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Labor market effects of outsourcing under industrial interdependence

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Abstract

The consequences of *international* outsourcing in traditional models of trade are already well understood. However, with regard to empirical research there seem to be still some important shortcomings. Empirical studies on the labor market effects of outsourcing are mainly based on the same techniques that have been used for years. In terms of the adopted econometric specifications, one assumption is typical and – as we will show – critical in this regard. Practically all studies we are aware of assume independence between industries and neglect any spillover and feedback effects across industries. In fact, this is at odds with multi-sector general equilibrium models of trade. It is this paper's focus to relax this restrictive assumption and to suggest the use of different econometric methods. We consider national input–output linkages and cross industrial flows of workers as two important channels of inter-industrial spillovers in labor market effects. We focus on these transmission channels in an Austrian panel data set of 21 two-digit industries in the 1990s and find that industrial interdependencies induce a multiplier effect for changes in industry-specific variables such as international outsourcing. Disregarding spillover effects, therefore, leads to a substantial underestimation of the labor market implications of international outsourcing.

JEL classification: C33; F14; F15; F16
Keywords: Fragmentation; Skill-specific employment; Simultaneous equations; Industrial interdependence

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1. Introduction

The notable increase of international outsourcing in the last few decades has come into the limelight of interest in the scientific discussion on the effects of globalization. As put forward by several authors, it is vertical fragmentation and international trade of intermediate goods that makes globalization today so different from market integration a hundred years ago. Krugman (1995, p. 331) remarks that "it is hard to argue that the sheer volume of trade marks a qualitative difference from previous experience" and Feenstra & Hanson (2001, p. 5) conclude that it is the composition of trade in general and the share of intermediate goods in particular which matters. Grossman & Helpman (2002b, p. 1) summarize the existing views by stating: "We live in an age of outsourcing."

Nowadays, international outsourcing is seen as an important alternative to skill-biased technical change as induced by the increasing use of computer facilities to explain factor market developments in the industrialized world.[2] Feenstra & Hanson (1996a, 1999) have shown that international outsourcing accounts for up to 30% of the increase in relative wages observed in US labor markets in the 1980s. In continental European economies, wage effects should be of minor importance, given the prevalence of institutions like trade unions. In a unionized economy, international outsourcing has employment rather than wage effects, since factor prices are not (fully) flexible. Using a panel of Austrian manufacturing industries, Egger & Egger (2003) confirm this hypothesis and show that international outsourcing to Central and Eastern European Economies (CEECs) significantly shifts relative employment in favor of skilled labor.

In the theoretical discussion on international outsourcing, two strands of the literature can be distinguished. On one hand, traditional models of the Ricardo, Heckscher–Ohlin and Ricardo–Viner type emphasize the locational aspect and investigate the role of transport costs, costs for service links and the like for international outsourcing as compared to production within the borders of a single economy (see Jones, 2000). On the other hand, models building upon contract theoretical approaches emphasize a firm's decision to produce in-house or to purchase inputs from outside the firm (see Grossman & Helpman, 2002a). In this case, the question of national versus international outsourcing is of second-order importance. However, as put forward by McLaren (2000), international openness may have important market thickness effects which are able to explain cross-country differences in the structure of industrial production.[3]

In this paper, we emphasize a specific aspect of the theoretical insights, namely the sectoral interdependence in a general equilibrium setting. It is well known from the literature that access to international outsourcing in a specific industry may have substantial feedback effects on other industries. On one hand, the outsourcing decisions of firms may depend on the production structure and factor intensities in other sectors. On the other hand, one may think of factor flows that transmit international outsourcing effects to other sectors. In any case, it is implausible from a theoretical point of view to assume sectoral developments as being independent.

[2] Potential gains and losses of international outsourcing have been put forward in a recent debate on the consequences of globalization. See the two articles by Samuelson (2004) and Bhagwati, Panagariya, & Srinivasan (2004). The latter conclude: "While outsourcing will increase aggregate income, it can, like international trade in goods, also lead to displacement of workers from certain sectors" (p.35).

[3] See Egger & Falkinger (2003a) for a rigorous discussion on the possible types of decisions involved, when a firm outsources input production.

Interestingly, the whole branch of empirical research on international outsourcing has so far neglected any interdependence of industries. But rather, industries are treated as independent clusters of firms. This is a major shortcoming, since the estimated wage and employment effects of international outsourcing may be downward biased, if inter-sectoral multiplier effects are ignored.

