Review of International Economics, 12(5), 833–843, 2004

Two Dimensions of Convergence: National and International Wage Adjustment Effects of Cross-border Outsourcing in Europe

*Peter Egger and Michael Pfaffermayr**

Abstract

The paper proposes a distinction between the two dimensions of convergence—*within* and *between* countries—when analyzing the impact of cross-border outsourcing on real wage rates in the EU-15 and the CEEC. In the CEEC, international outsourcing has not affected the adjustment of average real wage rates at the manufacturing industry level, but it has led to a closure of the gap within a typical EU economy. Between-country convergence is likewise fostered by cross-border outsourcing, supporting the hypothesis that outsourcing facilitates international factor price equalization.

1. Introduction

The driving forces of international factor price convergence and the international distribution of income have attracted a lot of interest in the last decades. International trade in final goods, especially, but also trade in intermediate goods resulting from cross-border outsourcing of production processes, are seen as forces towards factor price equalization between the developed and the less-developed economies. Nowadays, researchers widely agree upon the notion that trade in goods per se does not provide a sufficient explanation for the change in factor prices (Krugman, 1995; Feenstra and Hanson, 2001). However, the changing *composition* of trade, and the growing importance of *intermediate input trade* in particular, seems much more important in both theory and evidence; see Feenstra and Hanson (2001) for an overview.

Baier and Bergstrand (2001) derived simulation results from a stylized computable general-equilibrium model. Using reasonable parameter estimates, they found that intermediate goods trade (outsourcing) might account for about one-sixth of the growth of world trade between 1960 and 1990. Hummels et al. (2001, p. 15) find that "vertical specialization accounts for up to 30% of world exports."

There are at least two theoretical arguments for trade in intermediate goods to take place and, thereby, to affect factor prices. First, the theoretical outsourcing literature predominantly investigates the effects on the national skilled to unskilled workers' wage differential or the reward of capital relative to labor (Arndt, 1997; Deardorff, 2001; Feenstra and Hanson, 2001; Jones and Kierzkowski, 2001; Kohler, 2001, 2003). In these models, outsourcing is defined as the vertical splitting of the production process across borders according to comparative advantage, resulting in an inherent difference

* Egger, Pfaffermayr: Department of Economic Theory, Economic Policy and Economic History, University of Innsbruck, Universitaetsstrasse 15, A-6020 Innsbruck, Austria; and Austrian Institute of Economic Research, PO Box 91, A-1103 Vienna, Austria. E-mail: Peter.Egger@uibk.ac.at; Michael.Pfaffermayr@uibk.ac.at. We gratefully acknowledge helpful discussions and comments by Sourafel Girma, Wilhelm Kohler, Sajal Lahiri, Daniel Mirza, and Doug Nelson at the Leverhulme Centre for Research on Globalisation and Economic Policy conference on "Adjusting to Globalisation," held at the University of Nottingham, June 2002, and comments by two anonymous referees. Financial support by the Austrian National Bank through Jubiläumsfonds Grant no. 10057 is gratefully acknowledged.

in the labor intensity of intermediate goods exports and imports. For instance, capital-abundant economies outsource labor-abundant production stages, whereas labor-abundant countries outsource capital-abundant fragments, and both components are traded. Accordingly, the exploitation of specialization gains through outsourcing may foster international factor price equalization. Deardorff (2001, p. 135) concludes that, if there are some impediments to factor price equalization (e.g., transportation costs, tariff or nontariff barriers to trade, etc.), outsourcing may drive factor price equalization to "the extent that factor prices are not equalized internationally without outsourcing." Jones and Kierzkowski (2001, p. 31) mention that depending on the extent of dissimilarity in factor endowment proportions outsourcing may "bring factor prices closer together," but generally "almost anything can happen." Kohler (2003) derives similar conclusions in his higher dimensional analysis of outsourcing effects, which contains the models of Arndt (1997) and Feenstra and Hanson (1996, 1997) as special cases. In the now standard models of outsourcing, the equalization of wages *within* countries is assumed (through the perfect mobility of labor between sectors) and the equalization of wages *between* countries is a likely, and empirically highly relevant, outcome.

