost share of low skilled labour should in general increase in the relative wage, however this is an empirical issue. With regard to capital it is well established that while labour and capital are in general substitutes, capital is more readily substituted for low-skilled than for high-skilled labour [see, for instance, Griliches (1969)]. However previous empirical work by Berman et al. (1994) points to the fact that equipment and plant have a different impact on the skill intensity of production. Accordingly the coefficient of equipment should take on a negative sign while that of plant should take on a positive sign. Following the model of Feenstra and Hanson (1996) international outsourcing is expected to have a negative impact on the relative demand for low-skilled labour. Technological progress is presumably biased against unskilled labour [compare Berman et al. (1994)], hence the coefficient of the time dummies with 1993 as default category should also have a negative sign.

GMM regression results are shown in Table 3 columns (a)-(c). Columns (a) and (c) contain the results for narrow and wide outsourcing not differentiated between geographic regions for comparison.

In all model specifications the relative wage for manual workers is statistically significant and positive as expected. Furthermore we do not find a different effect of equipment and

plant, both, however insignificant, are negative. Output is found to be significant only in the specifications with the wide outsourcing measure. However, the sign of the coefficient is always negative indicating that if the production value does effect the skill composition at all it lowers relative demand for manual workers.

The time dummies, however, are highly statistically significant. The negative and in absolute terms increasing coefficients indicate a substantial decline in the within industry relative demand for manual workers since 1993 that cannot be explained by our explicit control variables. Our results therefore suggest an important role of other factors such as common technological progress for driving relative demand for manual workers down.

Regarding international outsourcing, applying the narrow concept and not differentiating by region we find only statistically insignificant effects on the wage bill share of manual workers. However, after we distinguish between international outsourcing in different geographic regions we find large positive statistically significant effects of outsourcing in Central and Eastern Europe. Our estimates suggest that a one percentage point increase in the outsourcing activity towards Central and Eastern Europe lowers the wage bill share of manual workers by more than four percentage points. Outsourcing towards countries outside Central and Eastern Europe is however rendered insignificant. Following the wide concept of international outsourcing, we now find a statistically significant overall negative effect of international outsourcing at least at the 10% level. However, when we differentiate between geographic regions only international outsourcing towards Central and Eastern Europe is found to be statistically significant. Following the wide concept, an one percentage point increase in the outsourcing activity in Central and Eastern Europe lowers the wage bill share of manual workers by almost three percentage points. For comparison we also report results for simple dummy variable OLS regressions not corrected for endogeneity of international outsourcing in Table 4. Clearly, not accounting for endogeneity of international outsourcing severely biases the estimated coefficients, which of course is also apparent through the exo-

geneity tests. Compared to our endogeneity consistent GMM results the negative impact of outsourcing in Central and Eastern Europe is significantly understated while the impact of outsourcing outside Central and Eastern Europe is overestimated. Not accounting for the endogeneity of international outsourcing therefore only can give lower bounds for the adverse effects of outsourcing on the relative demand for low skilled workers.

Our estimates sofar suggest an important role of international outsourcing towards Central and Eastern Europe for lowering relative demand for manual workers in German manufacturing industries. However, based on the point estimates we can evaluate the economic significance of international outsourcing more thoroughly. Particularly, we can asses how significant international outsourcing is in comparison to technological progress. Figures 7 and 8 show the predicted manual workers wage bill share as a solid line for the model with narrow and wide outsourcing respectively.[14] To asses the impact of international outsourcing we first predict the manual workers wage bill share holding outsourcing constant at its 1991 value which corresponds to the dashed line.[15] Subsequently, we assess the role of outsourcing and technological progress simultaneously by predicting the wage bill share holding outsourcing constant and recoding all time dummies to zero thereby abstracting from a common technological shift (dotted-dashed line). As becomes evident from the graphs outsourcing has had a pronounced negative effect on the manual workers wage bill share between 1991 and 2000. Overall our model predicts a decline in the manual workers wage bill share of about 4.7 percentage points. If, however, narrow outsourcing would not have grown since 1991 this

[14]The industry level wage bill share predictions have been aggregated using the respective industry's cost share (wages and salaries in total manufacturing wage and salary sum) as weights.

