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by Éva Katalin Polgár[2]

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Abstract

This paper analyses the relationship between openness to trade and wages at the industry level (15 manufacturing industries) in 25 EU countries over the period from 1995 to 2005. By applying a cross-country and industry-specific approach, it is possible to control for unobserved heterogeneity at both country and industry levels. We also differentiate between intra and inter-industry trade as well as between trade from western and eastern Europe and we try to assess the relative importance of foreign wages versus domestic productivity developments in an open environment. We find that trade is not an important driver of wages, since the wage response to trade is small. Moreover, in line with the Stolper-Samuelson reasoning, imports from the west generally benefit wages in central and eastern Europe, while imports from the east rather tend to harm wages in the west. The overall wage response is still negative in some sectors, particularly in more resource-based industries. Nevertheless, increased trade reinforces the productivity-wage link and weakens the co-movement of wages particularly in the west, while at the industry level there is little evidence of such a wage-disciplining effect of trade.

***JEL codes**: F14, F15, F16, J31*

***Keywords**: openness, wages, bilateral trade, European integration, wage discipline, industry level*

Non-technical summary

Globalisation is generally supposed to be welfare improving in the economic literature, inter alia via the diffusion of modern technology and knowledge or the realisation of economies of scale. However, the distribution of these openness-induced efficiency gains remains unclear in advance and there is no guarantee against losses for individual sectors of workers. Therefore it is not surprising that this positive assessment is often confronted by negative views regarding the impact of increased globalisation on employees. Fears of job losses arise from relocations of production plants within increasingly fragmented production networks; and increased cost competition between such plants is often associated with a downward pressure on wages.

In this paper we explore the effects of increased openness to trade on industry-level wages for the enlarged European Union. Trade liberalisation in the early 1990s boosted trade integration between the group of central and eastern European transition countries and western Europe. This boom was reinforced by the EU accession of the former country group. At the same time, prevailing GDP per capita and wage levels in these countries were substantially below those of the west, while due to their convergence process, they experienced significantly higher growth rates of these variables over the past decade. Therefore, they created a competitive challenge for their western counterparts in an increasingly open environment. This makes the EU an interesting case for analysing the consequences of increased trade flows for domestic wages. In particular, we address three innovative aspects of this relationship. First, our analysis is carried out at the sectoral level using bilateral trade data, thus allowing for a different influence of trade on wages in different economic activities on the one hand, and a varying impact of trade vis-à-vis different country groups on the other. Second, we differentiate between trade within the same sector (intra-industry trade) and up and downstream sectors (inter-industry trade). Third, we consider the possible influence of foreign wages on the domestic wage setting in an open environment.

In the economic literature it is surprisingly difficult to find clear-cut results for the influence of trade on wages, which contrasts with the public perception that trade could affect real wages by enhancing competition and thus pressing for lower production costs. Nevertheless, wage-relevant statements are often implicit in trade theoretical predictions, such as the theory of factor price equalisation or the Stolper-Samuelson theorem, according to which a rise in the relative price of a good will lead to a rise in the return to the factor used more intensively in its production. As trade is supposed to benefit goods produced with a more intensive use of the more abundant factor of production, leading to a rise in the relative price of such goods, the conclusion that trade raises the real return of the abundant and lowers that of the scarce production factor follows. The locally scarce factor, supposedly capital in developing and labour in developed countries, would thus ceteris paribus suffer from trade liberalisation in relative terms. However, the conclusion holds only in certain models of international trade (most notably in a Heckscher-Ohlin model context). Empirical contributions focusing explicitly on the trade-wage relationship yielded mixed results so far. Moreover, the empirical literature is characterised by a case-study approach, analysing countries separately.

In our empirical model we examine the impact of higher import ratios on average wage levels in the EU-25 over the period from 1995-2005, distinguishing between incumbent EU Member States (EU-15) and those that joined the EU in 2004 (EU-10). Industry-specific heterogeneity seems to be extremely relevant in the context of international trade, with greatly diverse trade developments within countries in different industrial activities. Using panel regression techniques, we find as a first result that trade can not be identified as a decisive factor in determining wage levels. This is actually quite important given the prevalence of the public

opinion mentioned before. Moreover, the relationship of trade and wages is in most cases positive, but its economic impact is generally rather small. We find notable differences between our two country groups. First, trade variables are more often significant for wages in central and eastern Europe. This is not surprising when we consider that in general these countries are more open to trade, and in addition, they have undergone a dynamic phase of restructuring accompanied by often high and persistent unemployment rates. These are all factors that would make wages more responsive to changes in the economic environment. Second, trade with western Europe is favourable for wages in the east, while the opposite holds the other way around. This is in line with the Stolper-Samuelson reasoning. Third, the aggregate net effect of trade on wages is negative only in a few, mostly resource-intensive industries.

We also take up the idea of trade acting as a wage-disciplining device in the sense that through increased trade openness, wages more strongly reflect the marginal product of labour and become less aligned with foreign wages. We observe wage co-movement in the sense of foreign wages having a positive impact on domestic wages in both country groups, though at the industry level this is only common in the EU-15. At the same time, in the EU-10 we find more evidence of wages being rather set in line with productivity and not with foreign wage developments when the degree of trade openness rises at the industry level, while such an effect is only present in the aggregate sample in the EU-15. Overall, the effect of trade enhancing wage discipline is only observed in a few sectors in both country groups.

In summary, we find that increased trade has only small and generally positive effects on wages. However, the results are in line with the rationale of the Stolper-Samuelson theorem, since trade with the central and eastern European countries is negatively related to wages in the west, while in the EU-10 trade with western Europe is a positive factor for the wage level. Yet trade can not be seen as a decisive factor in wage formation and thus represents no real threat to wages in either country group, since most of these effects are small. This is in line with the results of previous studies. However small the effects are, we do find a negative overall impact of trade in some sectors in both regions, which suggests that economic policy has to be carefully designed when addressing questions of increased trade integration. In particular, resource-based industries often emerge as losers from increased trade.

Further research should carefully investigate the issue of wage inequality in response to economic integration. Wage inequality has different dimensions, such as wage dispersion across industries or across individual employees due to differences in human capital. For instance, a useful distinction is often made between wages of low and high-skilled employees. In our data set, we could not identify systematic differences – possibly because the informative value of industry-level data is limited with regard to the human capital of the labour force – and therefore we did not elaborate on this issue, but this could be subject to further investigations. Overall, before drawing detailed policy conclusions, we see a need for continued careful research as well as for an improvement of available statistics to provide this research with meaningful input for comparative analyses.

1 Introduction, motivation and background

Globalisation is generally supposed to be welfare improving in the economic literature. Many arguments can be listed for a positive impact of increased trade integration on the long-term growth path, including the diffusion of modern technology and knowledge, or the realisation of economies of scale by increasing specialisation and a resulting higher degree of fragmentation of production. In particular, repeated warnings against the emerging signs of protectionism in the great financial crisis and lessons from past economic crises – where protectionism protracted the recession and delayed the recovery – illustrate the positive role of openness in economic development.[4] However, while openness can create efficiency gains, the distribution of these gains remains unclear in advance and there is no guarantee against losses for individual sectors of workers. Therefore it is not surprising that this positive assessment is often confronted by negative views regarding the impact of increased globalisation on employees. Fears of job losses arise from relocations of production plants within increasingly fragmented production networks; and increased cost competition between such plants is often associated with a downward pressure on wages.

In this paper we address the relationship between trade and wages for the enlarged European Union, focusing on three aspects. First, our analysis is carried out at the sectoral level using bilateral trade data, thus allowing for a different influence of trade on wages in different economic activities on the one hand, and a varying impact of trade vis-à-vis different country groups on the other. Second, we differentiate between trade within the same sector (intra-industry trade) and up and downstream sectors (inter-industry trade). Third, we consider the possible influence of foreign wages on the domestic wage setting in an open environment.

The fact that trade and wages often evolve differently across industries – as reflected by data at the sectoral level – could imply that the relationship between the two depends, inter alia, on the type of economic activity. For example, increased import penetration may induce a reallocation of domestic resources, leading to changes in specialisation patterns followed by different wage reactions in individual economic sectors. Increased trade openness could drive up average wages in more skill-intensive sectors, but exert a downward pressure on wages for low-skill activities, which tend to be replaced by imports. Furthermore, imported inputs could boost productivity and consequently average wages in an industry, either because they are cheaper and thus save costs of production or because they are of higher quality and thus increase output prices. This implies that within the same sector, the effects of intra-industry and inter-industry trade can differ. While intra-industry imports may pose a threat to employment and wages, imports in upstream industries may actually serve to increase wages.

Enhanced trade can also affect the factors relevant in the domestic wage setting mechanisms. In more integrated economies wage levels in trading partners can become a significant factor influencing domestic wages. At the same time, trade can increase competitive pressures on production costs, forcing a closer realignment of wages with productivity developments. This means that a high co-movement of foreign and domestic wages can go hand in hand with productivity actually gaining in relevance for the domestic wage setting at the cost of foreign wages. This is identified in Persyn (2008) as a wage-disciplining effect of trade.

[4] See the official communique issued at the close of the G20 London Summit (2 April 2009, http://www.londonsummit.gov.uk/resources/en/news/15766232/communique-020409) or the IMF report on The Implications of the Global Financial Crisis for Low-Income Countries (March 2009, http://www.imf.org/external/pubs/ft/books/2009/globalfin/globalfin.pdf) among others.

We do not aim at providing an exhaustive review of the relevant literature here, since it is indeed vast and given the complexity of the issue at hand, it includes analyses of the trade-wage relationship from many different angles. Instead, we try to concentrate on the strands of literature that are explicitly relevant for the focus of this paper. While there is a general perception that trade could affect real wages by enhancing competition and thus pressing for lower production costs, it is surprisingly difficult to find clear-cut results in economic theory for the influence of trade on wages.

Wage equations generally focus on the domestic determinants of wages (e.g. productivity and individual factors such as education, experience etc.) and have little to say about the impact of trade.[5] However, wage-relevant statements are often implicit in trade theoretical predictions, such as the theory of factor price equalisation or the Stolper-Samuelson theorem, according to which a rise in the relative price of a good will lead to a rise in the return to the factor used more intensively in its production. As trade is supposed to benefit goods produced with a more intensive use of the more abundant factor of production, leading to a rise in the relative price of such goods, the conclusion that trade raises the real return of the abundant and lowers that of the scarce production factor follows. The locally scarce factor, supposedly capital in developing and labour in developed countries, would thus ceteris paribus suffer from trade liberalisation in relative terms. However, the conclusion holds only in certain models of international trade, most notably in a Heckscher-Ohlin model context.[6] Moreover, the prediction is related to the relative intensity of factors in production, which cannot be established based on available data.

One implication of the Stolper-Samuelson reasoning – when considering skilled and unskilled labour as factors of production, the latter being relatively more abundant in less developed economies – is the increase in wage inequality in developed countries as a result of their trade with less developed, low-wage economies. This is at the heart of the literature on the debate about trade and wages, which originated from Krugman's 1995 Brookings paper, includes the early contributions of Freeman (1995) and Richardson (1995), as well as several contributions on the impact of outsourcing on wage inequality by Feenstra and Hanson (1996, 1997, 1999) or Leamer (1996a, 1996b). Feenstra and Hanson (2003) provide an overview of modelling approaches, as does the Jubilee edition of the Journal of International Economics (2000) with contributions of Leamer, Krugman, Deardoff and Panagariya. It is truly the documentation of a debate about methodological issues but also their theoretical background, where the suggested approaches differ author by author. There are several references to the importance of assumptions for the conclusions drawn[7], as well as to the fact that analysing the driving forces of factor prices ultimately remains an empirical exercise.[8]

Nonetheless, one can also cite more recent theoretical papers (based on different general equilibrium models) that come to the conclusion that international trade increases wage inequality within an economy (across different activities as well as across different skill segments etc.). An earlier example, which focuses on the effects of globalisation, is Manasse and Turrini (2001). In the trade model of Egger and Kreickemeier (2008), international trade

[5] See e.g. Mason (1994), Wolpin (2000) or Belzil (2006).

[6] Relaxing some of the assumptions and thus going beyond the standard 2-sectors, 2-factors of production, 2-countries framework can change the results. In his examination of theoretical results on the influence of a fall in import prices of labour-intensive imports on wages, Thompson (2007, p.12) concludes, "With more than the minimal number of inputs, there is no simple theoretical prediction regarding the wage."

[7] Just to cite one example: "The consequences of fragmentation for local labour markets are not clear cut in theory, depending on the models and assumptions chosen, outsourcing … can lead to decreases or increases in the wage of (unskilled) labour in the fragmenting economy …", Geishecker and Görg (2004).