Second, if there is Ethier-type specialization (Ethier, 1982), the productivity of final goods producers increases with the (horizontal) splitting of the production chain per se due to external scale economies. Countries then engage in intermediate goods trade to take advantage of a larger available variety of components rather than of exploiting comparative advantage in the production of fragments. However, this model does not imply factor intensity differences in the intermediate goods production between economies. If this type of specialization becomes technologically or economically feasible for exogenous reasons, Ethier demonstrates that factor prices equalize under free trade.

In the short run, the lack of labor mobility between sectors within a country due to national barriers to mobility (e.g., because of industry-specific knowledge of workers) and adjustment costs may impede the effects of outsourcing (or intermediate goods imports) on incomes to take place immediately. It is a stylized fact that wages vary systematically across industries with capital-intensive industries paying higher wages, and that this phenomenon is quite persistent over time (Krueger and Summers, 1988). However, in the steady state, one would expect that the rewards of different factors (capital and labor) grow at the same rate and wage differentials between industries within a country as well as between countries—if they exist at all—do not change. But even in the long run, average wage rates may differ across industries because a different mix of skilled and unskilled workers is used (e.g., due to worker quality variation even within skill groups).

The available empirical evidence on the consequences of cross-border outsourcing at the industry level for both the US and Europe mainly supports the Heckscher–Ohlin view: Feenstra and Hanson (1999, 2001), Greenaway et al. (1999), Egger and Egger (2001), and others identify a clear positive impact of outsourcing on the skilled-to-unskilled wage and/or employment ratio in high-wage countries. Feenstra and Hanson (1997) provide evidence that outsourcing raises the skilled-to-unskilled wage ratio in both the North (the US) and the South (Mexico).

So far, there seems to be no evidence on the impact of intermediate goods trade on the convergence of real wages in a large cross-section of industries and economies. This paper tries to fill this gap and assesses the effects of intermediate goods trade on the convergence of real wages both *within* and *between* countries in a unified empirical framework. We propose an empirical model to assess the impact of intermediate goods

trade in these two dimensions using two-digit manufacturing industry-level data of the 15 EU members and 5 CEEC (Czech Republic, Hungary, Poland, Slovenia, and Slovak Republic) covering the period 1993 to 2000. Given that in the steady state wage differentials are constant, intermediate goods trade may be expected to affect the speed of convergence, but not to induce differences in steady-state growth rates. Therefore, we start from a traditional β-convergence model as proposed by Barro and Sala-i-Martin (1995), which is designed to analyze dynamic adjustment processes with one-way cross-sectional units (e.g., countries, regions, firms). However, to decompose the intermediate goods trade effect into its within- and between-countries component, we account for the "two-way" character of the cross-sections and specify a bivariate system of differential equations, which drives the country-by-industry evolution of real wage rates.

According to our main empirical results, *between*-country convergence dominates the adjustment of real wage rates and intermediate goods trade facilitates *international* factor price equalization in Europe. Moreover, outsourcing accelerates convergence *within* the EU-15 member countries, while it does not lead to convergence *within* the CEEC, where interindustry wage differentials tend to persist.

The next section introduces the concept of the two dimensions of convergence, while section 3 discusses the database, the econometric specification, and the estimation results. The last section summarizes the main findings and concludes.

2. Two Dimensions of Convergence

To measure the speed of convergence of real wages *between countries* and *within countries* (across industries), we propose an extension of the standard β-convergence equation. Specifically, we hypothesize that the speed of convergence differs between the within-country (between industries) dimension (b_1) and the between-country dimension (b_2). If $b_1 < b_2$, the overall catching-up in real wage rates between countries dominates. If, on the other hand, $b_1 > b_2$ the interindustry wage rate differentials disappear quickly, but overall catching-up between countries is slow.