[15]Our simulation is out of sample for two reasons. First, we simulate the economic effects of international outsourcing for the period 1991-2000 although the model parameters are only estimated for 1993-2000 as lagged outsourcing values are used as instruments. Second, we estimated the model including the publishing and coke and petroleum industry. For these industries data on the wage bill share of manual workers are only available from 1995 onwards.

decline only had been 2 percentage points. Accordingly, narrow international outsourcing can explain about 2.7 percentage points or 57% of the overall decline in the wage bill share of manual workers. When we, in addition to holding narrow outsourcing constant, abstract from technological progress the manual workers wage bill share would have actually increased by 0.9 percentage points. Accordingly, international outsourcing and technological progress together account for a decline in the manual workers wage bill share of 5.6 percentage points. Following these results technological progress alone lowers the manual workers wage bill share by 2.9 percentage points.

For wide outsourcing a similar picture emerges. While our model predictions suggest an overall decline in the manual workers wage bill share of 4.8 percentage points, of this outsourcing can explain about 3.6 and technological progress 2 percentage points. That is, the wage bill share of manual workers would actually have increased between 1991 and 2000 by 0.8 percentage points without technological progress and had outsourcing remained at its 1991 level.

Summarising, international outsourcing is indeed an important economic factor that drives relative demand for manual workers down. However, technological change is equally important for explaining within industry skill upgrading.

VII Conclusion

Starting from the observation of significant within industry skill-upgrading during the 1990's we assess the role of international outsourcing in this process. Extending the existing literature we construct two alternative measures of international outsourcing and differentiate between the geographic region of an industries outsourcing activity.

The empirical analysis showed that international outsourcing, or more precisely international outsourcing towards Central and Eastern Europe, is indeed an important explanatory factor for the observed decline in relative demand for manual workers in German manufac-

turing. Applying a conservative narrow outsourcing measure and controlling for the adverse demand effects of skill-biased technological change, time changing industry characteristics, wages as well as fixed effects, international outsourcing towards Central and Eastern Europe is found to have lowered the manual workers wage bill share by 2.7 percentage points between 1991 and 2000. With relative wages that were fairly close to stable during the 1990's, the reduced demand for manual workers had to be mainly met by decreasing relative employment of manual workers. Does outsourcing to Central and Eastern Europe really threaten manual workers' jobs in Germany? Yes, our results clearly indicate this, at least in the short run.

Furthermore, in the light of growing integration in world markets, for instance due to the eastern enlargement of the EU, international outsourcing is likely to gain importance and to lead to further negative demand shifts away from manual workers in the future. Under the current regime of nearly inflexible relative wages, manual workers are therefore increasingly likely to be permanently excluded from the labour market in Germany.

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A Data

The empirical analysis is based on aggregated manufacturing industry data for the period 1991-2000, following the NACE Rev. 1.1 classification. Unfortunately, systematic changes in the industry classification prevent the usage of longer time series before 1991. Data is available for 22 manufacturing industries with maximal ten observations over time. However for the two-digit industries publishing and printing and oil refining, nuclear fuel and petroleum data for wages and salaries are only available from 1995 onwards. For our GMM estimation we use one and two years lagged variables as instruments. Accordingly, the model can only be estimated over the period 1993-2000 with 172 observations.

Data on the average wage, as well as on the total wage payments at a sectoral level, are available only for the broad groups of production and non-production workers. High-skilled workers are assumed to be non-production workers. This can be justified by the fact that the share of higher skill levels in non-production labour is higher than that in production labour. Data can be obtained from the online time series service of the German Federal Statistical Office (https://www-genesis.destatis.de/genesis/online/logon). Data on the used net capital at 1995 prices and nominal production values can also be obtained from this source.

The values of imported intermediates are derived from the OECD commodity trade statistic. Disaggregated SITC-5digit trade data is aggregated to NACE two-digit industries and then weighted using weights obtained from German annual input-output tables (Federal Statistical Office, Fachserie 18, Reihe 2).

The value of imported inputs and production is adjusted to the prices of 1995

using the price index for imported manufacturing goods (Federal Statistical Office, Fachserie 17, Reihe 8) and the aggregate producer price index for manufacturing goods (Federal Statistical Office, Fachserie 17, Reihe 21).