[8] See e.g. the start of Krugman's conclusions in Krugman (2000), p.69.

also increases domestic wage inequality as well as involuntary unemployment. According to Amiti and Davis (2008), trade liberalisation (reduction in tariffs) results in increased inequality.[9] However, these papers often treat wage inequality as a rather abstract concept that is not easily adaptable to data. Overall, theoretical statements include no straightforward and general predictions about the dependence of real wage developments on intensified trade.[10] They deliver complex results – mostly related to trends in relative wages – depending to a large extent on the assumptions of the models and features that cannot be completely controlled for in empirical work.[11]

Turning to empirical contributions, the results are also rather mixed. In a recent work Krugman considers past trends in trade and their effect on our understanding of the trade-wage nexus. He discusses in detail the consequences of aggregation at the sectoral level and concludes that with vertical integration it has become very complicated to judge which sectors are labour-intensive and which are skill-intensive. Hence, it is not trivial to put the Stolper-Samuelson theorem to an empirical test. In particular, he states that "the changing nature of world trade has outpaced our ability to engage in secure quantitative analysis … How can we quantify the actual effect of rising trade on wages? The answer, given the current set of data, is that we can't."[12] The evidence is also ambiguous regarding wage inequality. The already cited several contributions of Feenstra and Hanson also offer empirical investigations, generally arguing that outsourcing – and not only technology – is an important explanation behind the rising wage gap in the United States. However, in general the results of empirical papers on this topic are mixed.[13]

For the current study, it is interesting to focus on the literature dealing with European economies, not least because of the substantial differences between labour markets in Europe and in the USA. However, there are only a few studies explicitly examining trade and wages, since many papers focus on some related, but distinct aspects.[14] Wage effects are considered

[9] There are also other similar papers, which focus rather on labour demand. Helpman et al. (2008) investigate how trade impacts on unemployment (but find also a rise in wage inequality), as do Mitra and Ranjan (2009), Felbermayr et al. (2009) or Dutt et al. (2009), which however also conclude from the model used that wages decline in the capital-abundant and rise in the labour-abundant country due to international trade.

[10] In the specific context of offshoring, Hijzen et al. (2007; p.3) state that "In general, these studies conclude that almost anything can happen to wages depending on the configuration of sectoral factor-intensities, the relative factor-intensity of components relocated abroad and relative factor endowments." See also Stehrer (2005).

[11] This also holds for more recent theoretical papers on the topic. Felbermayr et al. (2008) combine heterogeneous firms, search frictions and wage bargaining structures into a theoretical model, and conclude that trade liberalisation (reducing trade costs or increasing the number of trading partners) leads to lower unemployment and higher real wages as long as it improves aggregate productivity net of transport costs. Bernard et al. (2007) come to a similar conclusion again interacting country, industry and firm characteristics in a general equilibrium model. Here, the Stolper-Samuelson logic holds, but trade liberalisation again improves aggregate productivity, dampening or even reversing real wage losses of scarce factors.

[12] Krugman (2008, p.27). In this statement, Krugman refers to the impact of trade on relative wages in the Stolper-Samuelson sense, and not the impossibility of testing more straightforward statements such as the relationship of trade and real wages on a specific level of sectoral aggregation as is done in this paper.

[13] Borjas and Ramey (1995) analyse the link between trade in concentrated industries and aggregate wage inequality, finding a small impact of trade on inequality. In general, a positive impact of trade on wage inequality is found by Amiti and Davis (2008) for Indonesia and by Rabbani (2005) for the United States. Positive, but small effects were established in Galiani and Sanguinetti (2003) in the case of Argentina and in Attanasio et al. (2004) for Colombia. By contrast, Mishra and Kumar (2005) find the opposite effect for India, suggesting that trade liberalisation has led to decreased wage inequality.

[14] Pula and Skudelny (2008) and Peltonen and Pula (2008) deal primarily with the impact of imports from low-cost countries on the demand for labour in some euro area countries. Rodríguez and Rodrik (2000) analyse the link between trade policy and economic growth. The employment effects of outsourcing to low-wage countries are analysed by Falk and Wolfmayr (2005). At the same time, trade and wages are analysed in several contributions of Geishecker and Görg (2004, 2008a, 2008b and with Munch, 2008).

in two papers by Onaran that focus on the impact of offshoring on employment and wages in Austria. Onaran (2008a) finds generally negative wage effects, while – when focusing on the Austrian manufacturing industry – Onaran (2008b) concludes that there is a negative impact on employment, but wages are actually positively affected by offshoring to eastern Europe, which indicates the dominance of scale effects.

Regarding transition economies, empirical evidence on the trade-wage nexus is even more limited. Again, most related papers investigate slightly different questions, like the effect of foreign direct investment (FDI) on wages or the employment effects of trade.[15] The trade-wage relationship in the region is explicitly considered in Onaran and Stockhammer (2006), who analyse the manufacturing sectors in five countries (the Visegrad countries and Slovenia) for the period from 2000 to 2004. According to their findings, the long-term net effect of exports and imports was negative for the period under review.[16] Wacker (2010) investigates the impact of exports towards western Europe on wages in the Visegrad countries and comes to mixed results, but argues that the impact seems to be negative in the short run and positive in the medium to long term at least for some of the countries analysed.

To summarise, the few papers that explicitly consider the relationship between trade and wages find that the effects of trade on wages are often insignificant or very small. Moreover, the literature is characterised by a case-study approach, especially when based on microdata. Even papers analysing more than one country run country-specific regressions, which in our view limits the validity of the results to the country in question. Our attempt is to explore the effects of increased openness to trade on industry-level wages for the enlarged European Union.[17] Trade liberalisation in the early 1990s boosted trade integration between the group of central and eastern European transition countries and western Europe. This boom was reinforced by the EU accession of the former country group. At the same time, prevailing GDP per capita and wage levels in these countries were substantially below those of the EU-15 (see footnote 17 for the definition of the country groups), while due to their convergence process, they experienced significantly higher growth rates of these variables over the past decade. Therefore, they created a competitive challenge for the EU-15 in an increasingly open environment. This makes the EU an interesting case for analysing the consequences of increased trade flows for domestic wages.

This paper is structured as follows. Section 2 describes the dataset and some stylised facts with respect to trade and wage developments at the industry level within the EU-25. Section 3 analyses the relationship between both intra-industry and inter-industry imports and the average wage level in eastern and western European countries. Section 4 discusses the influence of foreign wages versus domestic productivity developments on the domestic wage setting and section 5 concludes.

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[15] Bruno et al. (2005) focus on six manufacturing sectors in three countries (the Czech Republic, Hungary, Poland) in the period from 1993 to 2000 and try to relate FDI to the rising skill premium. Esposito and Stehrer (2007) focus instead on the sector bias of skill-biased technical change in the manufacturing sector in Hungary, the Czech Republic and Poland. Grotkowska (2008) investigates the impact of trade on employment in the Polish manufacturing sector. Onaran (2007) estimates a labour demand equation for some central and eastern European countries using a country-specific panel data analysis.

[16] In particular, they found that exports had a negative and imports a positive effect on wages, but overall the impact of international trade was small and negative in net terms.

[17] Our analysis is based on the EU-25 including 15 western European members (EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom) and 10 central and eastern European members (EU-10: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia). Due to data constraints, we could not include Bulgaria and Romania.

2 Stylised facts about wages, productivity and trade

The dataset used for the analysis is compiled from three main sources, with a few data series coming from other providers. The main dataset for all but trade variables is the EU KLEMS database. This database contains inter alia data on output, price developments, productivity, labour compensation and employment at the industry level for all EU-25 countries up to 2005.[18] As eight of the EU-10 countries are transition economies for which pre-1995 data are either unavailable or reflect untypical economic developments, we restrict the dataset for the period from 1995 to 2005. We complemented this with bilateral trade data at the industry level from the UN Comtrade database.[19] This dataset is extended with a few series at the country level from other sources – all the details and a description of how our variables were constructed are provided in Appendix 1. In the end, we arrive at a comprehensive dataset that links trade, output and wage data at the industry level. We have 15 manufacturing sectors (including agriculture) that are roughly at the two-digit NACE level. Therefore, in total our dataset comprises information for 25 countries, 11 years and 15 economic activities.

We calculate hourly wages (compensation of employees divided by hours worked) and hourly productivity (value added divided by hours worked) for each observation in our three dimensions (country, industry and year) from the EU KLEMS database. We decided to use hourly wages because, if reliable, hours worked give a clearer picture of labour used in the production process than the number of employees. Moreover, in our case the correlation of the two variables is very strong for all countries and industries, so there is no reason to assume that using the number of employed would produce a more reliable comparison.

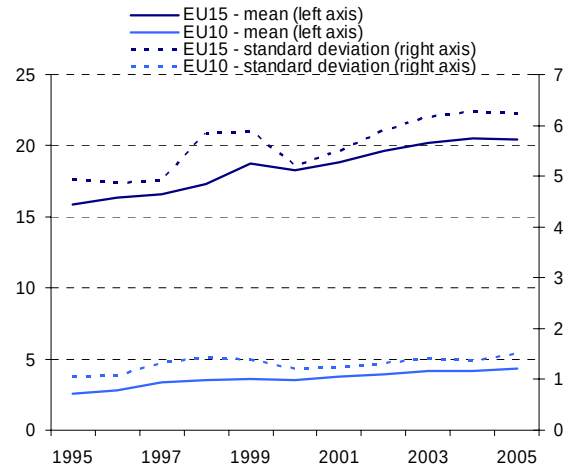
What do we see from the data at first sight? In terms of average hourly wages of the economy (that is, averaging across industries and countries), one can see a significant level difference between the EU-15 and the EU-10. This is obvious from chart 1a, where we took simple averages of the mean hourly wages in the respective countries. Both the mean and the standard deviation show an upward trend in both country groups.[20] Since the standard deviation is not dimensionless, cross-country comparisons are often based on the coefficient of variation, which is a normalised measure of dispersion. As Chart 2b shows, during the entire period the variability of average hourly wages (as a percentage of the mean) is actually higher in the EU-10 than in the EU-15. But while the cross-industry variation follows a broadly similar pattern in both country groups between 1995 and 2005, the marked increase in wage dispersion since 2004 in the EU-10 is nevertheless noticeable. This may indicate that the wage levels of the various industries have been affected quite differently by EU accession.

[18] The EU KLEMS dataset was established by a consortium led by the Groningen Growth and Development Centre. The time series start in 1970 and are currently being updated to include 2006 (2006 data were not yet available for this study). See Timmer et al. (2008).

[19] Merchandise trade data were converted from five-digit SITC codes to two-digit Nace Revision 1 industries using the correspondence keys implemented in the World Bank and UNCTAD WITS software.

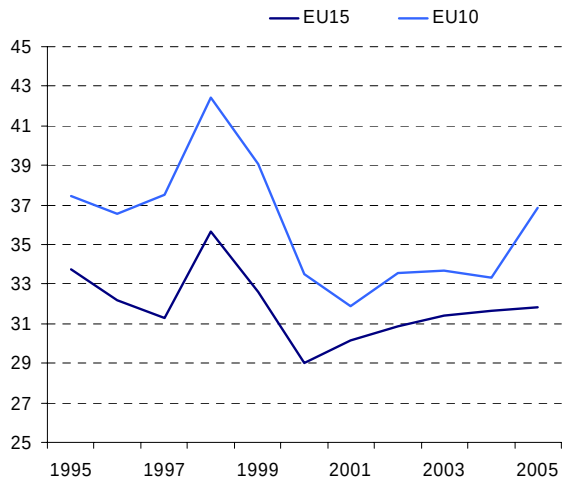
[20] Average real wages increased faster in the EU-10. Given that hours worked remained remarkably stable over time in most countries, this increase is therefore due to the rising compensation of employees in real terms.

Chart 1a: Mean and standard deviation of the average hourly wages of the economy



Source: EU KLEMS.
Note: Both the mean and the standard deviation of hourly wages are calculated across industries and then averaged for the countries of the respective country groups.

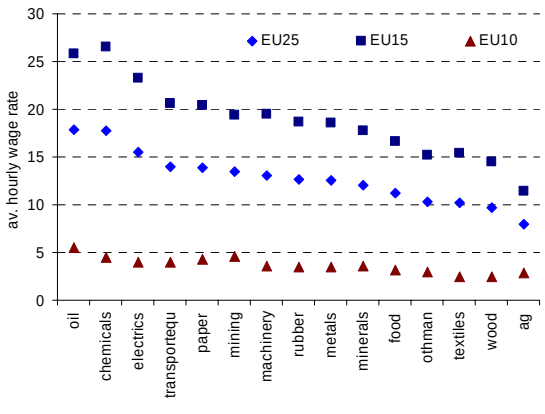
Chart 1b: Coefficient of variation of the average hourly wages of the economy



Source: EU KLEMS.
Note: The coefficient of variation is calculated by dividing the cross-industry standard deviation by the cross-industry mean for each country and then averaging for the country groups.