For a typical industry i in country c, convergence requires that the growth rate of a country's real wage rate be negatively proportional to its initial level (Barro and Sala-i-Martin, 1995). Formally, the log-linearization around the steady state is given by the following system of linear first-order differential equations:

$$\frac{d\omega_{ic}(t)}{dt} - \frac{d\omega_{.c}(t)}{dt} = -b_1[\omega_{ic}(t) - \omega_{.c}(t)], \tag{1}$$

$$\frac{d\omega_{.c}(t)}{dt} - \frac{d\omega^*(t)}{dt} = -b_2[\omega_{.c}(t) - \omega^*(t)], \tag{2}$$

$$\frac{d\omega^*(t)}{dt} = g. \tag{3}$$

$\omega_{ic}(t) = \ln w_{ic}(t)$ is the log of the real wage rate of industry i in country c, and $\omega_{.c}(t) = (1/I)\Sigma_{i=1}^{I} w_{ic}(t)$, where I denotes the number of industries. $\omega^*(t)$ denotes the log of the "worldwide" steady state of the real wage rate at time t with assumed constant growth rate g. Equation (2) states that the difference between a country's real wage growth ($d\omega_{.c}(t)/dt$) and the steady-state growth rate ($d\omega^*(t)/dt$) is higher, the higher the distance of the average log real wage rate of country c($\omega_{.c}(t)$) from its steady-state counterpart ($\omega^*(t)$) at time t. Equation (1) implies that the real wage rate in industry

i grows faster, the more it lags behind the average country-wide real wage rate. For simplicity, we assume that a single industry is too small to influence the country average. Hence, the system is only an approximation of the true, by far more complicated, system, where the real wages of all industries show up on the right-hand side of (1). Solving this system of differential equations results in the following equation for a period of length T:

$$\omega_{ic}^{T} = e^{-b_1 T}(\omega_{ic}^{0} - \omega_{.c}^{0}) + e^{-b_2 T}(\omega_{.c}^{0} - \omega^{0,*}) + \omega^{T,*}. \tag{4}$$

Equation (3) implies that the steady-state real wage rate in logs is defined by $\omega^*(t) = gt + \omega^{0,*}$, with $\omega^{0,*}$ as the exogenously given steady-state log wage rate at time 0. Subtracting the initial value ω_{ic}^{0} from both sides of (4), rearranging terms, dividing by T, and adding an i.i.d. error term u_{it}, we get a natural extension of the traditional convergence equation for the annual average growth rate of real wages in industry i over a period of length T:

$$\frac{1}{T}(\omega_{ic}^{T} - \omega_{ic}^{0}) = g - \frac{1}{T}(1 - e^{-b_1 T})(\omega_{ic}^{0} - \omega_{.c}^{0}) - \frac{1}{T}(1 - e^{-b_2 T})(\omega_{.c}^{0} - \omega^{0,*}) + u_{it}. \tag{5}$$

β-convergence is a necessary, however not sufficient, condition for convergence. Therefore, we additionally look at σ-convergence and investigate whether the standard deviation of real wage rates decreased over time, again both *within* and *between* countries. Formulating the system (1)–(3) in discrete time, substituting (2) and (3) in (1), and adding a random i.i.d. error term, which is uncorrelated with the right-hand-side variables, gives:

$$\omega_{ic}^{t} = \beta_1(\omega_{ic}^{t-1} - \omega_{.c}^{t-1}) + \beta_2(\omega_{.c}^{t-1} - \omega^{t-1,*}) + \omega^{t,*} + u_{it}, \tag{6}$$

where $\beta_1 = 1 - b_1$ and $\beta_2 = 1 - b_2$. The standard deviation of ω_{ic}^{t} can be easily calculated, when assuming that the overall mean of the real wage rate approximately corresponds to the steady state: $(1/IC)\Sigma_{c=1}^{C}\Sigma_{i=1}^{I}\omega_{ic}^{t} = \omega_{..}^{t} = \omega^{t,*}$, where C denotes the number of countries, and IC is the overall number of (country-by-industry) observations. Since $\omega_{..}^{t} = (1/IC)\Sigma_{c=1}^{C}\Sigma_{i=1}^{I}\omega_{ic}^{t} = (1/IC)\Sigma_{c=1}^{C}\beta_1(\omega_{.c}^{t-1} - \omega_{.c}^{t-1}) + (1/C)\Sigma_{c=1}^{C}\beta_2(\omega_{.c}^{t-1} - \omega^{t-1,*}) + \omega^{t,*} = \omega^{t,*}$, we have