B Figures and Tables

Figure 1: Outsourcing over time

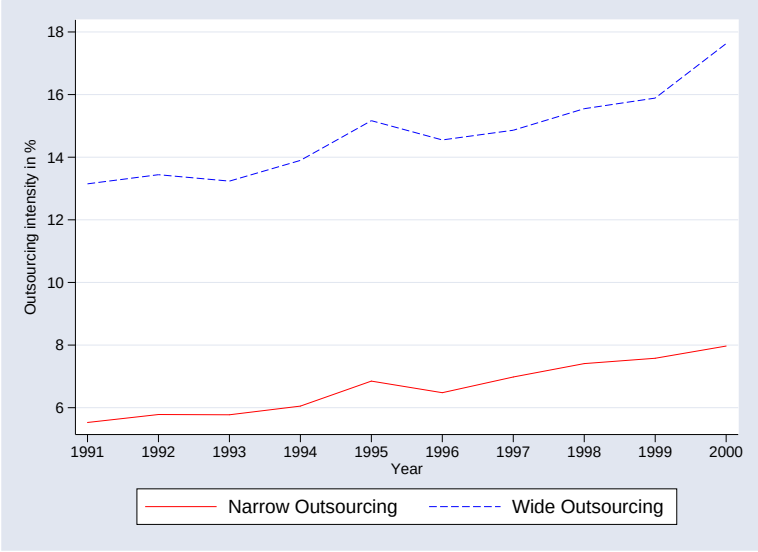

Figure 2: Outsourcing by industry

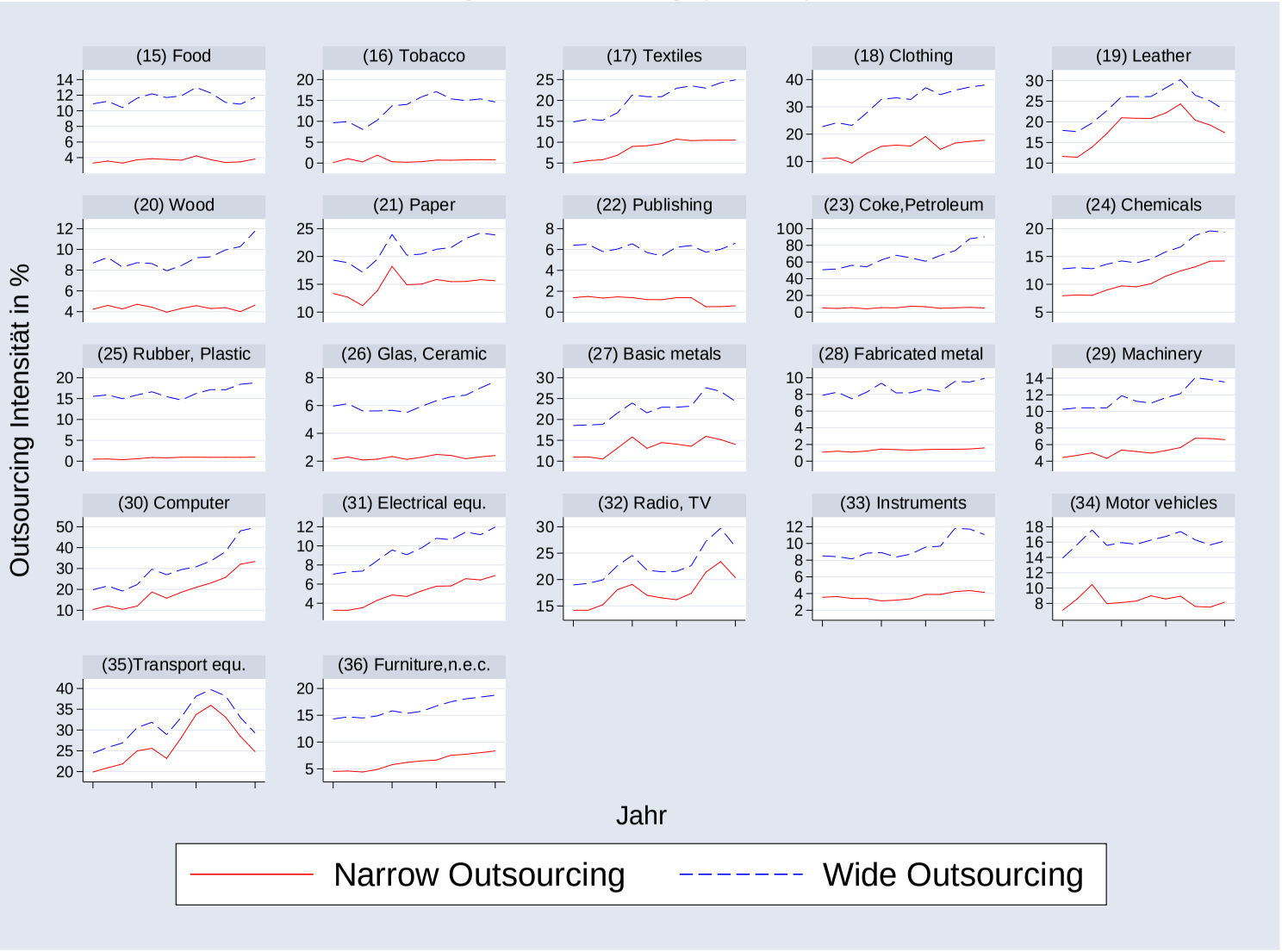