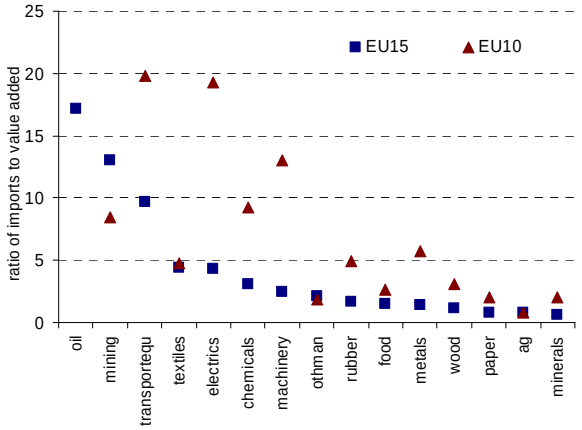
Interestingly, the relative wage structure of industries is remarkably similar in our country groups. If we rank the industries according to real wages paid on average during 1995-2005 in the EU-25, we find very few changes in the order of industries in our two subgroups (chart 2a). However, this does not hold for other industry characteristics, for example for trade penetration. Ranking industries by the ratios of imports to value added the EU-15 and the EU-10 show quite a different picture (chart 2b). This is also true for exports or export growth, suggesting that – in line with their distinct patterns of specialisation – the country groups differ to a much larger extent in their trade patterns than in terms of their wage structure.

Chart 2a: Relative wages by industry (1995-2005 average)



Source: EU KLEMS.

Chart 2b: Import-to-value added ratios by industry (2005)



Sources: UN Comtrade and EU KLEMS.
Note: The import ratio of the oil sector for the EU-10 is not shown on the chart, as it is very high (~560).

Given the similarities in the relative wage structure, we grouped the industries according to their wage level by dividing the range spanned by the highest and lowest wage paid evenly into three parts and naming them high-wage, medium-wage and low-wage sectors, respectively. In general, the wage distribution across industries is somewhat more skewed in

the EU-10 than in the EU-15, meaning that in the former group there are only two high-wage but six low-wage industries, while in the EU-15 three and four sectors belong to these groups, respectively. Therefore – as already shown by the coefficient of variation – wage inequality across sectors is higher in the EU-10. The oil industry belongs to the high-wage sectors in all country groups, while agriculture, textiles, other manufacturing and the wood industry always belong to the low-wage group.[21] To ease the presentation, in the following we are going to use these groups when presenting data for the industries.

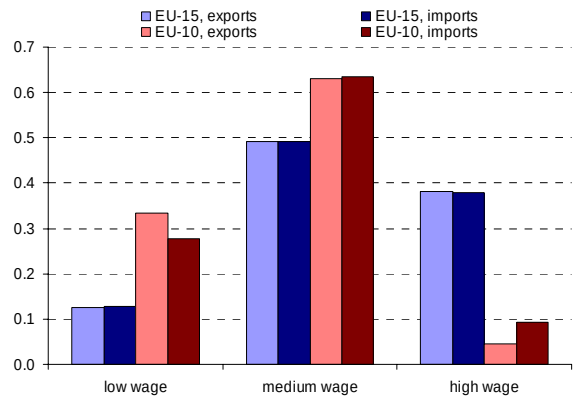
Turning to trade developments, in line with the growing global integration and openness of our country groups we can observe a substantial increase in total exports and imports of goods over time. In addition, export and import patterns are highly correlated in all countries. In order to judge the relevance of trade from different perspectives, we calculated on the one hand the share of each industry's exports/imports in total national exports/imports and the ratios of exports/imports to value added of the industries on the other. The shares indicate the industry's relevance for the overall trade performance of the respective economy. The medium-wage group provides most of the trade in both country groups cumulatively, but while the low-wage group accounts for the smallest part in the EU-15, in the EU-10 it is the high-wage group (chart 3a). This is especially true for exports, suggesting that in the case of the central and eastern European countries export competitiveness is much more driven by low production costs than in western Europe.[22]

Regarding trade orientation the EU-15 dominates in both country groups, while the share of trade with the EU-10 is small, especially in western Europe. In particular, in 2005 on average across the manufacturing sectors in the EU-15 62% of total imports came from within the group, 5% from central and eastern Europe and about one third from the rest of the world; while in the EU-10 these shares were 55%, 15% and 30%, respectively. The export shares are very similar. However, the average import share of the EU-15 declined slightly in both country groups, while that of the EU-10 increased significantly, particularly in the EU-15 where it rose by over 40% in eleven years. For exports this pattern is broadly similar, but the dominant share of the EU-15 in central and eastern Europe did rise (and not fall as for imports), and the increase of the share of exports towards the EU-10 in western Europe was less pronounced. Nevertheless, the enhanced integration in Europe did favour the share of central and eastern Europe in trade overall, which is however still moderate.

Turning the angle, the ratios of imports and exports to value added as well as trade openness (the sum of imports and exports divided by gross output) reflect how important trade is for a specific sector. Overall, industries in the EU-10 are more open than in the EU-15 (chart 3b). Moreover, trade is increasing in relation to value added with the wage level in both country groups, but while the differences are moderate in western Europe, they are rather striking in the central and eastern European countries. This is almost entirely driven by the oil sector in the high-wage group, which shows extremely high trade (especially import) penetration. Apparently trade volumes and value added are in a much more balanced relationship in this sector in the EU-15. It is also interesting to note that import ratios exceed export ratios in all industry groups in both country groups.

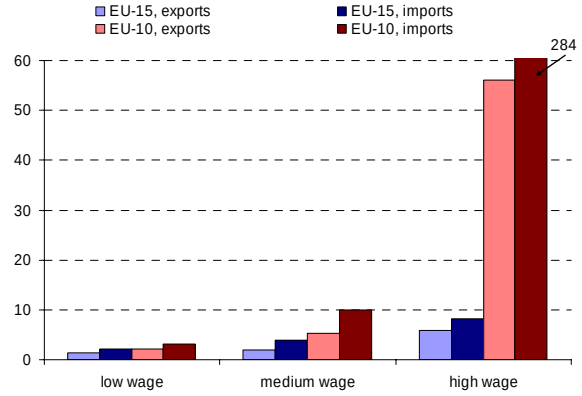
[21] See the full list of these industry groups for the EU-15 and the EU-10 countries in Appendix 2.
[22] This is even more pronounced if we check the average trade shares of the industry groups instead of the cumulated shares, since the high-wage group dominates there in the EU-15, while it accounts for a minor share of overall trade only in the EU-10, especially in the case of exports.

Chart 3a: Cumulated trade shares of industry groups (2005, country group averages)



Sources: UN Comtrade and EU KLEMS.

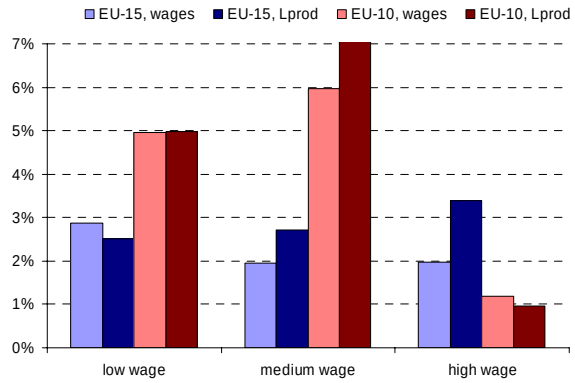
Chart 3b: Average trade-to-value added ratios of industry groups (2005)



Sources: UN Comtrade and EU KLEMS.

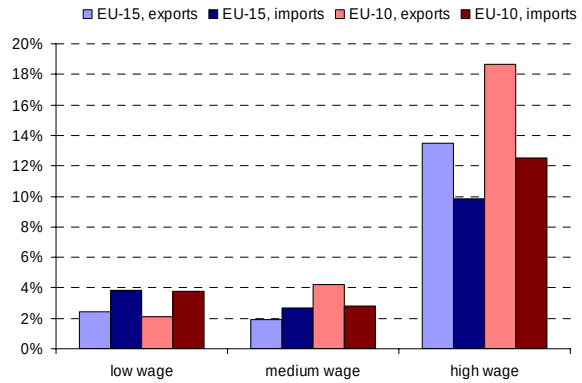
To investigate the dynamics of our main variables, we have also calculated their average annual growth rate in all countries and industries for the period 1995-2005. Starting with hourly wages and hourly labour productivity, first we find a confirmation of the catching-up process in the EU-10 towards EU-15 levels (chart 4a). In particular, both real wages and productivity developments have been more dynamic in the former region than in the EU-15, with the sole exception of the high-wage group. This is driven partly by the oil sector, the only sector where average productivity growth was strongly negative in the EU-10, while it was flat in the EU-15. Wage growth was actually faster in all industries in central and eastern Europe, but this is not properly reflected in the chart due to the different composition of wage groups. In the EU-10 the high-wage sectors were the least dynamic ones, while productivity rose at the fastest rate in this group in the EU-15. Moreover, while productivity growth generally exceeds wage growth, the opposite holds – suggesting a decline in competitiveness – for the high-wage sector of the EU-10 and the low-wage sector of the EU-15. Assuming that the wage level correlates to some extent with skill intensity and/or capital intensity, this seems to be in line with the logic behind the Stolper-Samuelson theorem.

Chart 4a: Average growth rate of hourly wages and hourly productivity by industry groups (1995-2005)



Source: EU KLEMS.

Chart 4b: Average growth rate of trade-to-value added ratios by industry groups (1995-2005)



Sources: UN Comtrade and EU KLEMS.

In terms of the growth rate in trade-to-value added ratios, the fastest rates of increase were recorded in the high-wage group in both country groups (chart 4b). It is also the industry group where export ratios increased significantly faster than import ratios in both country groups. Not only were trade ratios in all groups higher in the EU-10 at the end of the period

(as chart 3b demonstrated), they also increased generally faster during 1995-2005, except for the low-wage sectors. Given the different trade patterns in our industries both in terms of the trade ratios and in their change over time, analysing the relationship of wages and trade at the sectoral level seems reasonable. In the following section we turn to this econometric exercise.

3 No big threat: mixed evidence on the link between trade and wages

We empirically test the relationship of wages and trade at the sectoral level in the enlarged EU for the period from 1995 to 2005. Our aim is not testing trade theory or judging the validity of certain models of international trade. Instead our approach is an empirical one aimed at investigating the relationship of trade and wages in general, and testing whether the general perception that trade threatens wages receives support from the data in our sample. The literature suggests basically two distinct theory-based empirical frameworks in this context[23]: the first is based on wage regressions and the second on estimating labour demand functions. Wage regressions encompass the so-called "Mincerian wage equations", which are frequently used in labour economics and empirical studies based on micro-data, as well as so-called "mandated wage regressions", which are essentially grounded in a general equilibrium framework.[24] Our empirical model is essentially in the latter tradition, whereby the general equilibrium aspect (i.e. interdependencies across sectors) is captured in the following two ways: first, by pooling all observations across all sectors and second, by controlling for certain variables at the country-wide level as well as for trade in other sectors of the economy explicitly in each sector-specific specification. However, we are not trying to explicitly derive our empirical specification from theory, since we are trying to address an empirical issue based on available data. Therefore, our approach can be rather judged against other empirical papers, some of which use very similar regressions.[25]

Using a panel data approach, we take both the cross-sectional and the time series components of the dataset into account. Previous studies generally analysed countries separately, which enabled the use of much more detailed national information on the one hand, but restricted the validity of the results to the country under review on the other. Given the European-wide coverage of our study, we lack the details on workforce characteristics which are only available for individual countries. Since the aim of this paper is not to explain wage formation as such, but to identify the wage response to changes in a country's external regime (i.e. increased trade openness), we consider our setting appropriate.

3.1 The method of econometric estimation

Our model – in the spirit of a mandated wage equation – can be summarised in equation 1:

$$\ln(wage_{c,i,t}) = \alpha + \beta_1 * ur_{c,t} + \beta_2 * \ln(prod_{c,i,t}) + \beta_3 * open_{c,t} + \sum_{k=1}^{3} \delta_k * trade_{c,k,i,t} + \\ + \sum_{k=1}^{3} \varphi_k * trade\_other_{c,k,i,t} + \gamma_{i,c} + \varepsilon_{c,i,t} \quad (1)$$

[23] We thank an anonymous referee for clarifying our thoughts along these lines.
[24] Such wage regressions are linked to the zero-profit conditions of a competitive equilibrium, but they are difficult to derive rigorously.
[25] See e.g. Winter-Ebmer and Zimmermann (1998), Hofer-Huber (2003) or Onaran-Stockhammer (2006).