$$\begin{aligned}
\sigma_t^2 &= \frac{1}{IC}\sum_{c=1}^{C}\sum_{i=1}^{I}(\omega_{ic}^{t} - \omega_{..}^{t})^2 + \sigma_u^2 \\
&= \frac{1}{IC}\sum_{c=1}^{C}\sum_{i=1}^{I}\left[\beta_1(\omega_{ic}^{t-1} - \omega_{.c}^{t-1}) + \beta_2(\omega_{.c}^{t-1} - \omega^{t-1,*})\right]^2 + \sigma_u^2 \\
&= \frac{1}{IC}\sum_{c=1}^{C}\sum_{i=1}^{I}\Big[\beta_1^2(\omega_{ic}^{t-1} - \omega_{.c}^{t-1})^2 + 2\beta_1\beta_2(\omega_{ic}^{t-1} - \omega_{.c}^{t-1})(\omega_{.c}^{t-1} - \omega^{t-1,*}) \\
&\quad + \beta_2^2(\omega_{.c}^{t-1} - \omega^{t-1,*})\Big]^2 + \sigma_u^2 \\
&= \beta_1^2\sigma_{t-1,W}^2 + \beta_2^2\sigma_{t-1,B} + \sigma_u^2,
\end{aligned} \tag{7}$$

where $\sigma_{t,W}^2 = (1/IC)\Sigma_{c=1}^{C}\Sigma_{i=1}^{I}(\omega_{ic}^{t} - \omega_{.c}^{t})^2$ and $\sigma_{t,B}^2 = (1/C)\Sigma_{c=1}^{C}(\omega_{.c}^{t} - \omega^{t,*})^2$.

Hence, there are three principal opportunities to estimate the parameters of the two dimensions of convergence in real wage rates. First, we can use (5) to estimate the speed of convergence in a cross-section of industries and countries. Second, one can estimate (6) in a panel with industry, country, and time variation using the procedure proposed by Arellano and Bond (1991). Third, one could look at σ-convergence based on a regression of (7). Since the time-series dimension of our data is rather short, the

latter is not feasible. Rather, we follow Carree and Klomp (1997) and test whether the variance of real wage rates (σ_t^2, $\sigma_{t,W}^2$, and $\sigma_{t,B}^2$) decreased over the period 1993 to 2000.

We test below whether the speed of convergence depends on the volume of intermediate goods trade as a percentage of gross production (intermediate goods trade: o_{ic}). Its impact may differ *within* and *between* countries and also between the CEEC and the EU-15. Note, we rule out the possibility that the *level* of intermediate goods trade exerts any impact on the steady-state *growth* of wage rates. Rather, we assume that it affects only the *level* and the corresponding *transition* path. Hence, the wage growth effects of intermediate goods trade are assumed to be transitory. The rationale is the analogy to the impact of exogenous, labor-augmenting technical progress on the level of labor productivity in a Solow–Swan-type neoclassical growth model.

3. Data and Estimation Results

Data

Our data comprise 14 manufacturing industries, which are slightly higher aggregated than NACE two-digit ones. For simplicity, we refer to them as two-digits. The real wage data for the EU countries are taken from New Cronos Products (EUROSTAT). The CEEC wages are kindly provided by the Vienna Institute for International Economic Studies (WIIW). Wages are expressed in constant prices and US dollars using 1995 as the base year. For the EU countries, we have to estimate part of the year 2000 values from production data using a fixed industry-by-country within estimator. All wages are deflated by country-specific GDP-deflators and expressed in 1995 dollars, and we calculate average growth rates in line with the bulk of the convergence literature.

To construct the intermediate goods trade variable, we use data on bilateral intermediate goods trade volumes at the five-digit Standard International Trade Classification level from UNO's Broad Economic Categories (Fontagné et al., 1996) and aggregate them to obtain NACE two-digit manufacturing industry input trade volumes of each country with the EU and the CEEC. We aggregate each country's bilateral trade in intermediate goods with the EU and CEEC as the destination countries. For example, the intermediate goods trade measure of a specific German NACE two-digit manufacturing industry is the sum of Germany's exports and imports of intermediate goods of this industry to all other EU countries and the CEEC, and similarly for all other economies in the sample. In this way, we capture the impact of the overall volume of intermediate goods trade on the convergence of real wage rates and treat all countries symmetrically. We express two-digit industry input trade volumes as a percentage of a country's gross production to obtain a (wide) measure of the country-specific European (intra-sample) level of cross-border outsourcing of production. A couple of missing values are interpolated, especially for Greece. In the regressions below, the initial value refers to 1993.