It is the purpose of this paper to introduce spatial econometric methods for panel data (see Kapoor, Kelejian & Prucha, 2003) in the discussion on factor market implications of international outsourcing. Thereby, we focus on the employment effects of Austrian outsourcing to Central and Eastern European Economies, which dramatically increased in the period after the fall of the Iron Curtain. Based on earlier results by Egger & Egger (2003), we concentrate on the impact of the aforementioned industrial interdependencies. In particular, we show in which way the parameter estimates are influenced by this modification and that the total effects of international outsourcing may be substantially underestimated, if industrial interdependencies are not adequately accounted for.

The rest of the paper is organized in the following way. Section 2 provides a theoretical motivation for the considered transmission channels and relates our discussion to the existing literature. Section 3 discusses descriptive statistics and summarizes the results from the econometric benchmark case assuming industrial independence. Section 4 presents the empirical analysis and Section 5 concludes with a summary of the main results.

2. Theoretical motivation and related literature

In the theoretical literature, trade models in the spirit of Ricardo (Deardorff, 2001), Heckscher–Ohlin (Egger & Falkinger, 2003b; Jones & Kierzkowski, 2001a; Kohler, 2003) and Ricardo–Viner (Kohler, 2001) have been put forward to analyze the basic economic mechanisms at work, when international outsourcing opportunities affect factor prices. These traditional settings share an important feature, namely the assumption of more than one sector of production. This is in contrast to Feenstra & Hanson's (1996b) early contribution to the literature on international outsourcing that builds upon a one-sector framework (i.e., there is only one sector of *final* goods production). From a theoretical perspective, the latter is restrictive with respect to the possible channels of influence. In particular, inter-sectoral adjustment effects to an exogenous shock are ruled out by assumption. To be more precise, if access to international outsourcing in a particular sector impacts on employment and wages in that industry, we should expect spillovers to other industries, working through well-understood market forces.

Based on these insights, Arndt (1997) emphasized the sector bias of international outsourcing (as compared to a factor bias predicted by Feenstra & Hanson, 1996b), when analyzing the factor price effects in a two-sector Heckscher–Ohlin type model. The intuitively appealing idea that international outsourcing of an industrialized economy leads to lower wages, if firms have access to cheap labor abroad, may be misleading in a two-sector framework. According to the analysis of Arndt, the mere fact that firms have access to cheaper resources abroad makes them more competitive and, thus, raises output. The associated restructuring leads to employment adjustments in both sectors and affects factor prices. Such inter-sectoral spillover effects are an important implication of international outsourcing in a general equilibrium framework.

This points to a first transmission channel in case of sectoral interdependencies, which is driven by national worker flows triggered by expansion and contraction in the production of different sectors. In principle, these flows may be due to pure factor market effects, under perfect competition, or due to more

complex mechanisms, under institutional settings. In any case, such labor flows may have an impact on both the volume of employment and its composition in source and target sectors, thereby affecting production in other sectors.

Furthermore, the factor price adjustments may make restructuring in other sectors attractive, so that the mode of final goods production and the degree of vertical fragmentation in one sector is not independent of the outsourcing behavior in other sectors (Egger & Falkinger, 2003b). Jones & Kierzkowski (2001b, p. 33) point out that "changes in the costs of service links spill over to encourage vertical fragmentation in a horizontal array of industries." These developments can be amplified by adjustments in the production of intermediate goods, when firms manipulate their products to make them usable in a range of different (final goods) industries. Jones & Kierzkowski (2001b) provide a rigorous discussion on the two-way link between fragmentation and technological change. Moreover, recent insights into the role of market thickness effects (see Grossman & Helpman, 2002a; McLaren, 2000) indicate that outsourcing of one final goods producer may render outsourcing of other final goods suppliers (maybe belonging to other industries) more attractive, if additional input producers enter, "thickening" the market of intermediate goods. In sum, general equilibrium models accentuate the role of input–output linkages for understanding the factor market effects of international outsourcing.[4]

Despite these theoretical insights from general equilibrium frameworks, the empirical literature on international outsourcing has not accounted for these inter-sectoral spillover effects so far. To be more precise, the usually applied econometric techniques in empirical studies on international outsourcing treat sectors as independent clusters of firms and neglect any industrial interdependencies. This is an important shortcoming, which may result in a substantial underestimation of the outsourcing effects. The subsequent empirical analysis is intended to shed further light on this issue.

3. Descriptive statistics and earlier results

In this paper, we use the results in Egger & Egger (2003) on the role of Austrian outsourcing to Central and Eastern European Economies (CEECs) for the employment of skilled relative to unskilled labor in Austrian manufacturing industries as a starting point. There, we showed that trade unions in Austrian labor markets are of particular relevance.[5] Because of the country's geographical proximity to and the close historical ties with countries of Central and Eastern Europe, Austrian outsourcing is of particular interest for economists. Due to the country's geographical exposure to four CEECs, it is not surprising that Austrian outsourcing to these economies increased rapidly after the fall of the Iron Curtain. The annual growth rates of outsourcing to the CEECs were more than ten times higher than those of outsourcing to other Western European economies and more than six times higher than those of outsourcing to the average foreign economy.