The dependent variable is the natural logarithm of the real hourly wage in country *c*, industry *i* and year *t* (subscript *k* refers to different trading partners, see Appendix 1 for a description of the exact calculation of all variables).[26] We regress hourly wages on the unemployment rate (*ur*) and on the logarithm of sectoral hourly labour productivity (*prod*). Since we do not have sector-specific unemployment data, we use the country-wide unemployment rate to reflect the relative scarcity of the factor labour. While this is quite a restricted set of real economy and labour market-relevant variables, other indicators, such as sector-specific employment (a very crude proxy for labour supply conditions at the sectoral level), GDP growth as well as a time trend were either insignificant or did not change the results. Furthermore, this simple specification already gives a relatively good fit. We expect a negative coefficient on unemployment, since high unemployment – meaning the abundance of labour – should exert a downward pressure on wages. While the economy-wide unemployment rate can not reflect properly the conditions on the sectoral labour markets, it has the potential advantage of already incorporating changes in sector-specific unemployment levels attributable to inter-sectoral mobility.[27] Including unemployment also corresponds to implicitly assuming some kind of wage bargaining, e.g. a unionised labour market, which we will more explicitly assume in section 4. As for labour productivity, we expect a positive coefficient, since in equilibrium labour earns its marginal product.[28] Therefore, with higher output per employee firms can afford higher wages without endangering competitiveness.

Turning to the next set of regressors, we have to think about how we expect trade to affect wages. First, this influence can come both from the import and from the export side. Imports affect wages by displacing otherwise domestically produced goods and services, but their influence depends on whether they replace low-productivity and low-wage activities or whether they compete with high-productivity, high-wage activities. In the former case, we should observe a positive effect on the average wage level of a sector, while in the latter the relationship of imports and wages would be rather negative. Therefore, the sign of the import coefficient is ex ante unclear. Yet, as we expect the first effect to occur rather in more sophisticated activities, we expect a positive relationship in more technology and skill-intensive industries. Turning to exports, greater exposure to the global market would introduce more competition in a sector and hence again work in a positive and a negative way at the same time. Both an increase in demand due to exports and the potential pressure for increasing product quality could positively affect wages. At the same time, more competition may reduce trade union power and exert downward pressure on wages. It remains an empirical question which of these effects dominates.

We introduce trade into our model in the following way: First, we control for the general trade openness of a country by including the ratio of country-wide exports plus imports to GDP (*open*), since rising trade openness may induce an entirely new pattern of specialisation which indirectly impacts on the average wage level through changes in the composition of low and

[26] We are using the gross output price index to deflate nominal wages and not the consumer price index. While the latter is relevant for calculating the purchasing power of wages and thus for consumption and labour supply decisions, we are focusing here rather on the labour demand side and how firms' employment and cost decisions react to trade. Moreover, as the output price index is sector-specific, real wages thus reflect solely developments at the sectoral level. We thank Robert Stehrer for directing our attention to this point. For results using the other deflation procedure, see Polgar and Wörz (2009). They are qualitatively similar, though comparison is constrained by other differences in the methodology.

[27] We are not able to capture inter-sectoral labour mobility explicitly in our approach, which is based on the separate estimation at the level of individual industries, but we come close to capturing interdependencies between sectors in the pooled regression results. Furthermore, taking into account the potential impact of the country-wide unemployment rate does indirectly allow for some sectoral interdependence.

[28] There is a potential endogeneity problem here, since productivity can also be influenced by trade and wages.

high-wage tasks in the economy.[29] However, trade openness is closely related to the country size, i.e. bigger countries tend to be less open and rely more heavily on domestic demand. In order to eliminate this effect, we first regress trade openness on the (natural logarithm of) population and the gross domestic product of the country, and then use the residuals in the regression.[30]

Secondly, in order to measure the impact of intra-industry trade, we used the import ratio (imports to value added of the respective sector, *trade*) in our equation as the main sector-specific trade variable of interest.[31] This variable is to be interpreted as the additional effect of sector-specific openness beyond the effect from country-specific trade openness on the sectoral wage. Thus, the coefficients on the import ratio should be interpreted as the deviation from the coefficient on openness and it indicates how much the pure effect of the import share in that sector adds to or subtracts from the effect of openness of the country. If the coefficients are not significant, then we infer that they are not significantly different from the coefficient on openness.[32] Using bilateral trade data, we are able to differentiate between three different import ratios: the imports from the EU-15, EU-10 and the rest of the world (*k*). If the Stolper-Samuelson logic holds and we accept that the EU-15 is the more capital-abundant region, than we would expect a negative relationship of wages and imports from the EU-10 in this group. In a similar vein, in the EU-10 wages should be rather positively related to imports from the other country group. To avoid problems arising due to multicollinearity, we checked correlations between these import ratios, and found them to be generally low. Nevertheless, we also estimated the equations including only the trade ratio of the other country group, and found very similar results in terms of sign, significance and magnitude of the included ratio. Therefore, given that the full equations provide a much richer setup, we decided to present them in the paper.

However, wages in a specific industry are likely to be influenced by trade developments in the other sectors of the economy, as well. Therefore, we also included the average import ratio for the rest of the economy (*trade_other*) – i.e. in all sectors other than the one analysed – to account for the influence of trade on wages via upstream or downstream industries. Again we differentiate between imports from three different groups of trading partners: EU-15, EU-10 and rest of the world (*k*). (The same applies to the correlation of these trade ratios as said above.) Individual sectors of an economy are strongly linked through inputs from upstream industries and intermediate demand by downstream industries. Through the trade ratio in the rest of the economy we capture possible repercussions from increased import penetration in other sectors of the economy on the industry under review (inter-industry trade). This reflects

[29] We have also experimented with other trade variables – e.g. net exports, country-wide export and import ratios – but these often resulted in lower explanatory power. Moreover, controlling for a country's openness to trade seems adequate given that trade is always a two-way phenomenon.

[30] Using the terminology of Combes and Saadi-Sedik (2006), we use the trade-policy induced openness, eliminating natural openness, which is based on structural determinants. We feel that this is appropriate for two reasons: On statistical grounds, the country size is already captured in the fixed effects, thus we do not miss its impact. On policy grounds, size is an invariant factor, while openness to trade can be influenced by different economic policies. Even within the European Union, where trade policy is not a tool for national economic policy any more, there is still a wide room for manoeuvre with respect to national regulation, structural policies and other instruments which influence non-tariff barriers to trade.

[31] Results for exports are qualitatively similar and are available from the authors upon request. We are using trade ratios, i.e. volume data in our regression, while e.g. the Stolper-Samuelson theorem directs attention to prices. In the literature the relevance of prices versus volumes was a much-debated issue, but we find volumes important for our research question. In the sense of Krugman (2000), p.64: "we are not making an assertion about how markets work, we are trying to use market data to infer the answer to a "but-for" question. And for the exercise volume data are not only relevant, they are crucial."

[32] We thank the anonymous referee for this suggestion.

also the general-equilibrium idea behind mandated wage equations. For instance, in a case when imports affect wages negatively in the same industry due to higher competition pressures, higher imports by upstream industries could nevertheless offset this effect and boost wages not only by increasing productivity via cheaper and possibly also higher-quality inputs into production, but also through the composition effect mentioned above. Thus, the interconnectedness of different sectors in the economy is captured by this latter effect.

This specification is similar to equations used in the empirical literature (see footnote 25).[33] We estimate our model first across all countries and industries in the two country groups, since imposing the same model on all EU Member States seems inappropriate. Hence, we splitted the sample into two parts, the smaller and generally more open economies that joined the EU in 2004 (EU-10) and the EU-15 throughout the analysis. Due to its very special character, we excluded the oil sector from the econometric investigation. Therefore, our panels include 210 and 140 cross-section units in the EU-15 and EU-10, respectively (15/10 countries times 14 industries) over eleven years (1995-2005).

Interdependencies between sectors are captured by the common error structure in this setting. While we include country-industry fixed effects in this specification, we force the wage reaction to trade to be homogenous when pooling all sectors. Therefore, we also estimate the same model separately for each industry, thus allowing for a different reaction of wages on trade in each sector.[34] By using country-specific fixed effects in the regression, we control for the unobserved heterogeneity of countries, avoiding biased results where idiosyncrasies such as geographic location, institutional differences in national labour markets and collective bargaining are relevant. Econometrically we thus exploit the cross-country dimension, while we allow for different elasticities of wages with respect to trade in individual activities by running the regressions separately for individual industries. In line with the patterns found in the data in section 2, this way of proceeding seems reasonable. We are using a static panel regression with fixed effects and clustered standard errors, since in the industry-specific estimations the dynamic approach proved to be inappropriate.[35]

3.2 Results

The second and third column of Table 1 reports the results for the pooled sample across all industries (except for the oil industry). Starting with the real economy variables, labour productivity emerges as the main driver of wages, it is highly significant and shows the expected positive sign for most sectors in both country groups. The elasticity of wages with respect to labour productivity is around 0.5, slightly lower in the EU-15 than in the EU-10. By contrast, the country-wide unemployment rate has a differential effect for the EU-15 (expected negative sign) and the EU-10 (with a positive coefficient). This might be related to the fact that the unemployment rate enters the regression as a country fixed effect, and therefore does not necessarily signal labour supply conditions at the sectoral level.

[33] Due to the unavailability of data at the sectoral level we do neglect several aspects which may be relevant for wage developments in an international context, such as FDI or migration.

[34] We admit that the general equilibrium idea is less well incorporated in the sector-specific regressions, however, we would like to point out that by including country openness as well as imports in other sectors, sectoral reallocation effects are captured to some extent.

[35] When using the general method of moments (GMM) estimator proposed by Arellano and Bond (1991), we found severe dynamic misspecification in all sectors for both country groups. In particular, the lagged endogenous variable as well as the test for first order autocorrelation in the residuals was insignificant. Hence, we decided to use the static estimations for the individual sectors as well as the pooled sample. In a related paper using total (not bilateral) trade data, the dynamic specification proved to be better. See Polgar and Wörz (2009) for the results.

Let us now turn to the relationship between trade and wages. In the pooled sample general country-wide openness is significantly and positively related to wage rates in the EU-15 and negatively in the EU-10. However, while this is the only significant coefficient for the trade variables in the EU-15, in the EU-10 the negative coefficient is counterbalanced by the import ratio in the respective sector and in all other sectors of the economy, thus the overall impact is positive in both country groups. In particular, imports from the own country group are positively related to wages, while both inter and intra-industry imports from the rest of the world are also significant, but the coefficients are lower. From the EU-15 only inter-industry imports had a significantly positive correlation with wages.

Table 1: Results for equation 1 and 2 for the EU-15 and the EU-10

Variable	EU-15 Equation 1	EU-10 Equation 1	EU-15 Equation 2	EU-10 Equation 2
Unemployment	-0.005 ***	0.011 ***	0.002	0.009 ***
	-3.25	*4.63*	*1.12*	*4.03*
Ln(Productivity)	0.472 ***	0.545 ***	0.393 ***	0.485 ***
	12.1	*11.73*	*9.92*	*10.87*
Country openness	0.171 ***	-0.117 ***	0.121 **	-0.200 ***
	2.59	*-2.72*	*1.97*	*-5.71*
Import ratio - EU15	-0.001	0.001	0.022 ***	0.010 **
	-0.64	*0.47*	*3.11*	*2.29*
Import ratio - EU10	0.035	0.097 ***	0.003	0.088 ***
	0.57	*3.24*	*0.11*	*2.89*
Import ratio - rest of the world	-0.001	0.009 *	0.011 ***	0.012 ***
	-0.74	*1.84*	*3.08*	*2.62*
Import ratio; rest of economy - EU15	0.038	0.123 ***	0.018	0.123 ***
	1.03	*16.77*	*0.54*	*12.8*
Import ratio; rest of economy - EU10	0.160	0.111 *	-0.929 ***	0.030
	0.67	*1.67*	*-4.06*	*0.45*
Import ratio; rest of economy - ROW	-0.019	0.097 ***	-0.091 **	0.099 ***
	-0.35	*14.22*	*-2.05*	*14.57*
Foreign wages			0.632 ***	0.471 ***
			7.49	*4.35*
Foreign wages x sector openness			-0.026 ***	-0.010 **
			-3.28	*-1.96*
Productivity x sector openness			0.011 ***	0.005
			3.41	*0.82*
Constant	1.188 ***	-0.399 ***	-0.171	-1.515 ***
	8.12	*-6.05*	*-0.87*	*-5.94*
Obs.	2200	1500	2200	1500
No. of Groups	210	140	210	140
Adjusted R^2 (within)	0.60	0.81	0.67	0.82
F-Statistic	62.15	225.56	114.06	204.90

Notes: The dependent variable is the log real hourly wage, deflated by sectoral output-deflators. Pooled results for all sectors (except for the oil industry). t-ratios are reported below each coefficient, *(**)[***] indicate significance at the 10% (5%) [1%] level or below.