Starting from significantly lower wage rates after the fall of the Iron Curtain and the first step of systemic transformation, real wages grew substantially faster (by 1.3 percentage points per annum) in the 5 CEEC than in the 15 EU members. Intermediate goods imports in terms of gross production grew by approximately 1.3 percentage points per annum faster in the EU countries between 1993 and 2000, compared to the CEEC. This pattern is largely due to the increase in imports of manufacturing inputs originating from the EU countries themselves.

Econometric Specification

We estimate (5), allowing outsourcing to affect the adjustment process (i.e., the speed of adjustment) to the steady-state real wage rate both within and between countries. The associated β-convergence regression reads as follows:

$$\begin{aligned}
\Delta\omega_{ic} &= \gamma_0 + \gamma_1\tilde{\omega}^0_{ic} + \gamma_2\tilde{\omega}^0_{ic}o^0_{ic}D_{EU} + \gamma_3\tilde{\omega}^0_{ic}o^0_{ic}D_{CEEC} \\
&\quad + \gamma_4\omega^0_{.c} + \gamma_5\omega^0_{.c}o^0_{ic}D_{EU} + \gamma_6\omega^0_{.c}o^0_{ic}D_{CEEC} + u_{ic}, \\
\Delta\omega_{ic} &= \frac{\ln w^t_{ic} - \ln w^0_{ic}}{T}, \\
\tilde{\omega}^0_{ic} &= (\omega^0_{ic} - \omega^0_{.c}), \\
o^0_{ic} &= \frac{(\text{intermediates goods trade volume})^0_{ic}}{(\text{gross production})^0_{ic}}.
\end{aligned} \tag{8}$$

This means that we parameterize $-(1/T)(1 - e^{-b_1T})$ as $\gamma_1 + \gamma_2 o^0_{ic}D_{EU} + \gamma_3 o^0_{ic}D_{CEEC}$ and $-(1/T)(1 - e^{-b_2T})$ as $\gamma_4 + \gamma_5 o^0_{ic}D_{EU} + \gamma_6 o^0_{ic}D_{CEEC}$. D_{EU} takes the value 1 if a country belongs to the EU and 0 otherwise, and $D_{CEEC} = 1 - D_{EU}$ is the CEEC dummy. According to the discussion above, we allow European cross-border outsourcing to exert a different impact on the convergence *within* countries (i.e., between industries within a country: γ_2, γ_3) than *between* countries (γ_5, γ_6). Furthermore, outsourcing may affect the EU economies (γ_2, γ_5) and the CEEC (γ_3, γ_6) differently. γ_0 is the common steady-state growth of real wages. In this form, the specification implies *unconditional convergence*. Similar to previous work, we account for the other determinants of convergence by the direct effects of the initial levels (γ_1, γ_4). In a second specification, we add industry dummies to control for other unobserved industry-specific determinants of the steady-state growth of real wages. (See Carree et al. (2000) for a similar approach.) The resulting long-run differences in real wage growth rates may arise from shifts in the skill composition and, *inter alia*, also from short-run asymmetric business cycle effects. This specification implies *conditional convergence*.

As discussed in Quah (1993), β-convergence is not sufficient to guarantee overall convergence to a common steady state. Therefore, additional evidence on the distribution of real wages must be considered to assess the information obtained from the above regressions. Convergence to a single-peaked distribution supports results from β-convergence regressions. In our application, convergence of the real wage distribution (conditional on fixed industry effects) to a single peak is empirically supported and β-convergence analysis is informative.

Given single-peakedness, we further look at the distribution of wages and compute the associated variance of real wages across both countries and industries to see whether the distribution of real wages has significantly collapsed over time. As mentioned above, the small time dimension of our data does not allow us to run a σ-convergence regression. In our case, the dispersion of real wages is falling since 1995. This process is driven by convergence of wages between economies rather than *within* them. According to the t_2-statistic by Carree and Klomp (1997), differences in real wage rates *between* countries were significantly larger in 1993 than in 2000 ($t_2 = 64.2$, $p = 0.00$). Also the *overall* decrease in the variance is significant ($t_2 = 33.8$, $p = 0.00$). However, *within* the typical economy we observe a slightly increasing dispersion between industries.