The analysis in Egger & Egger (2003) made clear that international outsourcing to CEECs can explain a substantial share (about a quarter) of the relative employment change in favor of skilled labor in the Austrian manufacturing industries during the 1990s. Due to strong trade unions, factor price changes

[4] Baldwin (2001) emphasized the role of inter-sectoral interdependencies in a discussion on the implications of increasing fragmentation and globalization for the Word Trade Organization.

[5] Indeed, Austrian labor markets are characterized by high coverage rates, a high union density, and an intensive coordination among trade unions. See Nickell (1997) for a description.

Table 1
Descriptive statistics—Austrian input–output relations in manufacturing (1995)

Nace	Industry	Production	Usage in other industries in percent of own production
15,16	Food products, beverages, and tobacco	22,195.57	8.42
17,18,19	Manufacture of textiles and wearing apparel; tanning and dressing of leather	7076.47	27.17
20,36	Manufacture of wood and of products of wood and cork	15,479.47	23.48
21,22	Manufacture of pulp, paper and paper products; printing and publishing	26,494.42	43.80
23,24	Manufacture of coke, refined petroleum products, nuclear fuel, chemicals	20,219.17	56.46
25	Manufacture of rubber and plastic products	9506.74	94.67
26	Manufacture of other non-metallic mineral products	14,238.64	31.39
27,28	Manufacture of basic and fabricated metal products, except machinery and equipment	17,319.42	70.48
29	Manufacture of machinery and equipment n. e. c.	16,778.38	58.02
30	Manufacture of office machinery and computers	1642.86	71.29
31,32,33	Manufacture of electrical machinery and apparatus n. e. c., incl. ratio and TV, and precision instr.	13,080.07	45.26
34,35	Manufacture of motor vehicles, trailers and other transport equipment	3318.78	73.39
	Average (unweighted)	13,945.83	50.32

were rather moderate in the same period.[6] However, these results are potentially as preliminary as those of others, since they were derived under the assumption of inter-sectoral independence.

In this respect, the recommendation of new techniques for the analysis of labor market effects of outsourcing in the present paper means not only an extension but possibly a considerable improvement of all studies on the trade effects on labor markets. To the best of our knowledge, it is the first attempt to investigate the potential interdependencies of sectors in the empirical analysis on international outsourcing. For this purpose, we need detailed information on the transmission channels through which the interdependencies work.[7] Here, we focus on two channels. Motivated by the theoretical insights described in Section 2, we identify input–output linkages as one candidate for such a transmission channel. National labor flows are a second candidate. Tables 1 and 2 present descriptive statistics on input–output linkages and national labor flows.

In Table 1, we report data on total input production of each industry in 1995 in the first data column (for several two-digit industries, only aggregates are available). In the second data column, we compute the share of production, which serves as an input in other industries. The respective figures are in between 8% and 95%, indicating that a substantial share of a particular industry's output is used as an input in other industries. In the first data column of Table 2, we report the 1988–2000 average numbers of Austrian workers in a drawn individual worker sample used in Egger, Pfaffermayr, & Weber (2003). In the second data column of this table, we report the average portion of workers that changed the industry from year to year. The respective numbers are rather small, lying in between 0.4% and 5%. Hence, inter-sectoral interdependence through goods transactions is remarkably stronger than that one

[6] Between 1990 and 1998, relative employment in Austrian manufacturing industries grew with an annual rate of 4.43%, while relative wage growth with an annual rate of only 0.02% was negligible.

[7] With "short and fat" panel data (i.e., if the cross-sectional dimension is larger than the period coverage), we need to impose restrictions on the channels of spillovers among cross-sectional units (in our case, industries).

Table 2
Descriptive statistics—Austrian worker flows in manufacturing (1995) (sample average)