Figure 3: Narrow outsourcing by region

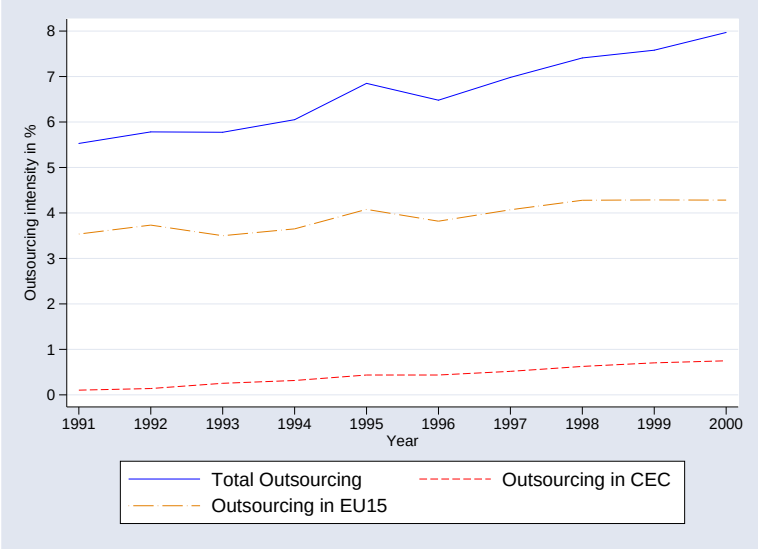

Figure 4: Wide outsourcing by region

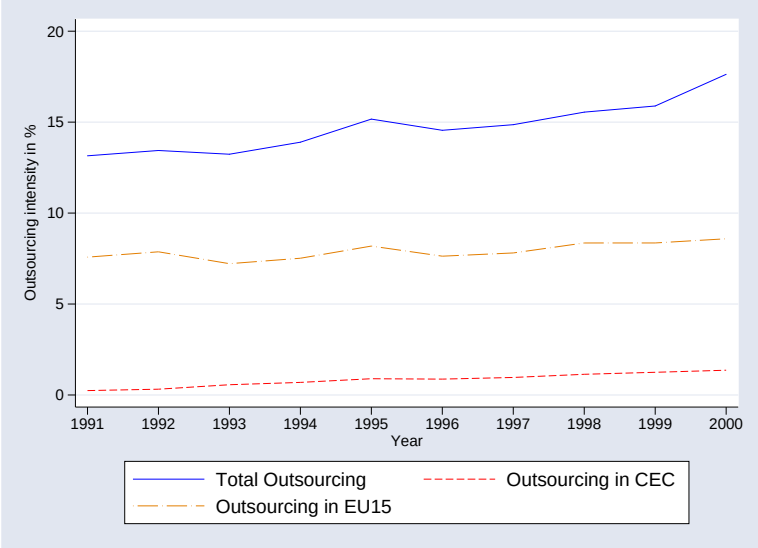

Figure 5: Narrow outsourcing by industry and region