Estimation Results

Comparing the results between the conditional and the unconditional convergence regression in Table 1, we find that the hypothesis of a common steady state across industries is rejected. This points to long-run differences in real wage growth rates across industries common to all countries and/or short-run asymmetric business cycle effects not explicitly addressed in the theoretical models discussed above. Nevertheless, the resulting point estimates of the convergence parameters are relatively similar, with some important exceptions.

The econometric evidence suggests that intermediate goods trade in the EU has speeded up the pace of adjustment to the industry steady state *within countries*. All estimated *between-country* conditional convergence parameters are significantly different from zero, and we find that outsourcing tends to foster convergence of both the CEEC (i.e., convergence *from below*) and the EU-15 member countries (on average, convergence *from above*). The difference in the CEEC and the EU marginal effects of the initial values (evaluated at the relevant means of intermediate goods trade) is significant regarding both convergence within countries (according to the *F*-test of $a - b = 0$ in Table 1) and overall convergence (according to the *F*-test of $(a + c) - (b + d) = 0$ in Table 1). Also the difference between the marginal effects of within versus between countries is rejected for both the EU-15 (according to the *F*-test of $b - d = 0$ in Table 1) and all countries together (according to the *F*-test of $(a + b) - (c + d) = 0$ in Table 1).

We assess the robustness of the estimation results in several ways. First, we apply simultaneous quantiles regressions to check for the influence of potential outliers. As the results for the median, the lower, and the upper quartile regressions in Table 2 indicate, the parameters are very close to the OLS outcome and our results are not driven by a few influential observations. Second, we look at the longest available time span of data covering the period 1990 to 2000 (including the years of transitional recession and systemic transformation before 1993, also reported in Table 2). Even in this respect, the parameters prove to be relatively robust. Third, we use 1999 as an alternative base year to construct real wages, which obtains the same sign of all β-convergence coefficients as the baseline models in Table 1. (For the sake of brevity, we do not report these results. They are available from the authors.) Given these results, we can proceed with the analysis based on the estimates in Table 1.

Table 3 collects information on the speed of adjustment, expressed as the average annual closure of the gap between actual and steady-state real wage rates for the EU and the CEEC. To illustrate the role of intermediate goods trade, we report the estimated speed of adjustment as observed and a counterfactual situation with zero intermediate goods trade in the initial period. Since unconditional convergence is rejected at convenient levels of significance, we concentrate on the conditional convergence results (i.e., the lower block of results in the table). Intermediate goods trade significantly speeds up the convergence of real wage rates *within* the EU-15 countries. In fact, intermediate goods trade of these economies closed the intersectoral wage gap by 5.54% per annum when evaluated at variable means, whereas there was no such effect within the CEEC. Hence, in the EU-15 intermediate goods trade puts a significant pressure on industries with above-average real wage rates in the typical economy, while it leads to a faster increase of real wage rates in industries below the country average. Further, outsourcing significantly accelerates the speed of convergence *between countries* in both the EU (the difference between 1.79% and 1.45% is significant at 1%) and the CEEC (the difference between 1.82% and 1.45% is also

Table 1. Regression Results (β-convergence, 1993–2000)