Nace	Industry	Number of workers	Average annual flows to other manufacturing industries in percent[a]
15	Food products and beverages	12,600	1.47
17	Manufacture of textiles	4209	2.07
18	Manufacture of wearing apparel, etc.	3198	2.94
19	Tanning and dressing of leather; manufacture of luggage, etc.	1223	3.19
20	Manufacture of wood and of products of wood and cork, except furniture	5787	2.83
21	Manufacture of pulp, paper and paper products	3575	1.43
23	Manufacture of coke, refined petroleum products and nuclear fuel	502	0.40
24	Manufacture of chemical and chemical products	5698	1.79
25	Manufacture of rubber and plastic products	4189	3.06
26	Manufacture of other non-metallic mineral products	5834	1.56
27	Manufacture of basic metals	6370	2.07
28	Manufacture of fabricated metal products, except machinery and equipment	11,187	3.49
29	Manufacture of machinery and equipment n. e. c.	10,440	2.28
30	Manufacture of office machinery and computers	363	4.68
31	Manufacture of electrical machinery and apparatus n. e. c.	4066	1.97
32	Manufacture of radio, television and communication equipment and apparatus	5800	3.10
33	Manufacture of medical, precision and optical instruments, watches and clocks	2398	3.34
34	Manufacture of motor vehicles, trailers and semi-trailers	3784	1.53
35	Manufacture of other transport equipment	1039	2.41
36	Manufacture of furniture; manufacturing n. e. c.	7486	2.64
	Average (unweighted)	4987	2.41

[a] Excluding Nace #16 and #22.

through worker flows. Because of this, we start with an analysis of the role of industrial interdependencies due to input–output relations for the labor market. We discuss the impact of the much weaker interdependencies through worker flows in an extension.

4. Empirical analysis

4.1. Data

In the empirical analysis, we use a panel of 20 Austrian manufacturing industries between 1990 and 1998. Since Austria is characterized by a unionized labor market, we focus on the determinants of outsourcing on skilled to unskilled employment rather than on relative wages (see Egger & Egger, 2003, for a theoretical exposition). We distinguish between four different sets of regressors (Appendix A provides summary statistics for all variables used in the empirical analysis).

First and in contrast to previous research, we allow for spillovers of relative employment effects among industries.[8] For this, we have to specify a channel through which this spillover occurs. One

[8] Spillover effects refer to both the impact of changes in one industry on relative employment in other industries and the associated feedback effects on the industry under consideration.

obvious candidate for such a transmission channel is national input–output relationships, as discussed in detail in Section 2. We use the Austrian input–output matrix of 1995 to get appropriate weights, when constructing the weighted skilled to unskilled employment matrix capturing spillovers across industries. However, we do not use the input–output matrix as such. But rather, we replace the diagonal of the input–output matrix by zero and consider only vertical manufacturing goods linkages *across* industries. We divide each cell of the matrix by the row sum. Hence, the elements of the normalized matrix of each row sum up to one. This facilitates the interpretation of the coefficients. Noteworthy, this matrix $\mathbf{W}_N$ has size N (i.e., N rows and N columns), with N being the number of industries. Further, we construct a block-diagonal matrix $\mathbf{W}_n$ of size n, the sample size of the panel, with $\mathbf{W}_N$ in its diagonal for each year.[9] Finally, we multiply this matrix by the $n \times 1$ vector of skilled to unskilled employment ratios. We speak of an outcome consistent with a long-run equilibrium, if the coefficient of the left-hand-side variable weighted with this normalized matrix is smaller than one in absolute value. The parameter for this variable is a measure of industrial interdependence and gives the transmission (or spillover) "intensity." A positive parameter estimate indicates that changes in skilled to unskilled labor ratios positively affect other industries. The more goods of a particular industry are used in another industry, the stronger are the spillovers between these two industries ceteris paribus. Of course, the obtained variable is endogenous and instrumental variable methods are necessary to overcome the related endogeneity bias (see below).[10]

Second, the skilled to unskilled wage ratio and international outsourcing[11] are considered as endogenous variables as well. Again, instrumental variable methods can help to overcome the related endogeneity problem. Even in unionized labor markets with wage bargaining, wages are typically considered to depend on employment.[12] However, by treating international outsourcing as endogenous, we deviate from most empirical applications. Since factor market conditions are usually considered to be a key determinant of international outsourcing decisions, factor market adjustments should give rise to feedback effects on foreign outsourcing. This indicates an endogeneity problem from a theoretical point of view, whenever the outsourcing variable is a regressor and relative employment is the dependent. In Egger & Egger (2003), this endogeneity problem is empirically analyzed. It is shown that treating international outsourcing as exogenous leads to biased estimates in relative employment regressions.

Third, there are several exogenous regressors. Of these, the export openness, the final-goods-import openness and the capital-to-output ratio are the continuous ones. Further, we include time dummy variables and three outlier dummies.

Fourth, there is a huge set of instrumental variables. Specifically, we follow Kelejian & Prucha (1999, 2003) by using the continuous exogenous variables mentioned in the previous paragraph but weighted by $\mathbf{W}_n$ and powers thereof ($\mathbf{W}_n^2$, $\mathbf{W}_n^3$). Further, we use the degree of trade union organisation (ORG), the industry price-cost margin (PCM), median firm size in the industry (MSIZE), trade barriers (TB), a non-tariff barrier dummy (NTBD), and a non-tariff barrier interaction term (NTBI) as natural candidates of

[9] In fact, our panel is unbalanced. However, we ignore this in the notation for the ease of presentation. A rigorous treatment of unbalancedness can be found in Baltagi, Egger, & Pfaffermayr (2004).