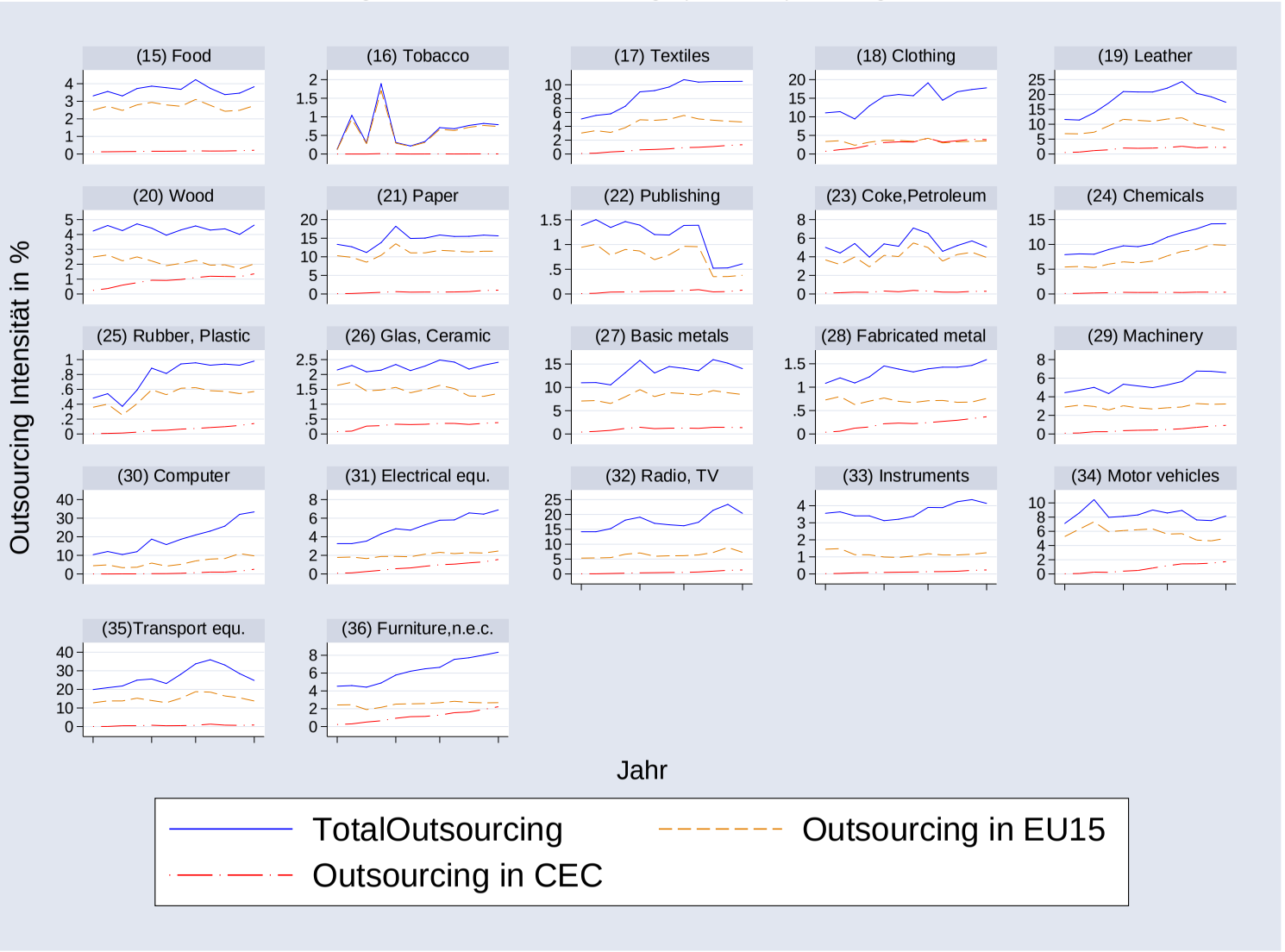

Figure 6: Wide outsourcing by industry and region

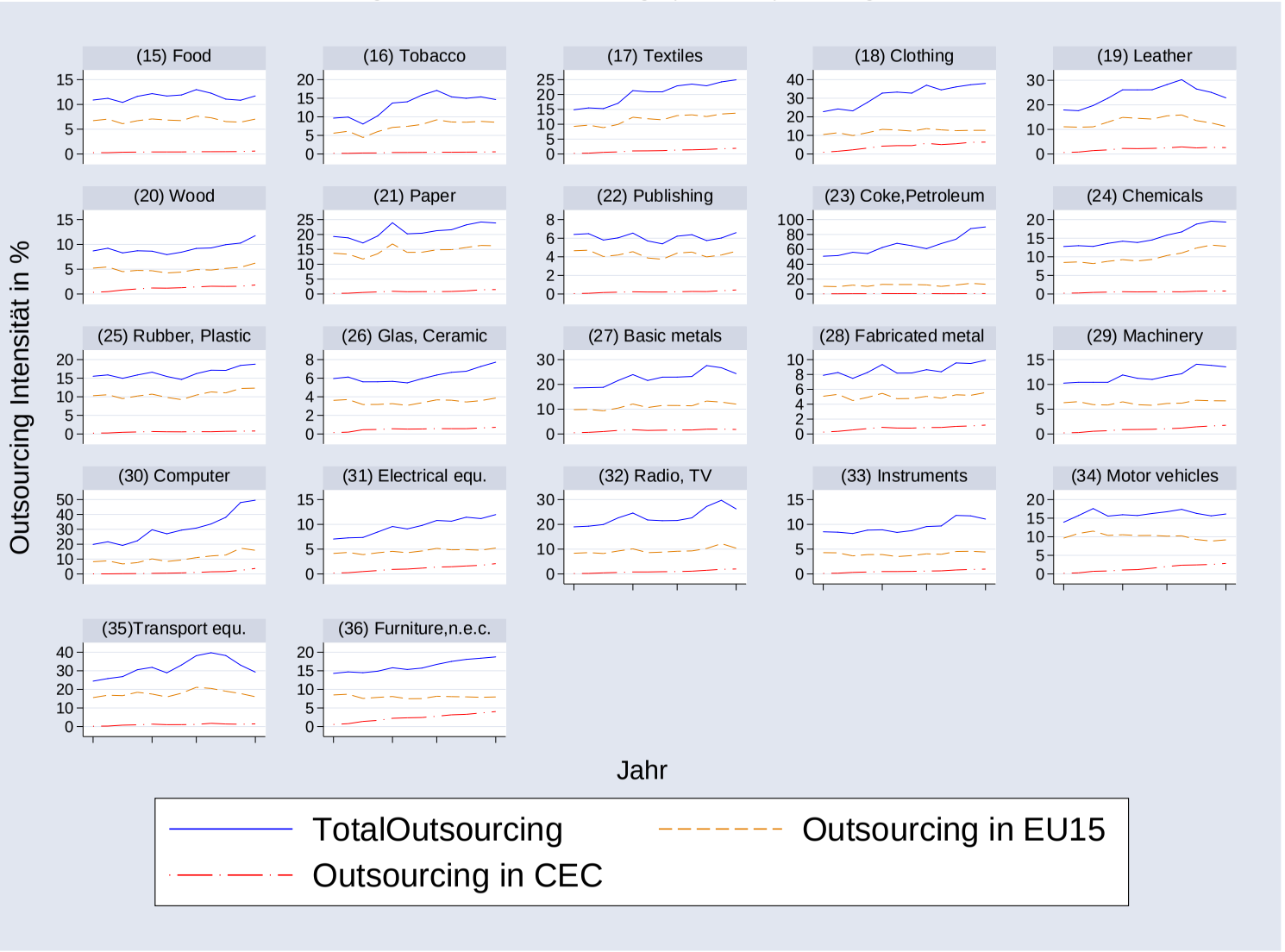

Figure 7: Simulation of narrow outsourcing and technology effects