Dependent variable: average log difference of real wages	*Unconditional convergence*		*Conditional convergence*	
Explanatory variables	*Coefficient*	*t*	*Coefficient*	*t*
Within countries				
Initial level	0.026	1.93*	0.009	0.41
Initial level × initial outsourcing × CEEC dummy (*a*)	0.025	0.50	–0.023	–0.48
Initial level × initial outsourcing × EU-15 dummy (*b*)	–0.011	–2.13**	–0.024	–3.01***
Between countries				
Initial level	–0.016	–4.04***	–0.014	–3.72***
Initial level × initial outsourcing × CEEC dummy (*c*)	–0.002	–0.51	–0.008	–1.67*
Initial level × initial outsourcing × EU-15 dummy (*d*)	–0.001	–1.95*	–0.002	–3.40***
Constant	0.057	5.10***	0.037	2.87***
Number of observations	240		240	
R^2	0.18		0.33	
Root-mean-square error	0.03		0.03	
Residual d.f.	230		217	
	p-value		*p-value*	
Heteroskedasticity (Cook and Weisberg, 1983): $\chi^2(1)$	0.12		0.03**	
Ramsey RESET test: $F(3,$ residual d.f.)	0.01***		0.46	
F-tests:				
Industry effects: $F(13,220)$	—		0.00***	
Marginal initial value effects evaluated at means:				
$a - b = 0$; $F(1,$ residual d.f.)	0.11		0.04**	
$a - c = 0$; $F(1,$ residual d.f.)	0.59		0.75	
$c - d = 0$; $F(1,$ residual d.f.)	0.81		0.85	
$b - d = 0$; $F(1,$ residual d.f.)	0.04**		0.00***	
$(a + c) - (b + d) = 0$; $F(1,$ residual d.f.)	0.11		0.05**	
$(a + b) - (c + d) = 0$; $F(1,$ residual d.f.)	0.33		0.03**	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%. Reported *t*-statistics are heteroskedasticity corrected.

significant at 1%). Finally, the impact on the speed of adjustment of the CEEC is somewhat stronger (though only at $\alpha = 29\%$). Summing up, our results support Deardorff's (2001) notion that outsourcing facilitates factor price equalization across countries.

4. Conclusions

This paper proposes a new concept to distinguish the two dimensions of convergence—*between* and *within* countries. We analyze the impact of outsourcing on the adjustment

Table 2. Conditional β-convergence Simultaneous Quantiles Regression Results and Longest Available Period Regression Result

Dependent variable: average log difference of real wages	*0.25 quartile (1993–2000)*		*Median (1993–2000)*		*0.75 quartile (1993–2000)*		*Long period (1990–2000)*	
Explanatory variables	*Coefficient*	*t*	*Coefficient*	*t*	*Coefficient*	*t*	*Coefficient*	*t*
Within countries								
Initial level	0.022	0.76	–0.015	–0.6	0.017	0.57	–0.013	–0.72
Initial level × initial outsourcing × CEEC dummy (*a*)	–0.092	–0.81	0.012	0.20	–0.004	–0.06	0.051	0.76
Initial level × initial outsourcing × EU-15 dummy (*b*)	–0.030	–2.62***	–0.019	–1.81*	–0.027	–2.03**	–0.017	–2.87***
Between countries								
Initial level	–0.016	–1.93*	–0.019	–3.45***	–0.017	–4.58***	–0.012	–3.25***
Initial level × initial outsourcing × CEEC dummy (*c*)	–0.019	–2.13**	–0.005	–0.77	0.003	0.6	–0.010	–1.91*
Initial level × initial outsourcing × EU-15 dummy (*d*)	–0.002	–2.78***	–0.001	–1.94*	–0.001	–1.87*	–0.001	–2.03**
Constant	0.033	1.13	0.055	2.95***	0.066	5.54***	0.037	2.89***
Pseudo-R^2/R^2	0.15		0.20		0.32		0.29	

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. Reported *t*-statistics are heteroskedasticity corrected.

Table 3. Estimated Speed of Convergence: Annual Closure of the Gap in Percent

	Within countries		*Between countries*	
	Overall	*Without outsourcing*	*Overall*	*Without outsourcing*
Unconditional convergence				
EU-15	–0.34	–2.41**	1.81***	1.66***
CEEC	–3.34**	–2.41**	1.76***	1.66***
Conditional convergence				
EU-15	5.54*	–0.92	1.79***	1.45***
CEEC	0.07	–0.92	1.82***	1.45***

Notes: ***significant at 1%; **significant at 5%; *significant at 10%.

of real wage rates in manufacturing of the EU-15 and 5-CEEC at the industry level. Specifically, we treat the impact of outsourcing transitorily and look at its effect on the speed of adjustment.