[10] This endogeneity of the transmission variable is a direct implication when inter-sectoral dependencies are prevalent.

[11] We understand international outsourcing in a rather narrow sense and focus on purchases of intermediates of an industry from firms of the same industry classification abroad.

[12] Based on insights of wage bargaining theory, one may hypothesize that the employment situation itself impacts on outside options, which are a key determinant of the outcome of wage bargaining (see Layard & Nickell, 1990; or Beissinger & Egger, 2004).

instruments to eliminate the endogeneity bias of wages and outsourcing. Since we stick to two-stage least-squares methods here, all endogenous variables are projected on the full set of instruments in the first-stage regressions.

4.2. Regression results

In the econometric analysis, we explicitly account for the panel nature of the data. Hence, the error term may consist of a (fixed or random) industry-specific component and a stochastic remainder error. We also follow Kelejian & Prucha (2001) in testing of whether further cross-industry spillovers related to the assumed $\mathbf{W}_n$ can be detected. This can be inferred by the Moran I test from "spatial" econometrics. If this test is rejected, the efficiency of the estimates could be improved. However, this is never the case in what follows so that we are faced with a standard instrumental variable problem. We estimate the following regression model:

$$s_{it} = \beta_0 + \beta_1 \mathrm{Ws}_{it} + \beta_2 \mathrm{o}_{it} + \beta_3 \mathrm{w}_{it} + \beta_4 \mathrm{x}_{it} + \beta_5 \mathrm{m}_{it} + \beta_6 \mathrm{k}_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

where "s" denotes the log skilled to unskilled labor ratio, "Ws" is the weighted log skilled to unskilled labor ratio as described above, "o" is the outsourcing variable, "w" denotes the skilled to unskilled wage ratio, "x" is the export openness, "m" refers to the final good import openness, and "λ_t" are fixed time effects. Finally, μ_i are industry-specific effects (fixed or random), and ε_{it} is the error term. All continuous variables are in logs and Table A.1 summarizes the descriptive statistics.

Table 3 summarizes the results from four versions of this model. In the first two columns of results, we report the estimates of the benchmark model, which ignores the possibility of inter-industrial dependence (i.e., restriction β_1=0 as usually assumed). Fixed effects and a random effects model are estimated. The last two columns of results relax this restriction, again in both a fixed effects framework and a random effects setting. In any case the Hausman test rejects, indicating that the industry-specific effects are correlated with the explanatory variables. Accordingly, we shall stick to the fixed effects parameters, although the parameter estimates are not too different from the random effects model. According to the F-statistics, the fixed effects are important and ignoring them leads to biased estimates. As the insignificant time effects indicate, there is no time pattern or trend in the data which is common to all manufacturing industries. The R^2 is fairly high, which means that the likelihood of a serious bias from omitted variables is minor. The Durbin–Wu–Hausman test statistic indicates that a simple panel regression leads to biased estimates. Further, the instruments work well for outsourcing in the sense that they are jointly relevant (see the F-statistics) and uncorrelated with the error term in the second stage (see the Sargan test statistic).

The weighted skilled to unskilled labor ratio enters significantly positive. This has the following implications. First, industries are interdependent as suggested by textbook, non-single-sector general equilibrium models of trade (see our discussion in Section 2). Second, since the outsourcing parameter (β_2) remains (more or less) unaffected, the restrictive models assuming β_1=0 underestimate the role of outsourcing (and of all other variables). The cross-industrial multiplier effect should be taken into account when inferring the impact of outsourcing. The overall effect would then consist of a direct effect in a particular industry and a spillover effect related to the impact of outsourcing on skilled to unskilled employment ratios in other industries through input–output linkages (indirect effect). Subsection 4.4. reports details on the magnitude of direct and indirect effects. Third, the industrial inter-dependence in skilled to unskilled employment ratios is positively related to national input–output relations as expected. As indicated above, this means that a given shock (e.g., induced by outsourcing) in a particular industry

Table 3
Regression results—the effects of outsourcing on skilled to unskilled employment in Austria