Overall, the results suggest that trade has a different effect on wages in the EU15 and the EU10. While greater openness seems to benefit workers in the EU-15 through higher wages, it is rather a disadvantage in the EU-10. However, taking into account also the import ratios, the overall impact is positive in both country groups and larger in the EU-10. Of course, these

pooled results mask considerable differences at the sectoral level. When allowing for a different reaction of trade on wages, we find the following interesting results.

For the EU-15 (see Appendix Table A3), openness is positively related to wages in only two sectors: agriculture and rubber. This positive correlation is reinforced by sector-specific trade within the own country group, and partly reduced by inter-industry imports from the own group in agriculture. However, we find ten industries which show no response to general country openness, but a significant wage response to inter or intra-industry imports (in eight cases a positive one). Therefore, the overall trade impact is positive in ten sectors and it is mostly coming from trade within the own country group. In particular, intra-industry imports from EU-15 show a significant positive correlation with wages in seven industries. It is negative in two sectors (paper and metals), which is mostly due to trade with the rest of the world and in one case (paper) also to trade with the EU-10. Overall, a closer look at individual activities reveals quite a differentiated view, albeit positive trade effects seem to dominate in the EU-15, but these are mostly due to importing from the own country group.

By contrast, sector-specific results for the EU-10 reveal a different picture (see Appendix table A4). Country openness is significantly negatively related to wages in six cases (mining, wood, paper, rubber, metals and machinery). In mining this is even reinforced by inter-industry trade from EU-10 partners, while imports from the other two groups work in the other direction, but the overall impact remains negative. Despite counterbalancing effects from inter and intra-industry trade in the remaining five sectors, the overall impact remains negative in the rubber and metal industry, leaving three sectors with an overall positive net effect from trade on wages. Taking into account all sectors (not only those where openness was a significant factor for wages), we find a positive overall impact in ten industries and negative in the three sectors already mentioned as well as chemicals. Apart from country openness, the negative impact is always due to trade within the own country group, despite observing a positive correlation with wages in more sectors than a negative one. Trade with the other country groups is always positively related to wage developments.[36]

However, the impact is generally small in economic terms. The overall semi-elasticity of wages to trade ranges between -2.5 and 1.1 in the EU-15 and -0.52 and 1.59 in the EU-10. To have an example, let us take the most negative scenario, the case of the paper industry in the EU-15. Here, if the ratio of imports from the EU-15 to value added increases by ten percentage points, wages are generally higher by about 7%, but a similar increase in the same import ratio of the rest of the economy would reduce this by about 1.7%. Intra-industry imports from the EU-10 "cost" 19% in terms of wages, while those from the rest of the world another 11% and this yields the overall impact of -25%. To put this a bit in perspective, in the EU-15 on average the intra-industry import ratio with respect to EU-10 partners (the one with the strongest negative wage impact) hardly grew more than one percentage point over the eleven years analysed, while the intra-industry import ratio from the rest of the world even slightly declined. At the same time, intra-industry imports in relation to GDP within the EU-15 rose strongly, by over 20 percentage points. Therefore the potential negative trade impact is less worrying when taking into account the historical changes in the trade ratios. In the EU-10 the largest overall impact of 1.59 is in the agricultural sector, and mainly comes from intra-industry imports from the own group. In particular, if this ratio increases by ten percentage points, the positive wage impact would be 7%. Between 1995 and 2005 this import ratio rose by about 5 percentage points. Therefore, taken together, the economic magnitude of the trade effect is rather small.

[36] As a robustness check we also tried instrumenting all trade ratios with their own lags, and found broadly similar results, with the magnitude of the coefficients being generally larger.

Overall, it is interesting to note that all trade effects apart from the general country openness are positive in the EU-10 on average, while in the EU-15 intra-industry trade with the other two country groups has a negative impact on wages. Therefore, while the net effect of trade was more often negative in the EU-10 than in the EU-15, imports from the other groups generally benefited wages in central and eastern Europe, while intra-industry imports from the EU-10 were negatively related to wages in the west. This is in line with the rationale behind the Stolper-Samuelson theorem, if we accept the EU-15 as the more developed group with more capital or skill-intensive production and the EU-10 as more labour abundant. The difference is found only in the case of intra-industry trade, while inter-industry trade was generally positively related to wages also in the EU-15. Moreover, the magnitude of this effect is in most sectors small, and thus can in no case support the general perception of trade exerting a significant downward pressure on wages for the EU-15. The relationship of trade and wages does indeed depend on the economic activity, but the composition of sectors with a significant correlation seems to be rather coincidental. An overall negative response to trade is however dominantly found in more resource-based industries.

4 Does trade bring more wage discipline?

In the previous section, we tested for a direct relationship between wages and imports as well as for a more general link between wages and trade openness. Trade could, however, also affect wages in a more indirect way. For instance, if trade facilitates the equalisation of factor prices, wages in different countries will tend to move closer together when trade flows are higher. This can be investigated by simply examining the relationship between wages in different countries. Yet, in a recent contribution Persyn (2008) argues that the results from such an analysis can be misleading since wages can actually become less interrelated despite such a co-movement. He proposes a – theoretically founded – framework (assuming a unionised labour market) where foreign wages and terms interacting trade openness with both foreign wages and productivity are added to a wage equation.[37] In general, Persyn finds that trade enhances wage discipline in the sense that wages become more aligned with the marginal product of labour as expressed in the level of labour productivity. In this case we may speak of enhanced wage discipline. This corresponds to a lower impact of foreign wages on the wage-setting, with productivity becoming more important as trade costs decrease.[38]

(2)

$$\ln(wage_{c,i,t}) = \alpha + \beta_1 * ur_{c,t} + \beta_2 * \ln(prod_{c,i,t}) + \beta_3 * open_{c,t} + \sum_{k=1}^{3} \delta_k * trade_{c,k,i,t} +$$
$$+ \sum_{k=1}^{3} \varphi_k * trade\_other_{c,k,i,t} + \beta_4 * \ln(forwage_{c,i,t}) + \beta_5 * \ln(forwage_{c,i,t}) * open_{c,i,t} +$$
$$+ \beta_6 * \ln(prod_{c,i,t}) * open_{c,i,t} + \gamma_{c,i} + \varepsilon_{c,i,t}$$

[37] He derives the optimal wage demand of a monopoly trade union operating at the sectoral level and facing internationally mobile firms. The intuition is that firms become more footloose with trade liberalisation, which makes raising wages above the marginal product of labour more expensive in terms of lost employment. Wages thus become more sensitive to either local labour productivity or the foreign wage level with increased trade, depending on the union preference for wages relative to employment. For the details of the model see section 2 of Persyn (2008).

[38] Persyn (2008) uses a sample of 13 EU countries (the EU-15 excluding Greece and Luxembourg) for the period from 1980 to 2001 to test this hypothesis. Lower trade costs are reflected in higher values for a trade freeness indicator as defined in his paper.

We tried to integrate this idea in our framework, by adding three variables to the previous model, namely the logarithm of foreign wages (i.e. of the average hourly real wage in the respective sector in all other EU-25 countries) and two terms interacting the openness of the industry with the logarithm of foreign wages and productivity. This new specification is described in equation 2. The results are generally robust for the variables in the earlier specification, but now more variables are significant (column three and four of Table 1). Productivity has a significant and positive coefficient, and its elasticity to wage is between 0.4 and 0.5 in the pooled samples. Unemployment only shows a significant and positive coefficient in EU-10.

The results for the trade variables are also robust. Country-openness shows again a significant positive effect on wages in the EU-15, but a negative one in the EU-10. Hence, we have again a differential impact of trade on wages. In addition to these general trade effects, intra-industry import ratios are positively, while inter-industry import ratios are negatively related to wages in the EU-15, while both sector-specific import ratios have positive coefficients in the EU-10. In particular, in the EU-10 both ratios of imports from the EU-15 have positive and significant coefficients, in the EU-15 however only inter-industry imports are significant and they are negatively related to wages. In this case therefore, the Stolper-Samuelson logic seems to hold for inter-industry imports, while country openness works in the other direction. Regarding the overall trade impact, this leads to a negative effect in the EU-15, but a positive one in the EU-10, and in both cases this primarily comes from trade with the other country group (and in the EU-10 also from trade with the rest of the world). This overall impact is however still rather limited and broadly in line with the previous findings.[39]

Turning to the new variables, foreign wages move in line with domestic wages in both country groups, which is not surprising given the high degree of economic integration achieved in the region.[40] As described above, in order to speak about a wage-disciplining impact of trade, we need to see a negative coefficient on the interaction term of foreign wages and sectoral openness and a positive one on the interaction term of productivity and sectoral openness. This is indeed the case in the EU-15, while in the EU-10 the second interaction term is not significant. Therefore, we find evidence for the disciplining power of trade in the Persyn sense for the EU-15 but not for the EU-10. The sector-specific results (see appendix tables A5 and A6) reveal that nevertheless, evidence for the influence of foreign wages and the wage-disciplining effect is found only in a few industries, and actually more often in the EU-10 than in the EU-15. In particular, in the EU-15 it is actually only food processing which shows the wage-disciplining effect, while in two sectors, wood and minerals, the opposite holds. In the EU-10 we have four sectors with a significant wage-disciplining effect (food, wood, mining and metals), and one (textiles) showing the opposite.

In terms of economic significance, in the EU-15 the elasticity of domestic wages with respect to foreign wages is the highest at 0.9 in other manufacturing, and is on average 0.5. In the EU-10 it is somewhat higher on average at about 0.8, but only significant in two sectors. The wage-disciplining effect as defined by Persyn is not only rarely observable but also negligibly small on average (around 0.1-0.2 in the EU-10 and 0.3 in the EU-15). Therefore, on the sectoral level we do not find much evidence for the wage-disciplining impact as defined here

[39] As a robustness check we also tried instrumenting all trade ratios with their own lags in this case, as well. The conclusions remain unchanged.

[40] If we split the variable for foreign wages for the two country groups and include both in the regression, we find that in the EU-15 the average wage level of both country groups is significant and positive, while in the EU-10 this is true for only the average level of the own group.

even in the EU-15, which is interesting, as we analysed broadly the same group of countries as Persyn, but have little confirmation of his results.[41]

To conclude, trade seems to strengthen wage discipline primarily in the EU-15 by forcing wage-setters to align wages rather with productivity than with wage developments in the main trading partners, but this does not hold for industrial activities if estimated separately. Nevertheless, in the EU-15 foreign wages are in many sectors positively related to domestic wages. By contrast, in the EU-10 the co-movement of foreign and domestic wages is also observed in only a few industries.

5 Summary and conclusions

In this paper we reconsider the effects of increased economic integration on the labour market. More specifically we examine the impact of higher import ratios on average wage levels in the EU-25, distinguishing between incumbent EU Member States and those that joined the EU in 2004. The literature is vast on this topic and the theoretical predictions remain inconclusive and dependent on the assumptions of the models and specific factors that condition the wage response to increased economic openness. There are two theory-based empirical approaches used in the literature, among which our strategy falls in the realm of wage regressions. In particular, our model is in the tradition of the so-called mandated wage equations as opposed to Mincerian equations, for which microdata are necessary. Against country-specific studies and those working at the aggregate macro level, in this paper we investigate the relationship between trade and wages for a comprehensive sample of 25 EU countries, with an explicit focus on individual industries.

Industry-specific heterogeneity seems to be extremely relevant in the context of international trade, with greatly diverse trade developments within countries in different industrial activities. Using panel regression techniques, we find as a first result that trade can not be identified as a decisive factor in determining wage levels. This is actually quite important, since in public opinion trade – and more generally "globalisation" – is often associated with a negative influence on wages. Moreover, the relationship of trade and wages is in most cases positive, but its economic impact is generally rather small.[42] We find notable differences in the relationship of wages and trade in individual economic activities which are not easy to generalise. Considerable differences also exist between the EU-15 and the EU-10. First, trade variables are more often significant for wages in central and eastern Europe. This is not surprising when we consider that in general these countries are more open to trade, and in addition, they have undergone a dynamic phase of restructuring accompanied by often high and persistent unemployment rates. These are all factors that would make wages more responsive to changes in the economic environment. Second, trade with western Europe is favourable for wages in the east, while the opposite holds the other way around. This is in line with the Stolper-Samuelson reasoning. Third, the aggregate net effect of trade on wages is negative only in a few, mostly resource-intensive industries.