Based on β-convergence regressions, we significantly reject *unconditional convergence* within both the EU and the CEEC. Our estimation results furthermore suggest that intermediate goods trade of the CEEC has not fostered the pace of adjustment *within* these economies. By way of contrast, it has led to a closure of the gap between observed and steady-state wage rates *within* the EU countries.

Looking at the convergence *between* countries, cross-border outsourcing strongly fosters convergence *from below* for the CEEC and *from above* for most of the EU countries. Hence, our empirical estimates support the hypothesis derived from traditional models, namely that cross-border outsourcing increases the possibility of international factor price equalization (Deardorff, 2001).

References

Arellano, Manuel and Stephen Bond, "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies* 58 (1991):277–97.

Arndt, Sven W., "Globalization and the Open Economy," *North American Journal of Economics and Finance* 8 (1997):71–9.

Baier, Scott and Jeffrey H. Bergstrand, "The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity," *Journal of International Economics* 53 (2001):1–27.

Barro, Robert and Xavier Sala-i-Martin, *Economic Growth*, New York: McGraw-Hill (1995).

Carree, Martin and Luuk Klomp, "Testing the Convergence Hypothesis: a Comment," *Review of Economics and Statistics* 79 (1997):683–6.

Carree, Martin, Luuk Klomp, and A. Roy Thurik, "Productivity Convergence in OECD Manufacturing Industries," *Economics Letters* 66 (2000):337–45.

Cook, Dennis R. and Sanford Weisberg, "Diagnostics for Heteroscedasticity in Regression," *Biometrika* 70 (1983):1–10.

Deardorff, Alan V., "Outsourcing in Simple Trade Models," *North American Journal of Economics and Finance* 12 (2001):121–37.

Egger, Hartmut and Peter Egger, "Cross Border Sourcing and Outward Processing in EU Manufacturing," *North American Journal of Economics and Finance* 12 (2001):243–56.

Ethier, Wilfred J., "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review* 72 (1982):950–9.

Feenstra, Robert C. and Gordon H. Hanson, "Foreign Investment Outsourcing and Relative Wages," in R. C. Feenstra, G. M. Grossman, and D. A. Irvin (eds.), *Political Economy of Trade Policy: Essays in Honor of Jagdish Bhagwati*, Cambridge, MA: MIT Press (1996):89–127.

———, "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras," *Journal of International Economics* 42 (1997):371–93.

———, "The Impact of Outsourcing and High-technology Capital on Wages, 1979–1990," *Quarterly Journal of Economics* 114 (1999):907–40.

———, "Global Production Sharing and Rising Inequality: a Survey on Trade and Wages," in K. Choi and J. Harrigan (eds.), *Handbook of International Trade*, Oxford: Basil Blackwell (2001).

Fontagné, Lionel, Michael Freudenberg, and Deniz Ünal-Kesenci, *Statistical Analysis of EC Trade in Intermediate Products*, Paris: EUROSTAT (1996).

Greenaway, David, Robert C. Hine, and Peter Wright, "An Empirical Assessment of the Impact of Trade on Employment in the United Kingdom," *European Journal of Political Economy* 15 (1999):485–500.

Hummels, David, Jun Ishii, and Kei-Mu Yi, "The Nature and Growth of Vertical Specialization in World Trade," *Journal of International Economics*, 54 (2001):75–96.

Jones, Ronald W. and Henryk Kierzkowski, "A Framework for Fragmentation," in Sven W. Arndt and Henryk Kierzkowski (eds.), *Fragmentation: New Production Patterns in the World Economy*, Oxford: Oxford University Press (2001):17–34.

Kohler, Wilhelm K., "A Specific-factors View on Outsourcing," *North American Journal of Economics and Finance* 12 (2001):31–53.

———, "The Distributional Effects of International Fragmentation", *German Economic Review* 4 (2003):89–120.

Krueger, Alan B. and Lawrence Summers, "Efficiency Wages and the Inter-industry Wage Structure," *Econometrica* 56 (1988):269–93.

Krugman, Paul R., "Growing World Trade: Causes and Consequences," *Brookings Papers on Economic Activity* (1995):327–62.

Quah, Danny, "Galton's Fallacy and Tests of the Convergence Hypothesis," *Scandinavian Journal of Economics* 95 (1993):427–43.