	Benchmark models				Cross-sectional dependence models			
	Fixed effects		Random effects		Fixed effects		Random effects	
Weighted skilled to unskilled labor employment	–		–		0.457 **		0.641 ***	
	–		–		0.215		0.194	
Outsourcing	0.095 **		0.097 **		0.104 ***		0.109 ***	
	0.040		0.040		0.037		0.039	
Skilled to unskilled wage rate	−0.927		−1.054		−1.533 *		−1.639 **	
	1.056		1.040		0.827		0.811	
Export openness	0.228 ***		0.228 ***		0.226 ***		0.202 ***	
	0.074		0.073		0.076		0.076	
Non-outsourcing imports	−0.254 ***		−0.239 ***		−0.228 ***		−0.161 **	
	0.081		0.078		0.083		0.072	
Capital to output ratio	−0.243 **		−0.257 **		−0.203 *		−0.288 **	
	0.119		0.116		0.121		0.116	
Constant	2.420 ***		2.539 ***		2.224 ***		2.541 ***	
	0.688		0.741		0.730		0.778	
Observations	179		179		179		179	
Industries	20		20		20		20	
Centered R^2	0.99				0.99			
Fixed effects:		p-Value		p-Value		p-Value		p-Value
Industries	389.19	0.00			185.75	0.00		
Time	7.81	0.45	8.28	0.41	6.91	0.55	7.77	0.46
Instrumentation:								
Durbin–Wu–Hausman	7.21	0.03			37.97	0.00		
Sargan overidentification	2.31	0.31			6.75	0.82		
Instrument relevance for								
Weighted relative employment	–	–			13.65	0.00		
Skilled to unskilled wage rate	1.40	0.24			0.96	0.51		
Outsourcing	9.89	0.00			14.90	0.00		
Cross-industry correlation of error term:								
Moran I statistic	0.84	0.20			0.08	0.47		

Figures below coefficients are standard errors. Significance level of two-tailed t-test: ***significant at 1%; **significant at 5%; *significant at 10%.

exerts a spillover to another industry that is the stronger, the more important the input–output relations between these industries are.

4.3. Extension: Cross-industrial worker flows as an alternative transmission channel

Although we found a significant relationship between national input–output linkages and inter-industrial spillovers in skilled to unskilled labor ratios this is not the only candidate for explaining inter-sectoral transmission effects. A second channel through which inter-sectoral spillovers may become prevalent are gross flows of (skilled and unskilled) workers between industries (see our discussion in Section 2). Information on such flows is of course not easily available. In our analysis, we use a table that is aggregated from a panel of Austrian workers at the individual level over the period 1988–2001.

The panel consists of randomly drawn individuals from the Austrian social security records (see Egger, Pfaffermayr, & Weber, 2003; and Table 2). We proceed in the same way as before with the only difference that the row-normalized matrix of two-way worker flows across industries (i.e., the average number of industry changers per year) is now considered as weighting matrix $\mathbf{W}_N$. Again, we construct a block-diagonal matrix $\mathbf{W}_n$ with blocks $\mathbf{W}_N$. Table 4 summarizes the results for two fixed effects models (in contrast to the random effects model, the fixed effects estimator guarantees consistency in case of correlation between the covariates and the unobserved cross-sectional effects).

As can be seen from the results in the first data column, we cannot identify worker flows as being significantly related to inter-industrial spillovers in general. However, this does not mean that outsourcing in a particular industry is independent of outsourcing in other industries, when transmission effects through worker flows are accounted for. To see this, consider the second column in Table 4. There, we use a narrow

Table 4
Alternative results—cross-sectional dependence through worker flows

	Fixed effects models			
Weighted skilled to unskilled labor employment	0.836		–	
	0.724		–	
Weighted outsourcing	–		0.299 *	
	–		0.171	
Outsourcing	0.038 *		0.085 ***	
	0.022		0.030	
Skilled to unskilled wage rate	0.465		0.169	
	0.380		0.431	
Export openness	0.184 ***		0.212 ***	
	0.056		0.059	
Non-outsourcing imports	−0.274 ***		−0.286 ***	
	0.061		0.062	
Capital to output ratio	−0.217 **		−0.236 **	
	0.086		0.093	
Constant	1.056 *		3.373 ***	
	0.584		0.962	
Observations	179		179	
Industries	20		20	
Centered R^2	0.99		0.99	
Fixed effects:		*p*-Value		*p*-Value
Industries	578.25	0.00	542.55	0.00
Time	1.27	1.00	11.71	0.16
Instrumentation:				
Durbin–Wu–Hausman	39.51	0.00	0.70	0.87
Sargan overidentification	5.31	0.69	3.48	0.39
Instrument relevance for				
Weighted relative employment	19.62	0.00	17.89	0.00
Skilled to unskilled wage rate	1.22	0.24	1.22	0.24
Outsourcing	3.33	0.00	3.33	0.00
Cross-industry correlation of error term:				
Moran I statistic	0.03	0.51	0.002	0.50

Figures below coefficients are standard errors. Significance level of two-tailed *t*-test: ***significant at 1%; **significant at 5%; *significant at 10%.