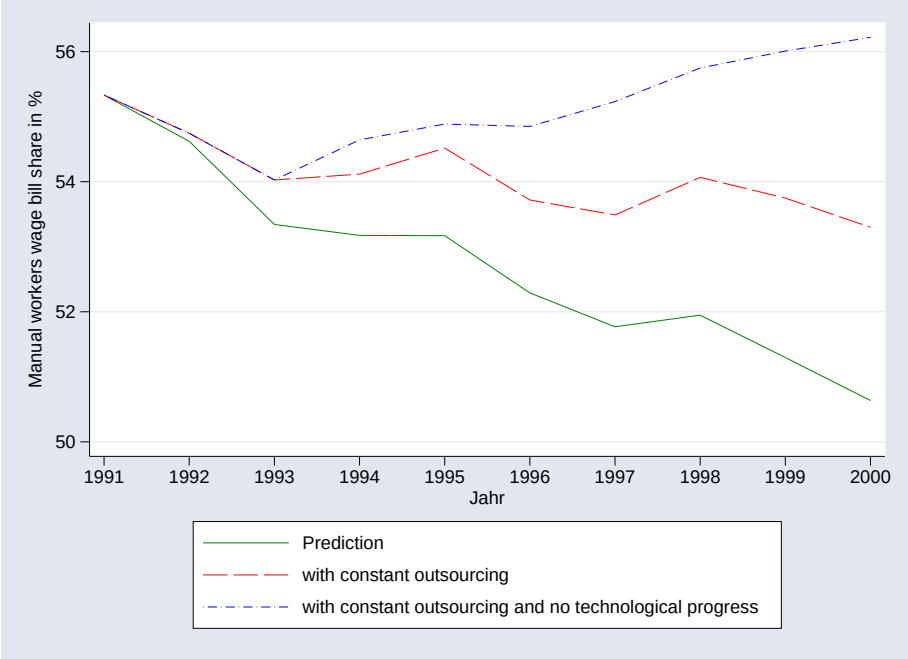

Figure 8: Simulation of wide outsourcing and technology effects

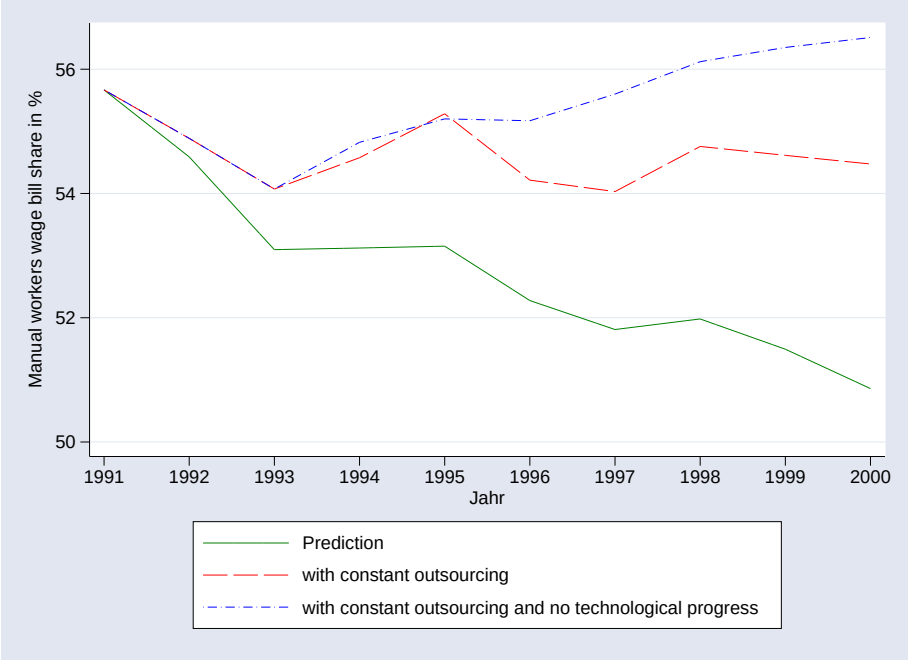

Table 2: Average yearly employment growth for different skill groups*

	Overall	Medium-Skilled	High-Skilled	Low Skilled
1975-2000	0.58%	1.32%	4.02%	-2.67%
1975-1990	0.73%	2.10%	4.32%	-3.55%
1991-2000	0.36%	0.15%	3.56%	-1.34%