We also take up the idea of trade acting as a wage-disciplining device in the sense that through increased trade openness, wages more strongly reflect the marginal product of labour and become less aligned with foreign wages. We observe wage co-movement in the sense of

[41] Persyn has a different time span for his sample (1980–2001 versus 1995–2005), and also applies a different estimation method (for the longer sample period, Persyn estimates an error correction model while we use a panel estimation as the time dimension in our sample is smaller).

[42] The lack of significance of trade variables in many sectors could also be due to the downward rigidity of wages.

foreign wages having a positive impact on domestic wages in both country groups, though at the industry level this is only common in the EU-15. At the same time, in the EU-10 we find more evidence of wages being rather set in line with productivity and not foreign wages with a higher degree of trade openness than in the EU-15 for the separate industries, while the effect is only present in the EU-15 in the aggregate sample. Overall, the effect of trade enhancing wage discipline is only observed in a few sectors in both country groups.

In summary, we find that increased trade has only small and generally positive effects on wages. However, the results are in line with the rationale of the Stolper-Samuelson theorem, since trade with the central and eastern European countries is negatively related to wages in the west, while in the EU-10 trade with western Europe is a positive factor for the wage level. Yet trade can not be seen as a decisive factor in wage formation and thus no real threat to wages in either country group, since most of these effects are small. This is in line with the results of previous studies. However small the effects are, we do find a negative overall impact of trade in some sectors in both regions, which suggests that economic policy has to be carefully designed when addressing questions of increased trade integration. In particular, resource-based industries often emerge as losers from increased trade.

Further research should carefully investigate the issue of wage inequality in response to economic integration. Wage inequality has different dimensions, such as wage dispersion across industries or across individual employees due to differences in human capital. For instance, a useful distinction is often made between wages of low and high-skilled employees. In our data set, we could not identify systematic differences – possibly because the informative value of industry-level data is limited with regard to the human capital of the labour force – and therefore we did not elaborate on this issue, but this could be subject to further investigations. Overall, before drawing detailed policy conclusions, we see a need for continued careful research as well as for an improvement of available statistics to provide this research with meaningful input for comparative analyses.

References

Amiti, M. and Davis, D. (2008): "Trade, Firms, and Wages. Theory and Evidence", NBER Working Paper No. 14106

Arellano, M. and Bond, S. (1991): "Some tests of specification for panel data: Monte Carlo evidence and application to employment equations", *Review of Economic Studies*, 58, 277-297.

Attanasio, O., Goldberg, P. and Pavcnik, N. (2004): "Trade Reforms and Wage Inequality in Colombia", *Journal of Development Economics*, 74 (2), 331-336.

Belzil, C. (2006): "Testing the Specification of the Mincer Wage Equation", GATE Working Paper No. 06-08

Bernard, A., Redding, S. and Schott, P. (2007): "Comparative Advantage and Heterogeneous Firms", *Review of Economic Studies*, 74, 31-66.

Borjas, G. and Ramey, V. (1995): "Foreign Competition, Market Power, and Wage Inequality", *The Quarterly Journal of Economics*, 110 (4), 1075-1110.

Bruno, G., Crinò and Falzoni, A. (2005): "Foreign Direct Investment, Wage Inequality, and Skilled Labor Demand in EU Accession Countries", University of Bergamo Working Paper No. 1, http.//wwwdata.unibg.it/dati/bacheca/656/14524.pdf

Combes, J., Saadi-Sedik, T. (2006): "How Does Trade Openness Influence Budget Deficits in Developing Countries?", IMF Working Paper No. 06/3

Deardoff, A. V. (2000): "Factor prices and the factor content of trade revisited: what's the use?", *Journal of International Economics*, 50, 73-90.

Dutt, P., Mitra, D. and Ranjan, P. (2009): "International trade and unemployment: Theory and cross-national evidence", *Journal of International Economics*, 78, 32-44.

Egger, H. and Kreickemeier, U. (2008): "Fairness, Trade, and Inequality", CESifo Working Paper No. 2344

Esposito, P. and Stehrer, R. (2007): "The Sector Bias of Skill-biased Technical Change and the Rising Skill Premium in Transition Economies", WIIW Working Paper No. 43

Falk, M. and Wolfmayr, Y. (2005): "Employment Effects of Outsourcing to Low Wage Countries", WIFO Working Paper No. 262

Feenstra, R. and Hanson, G. (1996): "Globalization, Outsourcing, and Wage Inequality", *The American Economic Review*, 86 (2), 240-245.

Feenstra, R. and Hanson, G. (1997): "Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras", *Journal of International Economics*, 42, 371-393.

Feenstra, R. and Hanson, G. (1999): "The Impact of Outsourcing and High-Technology Capital on Wages. Estimates for the United States, 1979-1990", *The Quarterly Journal of Economics*, 114 (3), 907-940.

Feenstra, R. and Hanson, G. (2003): "Global Production Sharing and Rising Inequality. A Survey of Trade and Wages", in: E. Kwan Choi and James Harrigan, Editors, *Handbook of International Trade*, Basil Blackwell, London

Felbermayr, G., Prat, J. and Schmerer, H. (2008): "Globalization and Labor Market Outcomes: Wage Bargaining, Search Frictions, and Firm Heterogeneity", IZA Discussion Paper No. 3363

Felbermayr, G., Prat, J. and Schmerer, H. (2009): "Trade and Unemployment: What Do the Data Say?", IZA Discussion Paper No. 4184

Freeman, R. B. (1995): "Are Your Wages Set in Beijing?", *Journal of Economic Perspectives*, 9 (3), 15-32.

Galiani, S. and Sanguinetti, P. (2003): "The impact of trade liberalization on wage inequality. Evidence from Argentina", *Journal of Development Economics*, 72 (2), 497-513.

Geishecker, I. and Görg, H. (2004): "Winners and Losers: Fragmentation, Trade and Wages Revisited", IZA Discussion Paper No. 982

Geishecker, I. and Görg, H. (2008a): "Winners and losers: a micro-level analysis of international outsourcing and wages", *Canadian Journal of Economics*, 41 (1), 243-270.
Geishecker, I. and Görg, H. (2008b): "Services offshoring and wages: Evidence from micro data", Kiel Working Paper No. 1434
Geishecker, I., Görg, H. and Munch, J. R. (2008):): "Do labour market institutions matter? Micro-level wage effects of international outsourcing in three European countries", Kiel Working Paper No. 1404
Grotkowska, G. (2008): "Impact of international trade on employment during transition period: The case of Polish manufacturing sector", Draft, Faculty of Economic Sciences, University of Warsaw, September, http.//coin.wne.uw.edu.pl/ggrotkowska/grotkowska_ etsg_2008.pdf
Helpman, E., Itskhoki, O. and Redding, S. (2008): "Inequality and Unemployment in a Global Economy", NBER Working Paper No. 14478
Hijzen, A., Pisu, M., Upward, R. and Wright, P. (2007): "Employment, Job Turnover and Trade in Producer Services: Firm-Level Evidence", GEP Research Paper 07/37
Hofer, H. and Huber, P. (2003): "Wage and Mobility Effects of Trade and Migration on the Austrian Labor Market", *Empirica* 30(2), 107-125.
Krugman, P. (1995): "Growing World Trade: Causes and Consequences", *Brookings Papers on Economic Activity*, 1995 (1), 327-377.
Krugman, P. (2000): "Technology, trade and factor prices", *Journal of International Economics*, 50, 51-71.
Krugman, P. (2008): "Trade and Wages, Reconsidered", Draft for the spring meeting of the Brookings Panel on Economic Activity, http.//www.princeton.edu/~pkrugman/ pk-bpea-draft.pdf
Leamer, E. E. (1996a): "In Search of Stolper-Samuelson Effects on U.S. Wages", NBER Working Paper No. 5427
Leamer, E. E. (1996b): "Wage Inequality from International Competition and Technological Change: Theory and Country Experience", *The American Economic Review*, 86 (2), 309-314.
Leamer, E. E. (2000): "What's the use of factor contents?", *Journal of International Economics*, 50, 17-49.
Manasse, P. and Turrini, A. (2001): "Trade, wages, and 'superstars'", *Journal of International Economics*, 54, 97-117.
Mason, P. L. (1994): "An empirical derivation of the industry wage equation", *Journal of Quantitative Economics*, 10(1), 155-170.
Mishra, P. and Kumar, U. (2005): "Trade Liberalization and Wage Inequality. Evidence from India", IMF Working Paper No. 05/20
Mitra, D. and Ranjan, P. (2009): "Offshoring and Unemployment: The Role of Search Frictions and Labor Mobility", IZA Discussion Paper No. 4136
Onaran. Ö. (2007): "Jobless Growth in the Central and Eastern European Countries: A country specific panel data analysis for the manufacturing industry", Vienna University of Economics Working Paper No. 103
Onaran. Ö. (2008a): "The Effect of Foreign Affiliate Employment on Wages, Employment and the Wage Share in Austria", Vienna University of Economics Working Paper No. 118
Onaran. Ö. (2008b): "The Effect of Import Penetration on Labor Market Outcomes in Austrian Manufacturing Industry", Vienna University of Economics Working Paper No. 119
Onaran, Ö. and Stockhammer, E. (2006): "The effect of FDI and foreign trade on wages in the Central and Eastern European Countries in the post-transition era: A sectoral analysis", Department of Economics Working Paper No. 94. University of Vienna, June
Panagariya, A. (2000): "Evaluating the factor-content approach to measuring the effect of trade on wage inequality", *Journal of International Economics*, 50, 91-116.

Peltonen, T. and Pula, G. (2008): "The Impact of Trade on Labor Demand in Euro Area Manufacturing Sector", ECB mimeo.
Persyn, D. (2008): "Trade as a Wage Disciplining Device", LICOS Discussion Paper No. 210.
Polgar, E. K. and Wörz, J. (2009): "Trade and Wages: Winning and Losing Sectors in the Enlarged European Union", *Focus on European Economic Integration*, Q1/2009, 6-35.
Pula, G. and Skudelny, F. (2008): "Globalisation and Euro Area Prices and Labor Markets: Some Evidence on the Impact of Low-Cost Countries", ECB mimeo, presented at the ECB conference on 'Globalisation and the macroeconomy' in July 2007
Rabbani, A. (2005): "Labor Market and International Trade. An analysis of Wage Inequality", draft, retrieved from http://economics.uchicago.edu/download/An%20Analysis%20of%20Wage%20Inequality.pdf on 9 February 2009
Richardson, J. D. (1995): "Income Inequality and Trade: How to Think, What to Conclude", *Journal of Economic Perspectives*, 9 (3), 33-55.
Rodríguez, F. and Rodrik, D. (2000): "Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence", NBER Working Paper No. 7081
Stehrer, R. (2005): "The effects of factor and sector biased technical change revisited", WIIW Working Paper No. 35
Thompson, H. (2007): "Prices and Wages in Trade Theory", Working Paper Auburn University, December; http.//www.auburn.edu/~thomph1/trade&wage.htm
Timmer, M., O'Mahony, M. and van Ark, B. (2008): "The EU KLEMS Growth and Productivity Accounts: An Overview", University of Groningen & University of Birmingham, www.euklems.net
Wacker, K. (2010): "The Influence of Trade with the EU-15 on Wages in the Czech Republic, Hungary, Poland, and Slovakia between 1997 and 2005", FIW Working Paper No. 47, April
Windmeijer, F. (2005): "A finite sample correction for the variance of linear efficient two-step GMM estimators", *Journal of Econometrics*, 126 (1), 25-51.
Winter-Ebmer, R. and Zimmermann, K. (1998): "East-West Trade and Migration: The Austro-German Case", IZA Discussion Paper No. 2, April
Wolpin, K. I. (2000): "Wage Equations and Education Policy", Penn Institute for Economic Research Working Paper No. 01-017

Appendix

Appendix 1: Definition and calculation of variables used

Time series obtained from EU KLEMS were in national currency at current prices. We converted all data into euro, using annual exchange rates from the IMF WEO[43] database. Trade data as obtained from UN COMTRADE were reported in USD and converted into euro using the annual ECU-EUR/USD exchange rates from the Main Economic Indicators database of the OECD, since no conversion rates were available from the IMF WEO database for the period prior to 1999. Variables were then deflated as indicated in the table below.