concept of transmission and weight the outsourcing variable by the worker flow matrix. This gives us a measure of spillover effects that are only related to outsourcing. The positive, significant parameter of this variable indicates that outsourcing in a particular industry fosters not only the skilled to unskilled employment ratio there but also generates spillovers through worker flows across industries. This spillover effect increases in the intensity of gross flows of workers and it is more than three times as strong as the

Table 5
Simulating the effect of a one-σ-increase in outsourcing on skilled to unskilled employment in Austrian manufacturing (based on the results in Table 1)

Nace	Manufacturing industry	One-σ-shock in outsourcing in percent	Total effect on H/L employment in percent	Cross-industry spillover effects in percent
15	Food products and beverages	22.8	7.9	72.7
17	Manufacture of textiles	46.1	12.2	67.1
18	Manufacture of wearing apparel, etc.	94.8	18.1	60.6
19	Tanning and dressing of leather; manufacture of luggage, etc.	29.4	9.3	70.9
20	Manufacture of wood and of products of wood and cork, except furniture	21.8	9.1	77.3
21	Manufacture of pulp, paper and paper products	41.3	10.9	66.7
23	Manufacture of coke, refined petroleum products and nuclear fuel	138.8	22.7	58.4
24	Manufacture of chemical and chemical products	18.6	8.8	79.6
25	Manufacture of rubber and plastic products	151.5	24.3	58.8
26	Manufacture of other non-metallic mineral products	62.2	14.4	64.4
27	Manufacture of basic metals	72.9	15.6	62.6
28	Manufacture of fabricated metal products, except machinery and equipment	47.1	12.3	66.9
29	Manufacture of machinery and equipment n. e. c.	34.4	10.8	71.3
30	Manufacture of office machinery and computers	196.5	29.7	59.9
31	Manufacture of electrical machinery and apparatus n. e. c.	113.8	23.4	65.0
32	Manufacture of radio, television and communication equipment and apparatus	203.2	31.1	60.8
33	Manufacture of medical, precision and optical instruments, watches and clocks	64.7	17.6	69.9
34	Manufacture of motor vehicles, trailers and semi-trailers	121.7	21.4	59.8
35	Manufacture of other transport equipment	141.7	23.8	59.7
36	Manufacture of furniture; manufacturing n. e. c.	107.4	19.1	59.0
Average (unweighted mean)		86.5	17.1	65.6

direct effect (β_2). However, since identification and instrumentation are somewhat better in our baseline model introduced in Subsection 4.2 (and summarized in Table 3), we stick to this specification in the subsequent analysis (i.e., we focus on input–output linkages as the central transmission channel).

4.4. Simulating the impact of outsourcing on Austrian manufacturing industries

From Table 3, it is not immediately obvious how important direct effects are relative to indirect spillover effects. In other words, we have not yet provided evidence for the role of spillover-related multiplier effects as compared to direct effects of international outsourcing on relative employment, if input–output linkages are the relevant transmission channel. Insights on the magnitude of the two effects can be gained from Table 5.

We consider a shock in the magnitude of one standard deviation (σ_i) over the available period and compute the average direct effect and the associated spillover effects. Since we account for industry-specific shocks, their magnitude may differ across industries. This becomes obvious from the first data column of Table 5. The total (direct plus spillover) employment effect of the shock is reported in the second data column and the last column summarizes the relative importance of the spillover effects as percentage of the total impact of the shock. Of course, the direct effect is nothing else than the shock (i.e. the standard deviation) multiplied by parameter β_2. However, the spillover effect takes into account that changes in a specific industry's skilled to unskilled labor ratio positively affect all other industries' ratios and that this effect feeds back to the considered industry (see Footnote 8). This indirect effect is the more pronounced, the higher the degree of vertical linkages is across industries.

In our application, a hypothetical surge of the outsourcing variable by about 87% results in an increase in the skilled to unskilled employment ratio of about 17%. Thereof, almost 66% are due to spillovers/feedback from other industries. These figures refer to the average Austrian manufacturing industry. Of course, there is variation between manufacturing industries with respect to the relative importance of spillovers. Industries less interrelated with others through input–output linkages exhibit a lower impact working through the indirect effect and those with stronger inter-sectoral input–output linkages exhibit a higher one. The share varies in between 58% for "Manufacture of coke, refined petroleum products and nuclear fuel" and 77% for "Manufacture of wood and of products of wood and cork, except furniture." In any case, we can conclude that estimates on the labor market implications of international outsourcing should be substantially downward biased if inter-industrial spillovers are not accounted for.