* Only Western Germany and Berlin-West

Source: Reinberg and Hummel (2002), authors' calculations

Table 3: GMM regression results

	Narrow Outsourcing		Wide Outsourcing	
	(a)	(b)	(c)	(d)
$Outs^{World}$	0.010		-0.259	
	[0.07]		[1.72]*	
$Outs^{CEC}$		-4.357		-2.694
		[4.45]***		[4.81]***
$Outs^{ROW}$		0.139		-0.175
		[1.16]		[1.54]
$\ln \frac{W^{HS}}{W^{LS}}$	0.257	0.229	0.280	0.272
	[4.84]***	[3.90]***	[4.69]***	[4.24]***
$\ln Y$	-0.016	-0.053	-0.072	-0.088
	[0.45]	[1.53]	[1.69]*	[2.27]**
$\ln \frac{Equ}{Y}$	-0.045	-0.042	-0.099	-0.085
	[1.32]	[1.30]	[2.56]**	[2.38]**
$\ln \frac{Plant}{Y}$	-0.035	-0.073	-0.045	-0.075
	[0.94]	[2.01]**	[1.20]	[2.10]**
Year=1994	-0.009	-0.005	-0.005	-0.002
	[1.69]*	[1.22]	[0.98]	[0.57]
Year=1995	-0.014	-0.004	-0.007	0.001
	[2.66]***	[0.66]	[1.33]	[0.15]
Year=1996	-0.021	-0.011	-0.017	-0.010
	[4.42]***	[2.24]**	[3.75]***	[1.92]*
Year=1997	-0.028	-0.017	-0.024	-0.016
	[5.36]***	[3.24]***	[4.77]***	[2.90]***
Year=1998	-0.032	-0.017	-0.025	-0.014
	[5.20]***	[2.55]**	[4.31]***	[2.13]**
Year=1999	-0.038	-0.023	-0.029	-0.017
	[5.64]***	[3.05]***	[4.16]***	[2.25]**
Year=2000	-0.045	-0.029	-0.031	-0.020
	[5.78]***	[3.67]***	[3.90]***	[2.41]**
Constant	0.611	0.819	1.034	1.111
	[2.47]**	[3.31]***	[3.48]***	[4.03]***
Observations	172	172	172	172
R^2	0.99	0.99	0.99	0.99
Test of predictive power of instruments				
F-test	22.72	8.99/17.42	16.89	25.03/8.21
P-value	0.00	0.00/0.00	0.00	0.00/0.00
Test of orthogonality of instruments				
Hansen J-statistic	0.065	1.885	2.658	1.657
P-value	0.798	0.390	0.103	0.437

Notes: t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
All regressions include full set of industry dummies

Table 4: Dummy OLS regression results

	Narrow Outsourcing		Wide Outsourcing	
	(a)	(b)	(c)	(d)
$Outs^{World}$	0.029		-0.087	
	[0.39]		[1.24]	
$Outs^{CEC}$		-2.236		-1.864
		[4.05]***		[4.58]***
$Outs^{ROW}$		0.173		0.009
		[2.19]**		[0.13]
$\ln \frac{W^{HS}}{W^{LS}}$	0.250	0.243	0.257	0.265
	[4.76]***	[4.89]***	[4.98]***	[5.48]***
$\ln Y$	-0.011	-0.023	-0.030	-0.049
	[0.37]	[0.81]	[0.99]	[1.70]*
$\ln \frac{Equ_{it}}{Y_{it}}$	-0.041	-0.037	-0.056	-0.055
	[1.50]	[1.45]	[1.97]*	[2.06]**
$\ln \frac{Plant_{it}}{Y_{it}}$	-0.035	-0.050	-0.044	-0.061
	[1.05]	[1.55]	[1.33]	[1.96]*
Year=1994	-0.009	-0.008	-0.008	-0.006
	[1.94]*	[1.76]*	[1.69]*	[1.38]
Year=1995	-0.014	-0.010	-0.012	-0.007
	[2.96]***	[2.24]**	[2.37]**	[1.36]
Year=1996	-0.021	-0.017	-0.020	-0.015
	[4.38]***	[3.61]***	[4.05]***	[3.11]***
Year=1997	-0.028	-0.024	-0.027	-0.021
	[5.53]***	[4.76]***	[5.25]***	[4.25]***
Year=1998	-0.032	-0.026	-0.030	-0.022
	[5.89]***	[4.80]***	[5.40]***	[4.02]***
Year=1999	-0.038	-0.031	-0.035	-0.027
	[6.71]***	[5.45]***	[5.99]***	[4.54]***
Year=2000	-0.046	-0.039	-0.043	-0.033
	[7.31]***	[6.25]***	[6.35]***	[4.99]***
Constant	0.660	0.761	0.838	1.007
	[2.38]**	[2.89]***	[3.02]***	[3.82]***
Observations	172	172	172	172
R^2	0.50	0.55	0.50	0.56

Notes: t-statistics in parentheses * significant at 10%, ** at 5%, *** at1%
All regressions include full set of industry dummies