Table A1: Description of variables

Variable	Source	Calculation / description	Unit
Real wage	EU KLEMS	Compensation of employees divided by hours worked, deflated by the gross output price index	EUR
Productivity	EU KLEMS	Gross value added (GVA) in the respective sector deflated by the gross value added price index and divided by hours worked	EUR
Import ratio	COMTRADE & EU KLEMS	Imports of the respective sector deflated by the gross output price index and divided by the gross value added deflated by the GVA price index	ratio
Import ratio for the rest of the economy	COMTRADE & EU KLEMS	Imports (deflated by the gross output deflator) summed across all sectors except the respective industry, divided by the GVA-deflated value added of all sectors except the respective industry	ratio
Export ratio	COMTRADE & EU KLEMS	Same as the import ratio using exports	ratio
Export ratio for the rest of the economy	COMTRADE & EU KLEMS	Same as the import ratio for the rest of the economy, using exports	ratio
Trade openness	COMTRADE & EU KLEMS	Total export plus import volume vis-à-vis the world, divided by gross output (deflated by its own price index)	ratio
Foreign wages	EU KLEMS	Sum of labour compensation deflated by the gross output price index in all countries except the respective country, divided by hours worked summed in all but the respective country	EUR
Unemployment	WEO	Unemployment rate	%

[43] International Monetary Fund, World Economic Outlook.

Appendix 2: Grouping of industries by the wage level

We grouped the industries into high-wage, medium-wage and low-wage sectors. To this end, we divided the range spanned by the highest and lowest wage paid evenly into three parts for both of our country groups. The full list of individual sectors in the three wage groups is provided in table A2 below.

Table A2: Grouping of industries by the wage level

EU-15		**EU-10**	
NACE code	**Industry**	**NACE code**	**Industry**
High-wage sectors			
24	chemicals	23	oil refining & products
23	oil refining & products	C	mining
30t33	electrical & optical equipment		
Medium-wage sectors			
34t35	transport equipment	24	chemicals
21t22	paper & printing	21t22	paper & printing
29	mechanical machinery	30t33	electrical & optical equipment
C	mining	34t35	transport equipment
25	rubber and plastics	26	minerals
27t28	metals	29	mechanical machinery
26	minerals	25	rubber and plastics
15t16	food products		
Low-wage sectors			
17t19	textiles & clothing	27t28	metals
36t37	other manufacturing	15t16	food products
20	wood	36t37	other manufacturing
AtB	agriculture	AtB	agriculture
		20	wood
		17t19	textiles & clothing

Appendix 3: Results for equation 1 for the two country groups

Table A3: Results for equation 1 (page 15) for the EU-15

Variable	Agriculture	Mining	Food	Textiles	Wood	Paper	Chemicals	Rubber	Minerals	Metals	Machinery	Electr. equ.	Transport equ.	Man. n.i.e.
Unemployment	-0.016 ***	0.006	0.002	-0.007 **	-0.004	-0.001	-0.007 *	-0.006	0.005 **	-0.011 ***	-0.003	-0.007	0.002	-0.002
	-4.52	*0.95*	*0.70*	*-2.10*	*-1.50*	*-0.41*	*-1.82*	*-1.15*	*2.01*	*-2.86*	*-1.07*	*-1.26*	*0.36*	*-0.41*
Ln(Productivity)	0.688 ***	0.077	0.549 ***	0.638 ***	0.534 ***	0.588 ***	0.460 ***	0.470 ***	0.580 ***	0.682 ***	0.613 ***	0.586 ***	0.468 ***	0.595 ***
	5.41	*0.49*	*10.56*	*5.51*	*7.19*	*6.41*	*6.72*	*6.08*	*5.02*	*4.16*	*6.45*	*5.65*	*6.59*	*4.63*
Country openness	0.440 **	-0.307	-0.003	-0.056	0.127	0.085	-0.055	0.360 *	-0.094	0.077	0.030	-0.230	-0.034	0.087
	2.49	*-1.23*	*-0.04*	*-0.40*	*1.00*	*0.66*	*-0.27*	*1.71*	*-0.71*	*0.50*	*0.20*	*-0.93*	*-0.14*	*0.58*
Import ratio - EU15	0.591 ***	0.007 *	0.181 *	-0.009	0.059	0.705 ***	0.071 **	0.202 **	0.406 **	0.030	0.017	0.024	0.000	0.058
	2.94	*1.78*	*1.70*	*-0.34*	*0.80*	*4.16*	*2.21*	*2.25*	*2.19*	*0.25*	*0.99*	*0.92*	*0.55*	*1.41*
Import ratio - EU10	1.559	0.281	-0.857	-0.031	0.595 **	-1.955 *	0.400	-0.277	-0.404	-0.040	0.042	0.023	-0.041	0.278
	1.21	*1.32*	*-1.39*	*-0.30*	*2.33*	*-1.89*	*0.67*	*-0.34*	*-0.43*	*-0.08*	*0.25*	*0.09*	*-1.48*	*1.05*
Import ratio - rest of the world	0.181	0.006	0.632 ***	0.067 ***	0.237	-1.110 ***	-0.006	-0.512	-0.051	0.028	0.061	0.037	0.001	0.105
	0.93	*0.83*	*2.91*	*2.67*	*1.55*	*-3.27*	*-0.05*	*-1.33*	*-0.11*	*0.60*	*1.48*	*0.88*	*1.13*	
Import ratio; rest of economy - EU15	-0.227 *	-0.017	0.051	0.071	0.034	-0.167 **	-0.116	-0.117	0.114 *	0.006	0.062	0.332 *	0.235 *	0.171
	-1.88	*-0.11*	*0.80*	*0.63*	*0.67*	*-2.32*	*-1.25*	*-1.13*	*1.84*	*0.10*	*1.12*	*1.79*	*1.78*	*1.33*
Import ratio; rest of economy - EU10	-0.241	0.318	0.374	-0.899	-0.206	-0.047	1.038 **	-0.105	0.664	-0.507	0.334	1.007	1.101	-1.501
	-0.25	*0.22*	*0.46*	*-1.29*	*-0.42*	*-0.05*	*1.97*	*-0.16*	*0.98*	*-1.55*	*0.70*	*1.34*	*1.12*	*-1.62*
Import ratio; rest of economy - ROW	0.186	-0.007	0.153 **	0.045	-0.010	0.088	-0.104	0.198	-0.005	-0.152 *	-0.005	-0.143	-0.118	0.132
	0.87	*-0.04*	*1.96*	*0.40*	*-0.09*	*1.00*	*-1.04*	*1.05*	*-0.04*	*-1.80*	*-0.04*	*-0.62*	*-0.57*	*0.74*
Constant	-0.311	2.443 ***	0.463 **	0.579	0.752 ***	0.737 *	1.363 ***	1.309 ***	0.490	0.743	0.783 **	0.586	1.175 ***	0.556
	-0.53	*3.35*	*2.31*	*1.38*	*3.61*	*1.78*	*3.48*	*3.31*	*1.15*	*1.25*	*2.14*	*1.05*	*2.98*	*1.12*
Obs.	157	156	157	157	157	157	157	157	157	157	157	157	157	157
No. of Groups	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Adjusted R^2 (within)	0.73	0.05	0.80	0.83	0.79	0.64	0.75	0.59	0.76	0.57	0.76	0.86	0.71	0.72
F-Statistic	186.01	5.61	61.37	124.48	59.03	23.72	80.70	15.51	15.40	21.91	23.90	51.96	261.77	91.83

Notes: The dependent variable is the log real hourly wage, deflated by sectoral output-deflators. t-ratios are reported below each coefficient, *(**)[***] indicate significance at the 10% (5%) [1%] level or below.

Table A4: Results for equation 1 (page 15) for the EU-10

Variable	Agriculture	Mining	Food	Textiles	Wood	Paper	Chemicals	Rubber	Minerals	Metals	Machinery	Electr. equ.	Transport equ.	Man. n.i.e.
Unemployment	0.001	0.022 ***	0.017 ***	0.013 ***	-0.002	0.010 *	0.011	-0.004	0.015 ***	0.008	0.016 **	0.007	0.009	0.004
	0.13	*2.74*	*3.45*	*3.32*	*-0.33*	*1.74*	*1.20*	*-1.10*	*4.09*	*1.19*	*2.06*	*1.42*	*1.25*	*1.03*
Ln(Productivity)	0.668 ***	0.514 ***	0.545 ***	0.467 ***	0.641 ***	0.723 ***	0.754 ***	0.722 ***	0.426 ***	0.706 ***	0.615 ***	0.512 ***	0.613 ***	0.485 ***
	5.89	*4.87*	*4.35*	*4.79*	*7.47*	*10.37*	*4.32*	*10.00*	*3.38*	*4.02*	*5.48*	*4.73*	*5.24*	*5.47*
Country openness	-0.016	-0.471 ***	0.042	0.026	-0.323 ***	-0.181 *	-0.145	-0.288 ***	-0.170	-0.310 *	-0.171 *	0.125	-0.043	-0.140
	-0.09	*-2.99*	*0.32*	*0.35*	*-3.08*	*-1.66*	*-0.98*	*-2.86*	*-1.32*	*-1.90*	*-1.70*	*0.90*	*-0.26*	*-1.13*
Import ratio - EU15	0.426 ***	0.070	0.127 ***	-0.001	-0.038 ***	0.161 ***	0.040 ***	0.005	0.098 **	0.012	0.009 **	0.005 **	0.001	0.011
	3.53	*1.23*	*3.61*	*-0.24*	*-6.07*	*3.23*	*2.86*	*0.56*	*2.07*	*0.78*	*2.02*	*2.51*	*0.82*	*0.15*
Import ratio - EU10	0.719 **	0.363	0.421 ***	0.513 ***	0.350 *	0.156	0.093	0.282 ***	0.695	0.141	-0.001	-0.048	-0.005	0.309
	2.42	*1.49*	*2.95*	*2.89*	*1.91*	*0.75*	*1.56*	*9.16*	*1.41*	*1.08*	*-0.03*	*-0.91*	*-0.13*	*1.49*
Import ratio - rest of the world	0.212 **	0.019 *	0.023	0.009	0.012	-0.062	-0.006	0.021 *	0.108	0.022	0.000	0.007	0.006	-0.034
	2.11	*1.76*	*0.97*	*0.25*	*0.97*	*-0.95*	*-0.27*	*1.75*	*0.71*	*0.63*	*-0.05*	*1.49*	*1.02*	*-0.33*
Import ratio; rest of economy - EU15	0.034	0.139 ***	0.043 *	0.092 ***	0.134 ***	0.027	0.100 ***	0.102 ***	0.097 ***	0.134 ***	0.109 ***	0.112 ***	0.120 ***	0.112 **
	0.90	*7.57*	*1.93*	*3.32*	*10.62*	*0.55*	*7.95*	*7.60*	*6.96*	*4.22*	*4.21*	*5.43*	*7.86*	*2.26*
Import ratio; rest of economy - EU10	0.229 *	-0.309 ***	-0.252	0.022	0.189	0.208	-0.489 ***	-0.221 **	-0.169	-0.199	0.116	0.531 **	0.363 ***	0.191
	1.70	*-2.99*	*-1.49*	*0.26*	*1.59*	*0.78*	*-3.05*	*-2.14*	*-0.57*	*-0.40*	*1.03*	*2.07*	*3.91*	*0.83*
Import ratio; rest of economy - ROW	0.002	0.104 ***	0.042 **	0.095 ***	0.111 ***	0.117 **	0.087	0.077 ***	0.074 *	0.110 **	0.128 ***	0.093 **	0.091 ***	0.101 ***
	0.04	*5.13*	*2.34*	*5.75*	*9.00*	*2.10*	*1.35*	*4.99*	*1.75*	*2.26*	*6.10*	*1.97*	*4.94*	*14.62*
Constant	-0.941 ***	-0.445 *	-0.410 **	-0.324 ***	-0.583 ***	-0.668 ***	-0.750 **	-0.557 ***	-0.377 *	-0.569 **	-0.413 **	-0.240 *	-0.339 **	-0.295 ***
	-4.00	*-1.76*	*-2.26*	*-3.85*	*-5.41*	*-6.27*	*-2.08*	*-6.64*	*-1.75*	*-2.19*	*-2.28*	*-1.72*	*-1.99*	*-3.12*
Obs.	110	108	110	110	110	110	110	110	110	110	110	110	110	110
No. of Groups	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Adjusted R^2 (within)	0.89	0.67	0.84	0.87	0.89	0.88	0.82	0.92	0.86	0.70	0.88	0.89	0.87	0.85
F-Statistic	400000	9100	39000	695	20000	4300	1700000	18000	2100000	35000	4800	200000	100000	1900

Notes: The dependent variable is the log real hourly wage, deflated by sectoral output-deflators. t-ratios are reported below each coefficient, *(**)[***] indicate significance at the 10% (5%) [1%] level or below.