5. Conclusions

The purpose of this paper was to confront the empirical literature on factor market effects of international outsourcing with econometric techniques that allow for an adequate representation of inter-sectoral spillover effects. Based on theoretical insights from general equilibrium models in the tradition of Ricardo, Heckscher–Ohlin and Ricardo–Viner, we discussed possible transmission channels for such inter-sectoral spillover effects. Thereby, two obvious candidates were identified. On the one hand, input–output linkages may explain how international outsourcing in one sector impacts on relative employment in other industries and in which way these feed back on the industry under consideration. On the other hand, national labor flows across industries may also be a candidate for an inter-sectoral transmission channel.

In an empirical application for Austrian outsourcing to Central and Eastern European Economies, our analysis was capable to show that inter-sectoral spillovers are of particular relevance and that neglecting such spillovers leads to a substantial underestimation of the possible labor market effects of international outsourcing. Due to the prevalence of strong trade unions in Austrian labor markets, the focus was on relative employment effects. Thereby, it was shown that indirect spillover effects account for about two-thirds of the estimated employment effects of international outsourcing.

Our analysis is a first attempt to introduce spatial econometric techniques to the empirical literature on international outsourcing. Although the associated implications are shown to be important, there needs to be further research before making a definite conclusion on how this modification impacts on the factor market implications of increased globalization in the form of international outsourcing of input production.

Appendix A

A.1. Trade data

Data on final and intermediate goods exports and imports are provided by Statistics Austria. We apply a narrow measure of outsourcing, which accounts for intermediate goods imported from Central and Eastern Europe. We require these goods to be produced by industry *i* firms abroad and used by industry *i* firms in Austria. For Austria, this measure can be computed based on input–output statistics and trade statistics from Statistics Austria. Further details can be found in Egger & Egger (2003).

We use most-favored-nation tariff rates (TB) and frequency ratios of non-tariff barriers (NTB) from OECD and UNCTAD as instruments. Regarding NTBs, we construct a dummy variable NTBD=1, if NTB>0 and NTBD=0, else. Further, a variable NTBI takes the log of NTB, if NTBD=1, while NTBI is set equal to zero if NTBD=0. All trade barrier variables vary in both dimensions of the panel (industry and time).

A.2. Skill and union data

Information on skill-specific employment and wages is available from the Austrian ”Lohn—und Gehaltsstatistik” published by the Austrian Chamber of Commerce. The advantage of this data set is that employees are classified according to their utilization rather than their education or training. Workers with jobs requiring a high/special qualification level are classified as high-skilled (or skilled) workers. All other employees are classified as low-skilled (or unskilled).

Data on union membership were kindly provided by the Austrian Trade Union Confederation. We measure the degree of organization at the industry-level relative to the average industry in each year *t*. ORG only varies over 11 groups of industries (basically aggregates of NACE 2-digit industries) due to the organization of the Austrian Trade Union Federation.

A.3. Remaining variables

Median firm size (MSIZE) and price-cost margins (PCM) are used as instruments. These variables could be relevant for the power of employees in wage bargaining. Median firm size is taken from the

Table A.1
Descriptive statistics

Variables	Mean	Standard deviation	Minimum	Maximum
Endogenous variables				
Log skilled-to-unskilled employment	0.54	0.70	−1.10	1.97
Log skilled-to-unskilled wage rates	0.36	0.14	0.11	0.65
Log outsourcing-to-output ratio	−5.49	1.33	−9.61	−2.86
Exogenous variables				
Log export openness	−0.56	1.17	−3.64	3.84
Log import openness	−0.36	1.36	−2.21	5.03
Log capital–output ratio	4.22	0.44	2.32	5.14
Instruments				
Log number of unionized workers	−0.35	0.72	−1.73	2.08
Log price-cost margin	−1.69	0.27	−2.96	−0.92
Log median firm size	12.31	1.16	9.88	17.05
Log tariff barriers in percent	1.98	0.58	0.74	3.85
Log non-tariff barrier frequency	−3.21	8.02	−29.75	4.44
Log CEEC unit labor costs	0.53	0.31	−0.56	1.17

179 Observations.

monthly WIFO investment survey of Austrian manufacturing firms (NACE 2-digit). PCM is measured as the ratio of value added minus wage costs and gross production. Data on gross production, value added, nominal capital stocks, and capital deflators come from Statistics Austria. The percentage of hours of capital stock in use is available from the WIFO investment survey.

Unit labor costs of seven Eastern economies (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic, Slovenia) are available from the Vienna Institute for Comparative Economic Studies (WIIW). This variable is used to approximate unit labor costs for the Eastern countries as a whole (ULCE), including Central and Eastern Europe and the former Soviet Union.

Table A.1 summarizes descriptive statistics. Further details on the compilation of data from the various sources can be found in Egger & Egger (2003).

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