Appendix 4: Results for equation 2 for the two country groups

Table A5: Results for equation 2 (page 22) for the EU-15

Variable	Agriculture	Mining	Food	Textiles	Wood	Paper	Chemicals	Rubber	Minerals	Metals	Machinery	Electr. equ.	Transport equ.	Man. n.i.e.
Unemployment	-0.004	0.012 *	0.008 ***	-0.004	-0.002	-0.002	-0.001	0.002	0.005 **	-0.006	0.003	0.006	0.005	0.006
	-1.06	*1.89*	*3.08*	*-1.17*	*-0.63*	*-0.49*	*-0.17*	*0.28*	*1.99*	*-1.37*	*0.98*	*1.12*	*0.96*	*1.26*
Ln(Productivity)	0.442 **	0.055	0.329 ***	0.633 ***	0.551 ***	0.441 ***	0.419 **	0.324 **	1.027 ***	0.789 ***	0.564 ***	0.572 ***	0.514 ***	0.852 ***
	2.41	*0.32*	*5.08*	*3.66*	*6.42*	*5.99*	*2.21*	*2.28*	*5.83*	*3.19*	*4.40*	*6.03*	*5.42*	*5.01*
Country openness	0.464 **	-0.444 *	-0.020	0.130	-0.027	0.105	0.000	0.414	-0.230 **	0.072	0.022	-0.013	-0.092	0.044
	2.27	*-1.86*	*-0.16*	*0.95*	*-0.23*	*0.77*	*0.00*	*1.35*	*-2.01*	*0.41*	*0.15*	*-0.05*	*-0.37*	*0.33*
Import ratio - EU15	0.376 *	0.000	0.242 ***	0.071	-0.121 **	0.783 ***	0.025	0.213 *	-0.070	0.115	0.038	0.091 ***	0.028 **	0.103 **
	1.84	*-0.01*	*3.16*	*1.04*	*-2.35*	*3.54*	*0.58*	*1.69*	*-0.39*	*0.88*	*1.02*	*4.11*	*2.53*	*2.15*
Import ratio - EU10	1.340	0.279	-1.392	-0.011	0.495 ***	-1.755	-0.140	-1.139	-0.428	-0.263	-0.094	-0.405	0.039	-0.291
	1.20	*1.42*	*-1.63*	*-0.09*	*3.07*	*-1.48*	*-0.23*	*-1.08*	*-0.53*	*-0.52*	*-0.53*	*-1.64*	*0.64*	*-1.21*
Import ratio - rest of the world	0.561 *	0.004	0.672 ***	0.109 ***	-0.106	-0.719	-0.105	-0.430	-0.103	-0.001	0.062	0.103 ***	0.015 ***	0.133 *
	1.77	*0.67*	*4.22*	*2.73*	*-1.28*	*-1.19*	*-0.76*	*-0.96*	*-0.25*	*-0.01*	*0.60*	*3.33*	*2.77*	*1.66*
Import ratio; rest of economy - EU15	-0.177 *	-0.011	0.071	-0.009	0.024	-0.158 **	-0.088	-0.131	0.166 ***	-0.022	0.047	0.160	0.193	0.193 **
	-1.93	*-0.08*	*1.15*	*-0.09*	*0.86*	*-2.25*	*-1.57*	*-1.13*	*2.91*	*-0.31*	*0.95*	*1.27*	*1.34*	*2.15*
Import ratio; rest of economy - EU10	-1.793 ***	-0.209	0.038	-1.351 **	-1.092 **	-0.593	0.132	-0.968 *	0.081	-1.147 **	-0.768 *	-0.873	-0.089	-1.594 **
	-2.93	*-0.15*	*0.07*	*-2.11*	*-2.24*	*-0.78*	*0.23*	*-1.67*	*0.15*	*-2.55*	*-1.66*	*-1.19*	*-0.10*	*-2.29*
Import ratio; rest of economy - ROW	-0.006	0.004	0.014	-0.041	0.023	0.036	-0.252 ***	0.096	0.055	-0.128	-0.060	-0.307 ***	-0.072	-0.049
	-0.04	*0.02*	*0.16*	*-0.44*	*0.31*	*0.41*	*-2.66*	*0.43*	*0.67*	*-1.36*	*-0.50*	*-2.84*	*-0.45*	*-0.35*
Foreign wages	0.723 ***	0.773 **	0.601 ***	0.283	0.411 *	0.436	0.449	0.823 **	-0.405 **	0.426 *	0.489 ***	0.608 ***	0.211	0.902 **
	3.58	*2.44*	*3.49*	*1.07*	*1.77*	*1.33*	*1.58*	*2.13*	*-2.34*	*1.73*	*2.91*	*2.62*	*1.23*	*2.50*
Foreign wages x	-0.413	0.005	-0.506 **	-0.052	0.494 ***	-0.388	0.093	-0.197	1.326 ***	0.161	-0.020	-0.005	-0.037 *	0.111
sector openness	*-0.95*	*0.58*	*-2.46*	*-0.82*	*3.08*	*-1.51*	*1.52*	*-0.65*	*4.01*	*0.63*	*-0.35*	*-0.10*	*-1.89*	*0.94*
Productivity x	0.160	0.000	0.344 ***	-0.002	-0.242 **	0.276	-0.061	0.141	-0.898 ***	-0.151	0.007	-0.028	0.017	-0.124 *
sector openness	*0.59*	*-0.05*	*2.67*	*-0.04*	*-1.98*	*1.49*	*-0.98*	*0.70*	*-3.20*	*-0.69*	*0.16*	*-0.57*	*1.33*	*-1.83*
Constant	-0.710	0.464	-0.290	0.140	-0.266	0.034	0.192	-0.373	-0.007	-0.802	-0.409	-0.929	0.442	-2.329 **
	-0.91	*0.61*	*-0.85*	*0.31*	*-0.58*	*0.03*	*0.45*	*-0.43*	*-0.01*	*-1.12*	*-0.63*	*-1.32*	*0.68*	*-2.02*
Obs.	157	156	157	157	157	157	157	157	157	157	157	157	157	157
No. of Groups	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Adjusted R^2 (within)	0.78	0.13	0.84	0.84	0.85	0.65	0.79	0.63	0.81	0.64	0.79	0.90	0.75	0.80
F-Statistic	315.52	42.64	154.35	171.72	1700.00	57.54	60.24	15.54	50.06	34.03	93.28	2400.00	1400.00	587.99

Notes: The dependent variable is the log real hourly wage, deflated by sectoral output-deflators. t-ratios are reported below each coefficient, *(**)[***] indicate significance at the 10% (5%) [1%] level or below.

Table A6: Results for equation 2 (page 22) for the EU-10

Variable	Agriculture	Mining	Food	Textiles	Wood	Paper	Chemicals	Rubber	Minerals	Metals	Machinery	Electr. equ.	Transport equ.	Man. n.i.e.
Unemployment	-0.001	0.014 ***	0.015 **	0.008 *	-0.002	0.009	0.006	-0.004	0.016 ***	0.003	0.017 *	0.003	0.008	0.001
	-0.21	*2.79*	*2.32*	*1.87*	*-0.27*	*1.44*	*0.66*	*-1.04*	*4.20*	*0.37*	*1.87*	*0.51*	*1.06*	*0.11*
Ln(Productivity)	0.584 ***	0.435 ***	0.290 **	0.773 ***	0.610 ***	0.518 ***	0.733 ***	0.764 ***	0.310 **	0.317 **	0.499 ***	0.461 ***	0.509 ***	0.544 ***
	3.05	*4.15*	*2.31*	*5.51*	*6.26*	*3.19*	*4.41*	*8.87*	*2.43*	*2.34*	*2.65*	*3.83*	*3.50*	*2.70*
Country openness	-0.177	-0.406 ***	0.013	-0.286 ***	-0.198	-0.192 *	-0.084	-0.240 **	-0.206 **	-0.074	-0.121	-0.005	-0.049	-0.227 **
	-1.30	*-2.99*	*0.09*	*-3.21*	*-1.46*	*-1.83*	*-0.47*	*-2.44*	*-2.26*	*-0.55*	*-0.91*	*-0.04*	*-0.31*	*-2.32*
Import ratio - EU15	0.390	0.073 **	0.237 ***	0.021	0.071	0.220 ***	0.054 **	0.020 *	0.206 ***	0.060 *	0.014	0.019 **	0.014 ***	0.034
	1.41	*2.17*	*2.84*	*1.05*	*1.05*	*3.57*	*2.31*	*1.89*	*2.63*	*1.76*	*1.58*	*2.11*	*2.59*	*0.45*
Import ratio - EU10	0.491 *	0.482 ***	0.377 ***	0.504 ***	0.427 ***	0.254	0.158 **	0.307 ***	0.766	0.129	-0.004	-0.047	0.015	0.199
	1.92	*2.64*	*3.39*	*3.60*	*3.03*	*1.05*	*2.48*	*7.41*	*1.61*	*0.95*	*-0.13*	*-1.13*	*0.45*	*1.01*
Import ratio - rest of the world	0.264 **	0.095 ***	-0.022	0.068	0.071 *	-0.048	0.014	0.047 ***	0.101	0.077 *	0.001	0.013 *	0.014 ***	-0.001
	2.28	*4.20*	*-0.44*	*1.55*	*1.86*	*-0.88*	*0.41*	*3.87*	*0.64*	*1.88*	*0.14*	*1.87*	*3.10*	*0.00*
Import ratio; rest of economy - EU15	0.017	0.126 ***	0.017	0.107 ***	0.116 ***	-0.002	0.064	0.079 ***	0.052	0.054	0.093 **	0.081 **	0.116 ***	0.119 ***
	0.52	*9.17*	*0.50*	*7.25*	*10.68*	*-0.04*	*1.55*	*3.47*	*1.40*	*1.08*	*2.08*	*2.31*	*6.38*	*2.92*
Import ratio; rest of economy - EU10	0.298	-0.330 ***	-0.241 *	-0.132	0.212 *	0.072	-0.674 ***	-0.304 **	-0.298	-0.426	0.098	0.257	0.131	0.114
	1.30	*-3.50*	*-1.65*	*-0.94*	*1.92*	*0.27*	*-3.56*	*-2.44*	*-0.91*	*-0.79*	*0.81*	*0.91*	*1.30*	*0.60*
Import ratio; rest of economy - ROW	-0.009	0.099 ***	0.034 *	0.079 ***	0.099 ***	0.120 ***	0.033	0.033 **	0.071	0.045 *	0.119 ***	0.098 *	0.079 ***	0.098 ***
	-0.26	*6.07*	*1.70*	*2.98*	*6.46*	*2.64*	*0.34*	*2.22*	*1.40*	*1.87*	*6.48*	*1.65*	*5.48*	*5.47*
Foreign wages	0.643	0.602	0.539	0.414	-0.346	1.228 **	0.285	0.259	0.454	0.617	0.306	0.422 **	0.472	1.086
	1.24	*1.45*	*1.55*	*0.99*	*-1.09*	*2.49*	*0.66*	*1.00*	*1.06*	*1.50*	*0.62*	*2.04*	*1.23*	*1.17*
Foreign wages x	0.218	-0.080 ***	-0.464 *	0.140 ***	-0.099 *	-0.104 *	-0.026	-0.015	-0.226 **	-0.107 ***	-0.014	-0.007	-0.013 **	0.024
sector openness	*0.35*	*-4.34*	*-1.95*	*3.98*	*-1.72*	*-1.88*	*-0.92*	*-0.95*	*-2.11*	*-3.84*	*-0.85*	*-0.45*	*-2.38*	*0.26*
Productivity x	-0.308	0.025 *	0.583 **	-0.261 ***	0.062 *	0.063	0.016	-0.039	0.184	0.138 ***	0.023	-0.003	0.010	-0.098
sector openness	*-0.61*	*1.64*	*2.06*	*-4.12*	*1.64*	*0.45*	*0.34*	*-1.40*	*1.42*	*2.66*	*0.63*	*-0.09*	*1.43*	*-0.59*
Constant	-1.967 ***	-1.679	-1.205	-1.579 **	0.300	-3.674 ***	-1.413	-1.124 *	-1.130	-1.376	-1.107	-1.284 **	-1.530	-2.951
	-2.92	*-1.47*	*-1.52*	*-2.05*	*0.45*	*-2.81*	*-1.18*	*-1.84*	*-1.16*	*-1.37*	*-0.92*	*-2.32*	*-1.45*	*-1.40*
Obs.	110	108	110	110	110	110	110	110	110	110	110	110	110	110
No. of Groups	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Adjusted R^2 (within)	0.90	0.75	0.86	0.90	0.89	0.89	0.83	0.93	0.87	0.76	0.88	0.91	0.89	0.87
F-Statistic	1100.00	235.54	226.03	2700.00	6000.00	173.37	920.64	91.98	132.70	2.3e+0.4	821.88	246.14	506.28	89.51

Notes: The dependent variable is the log real hourly wage, deflated by sectoral output-deflators. t-ratios are reported below each coefficient, *(**)[***] indicate significance at the 10% (5%) [1%] level or below.