

# Trade and Wages: Winning and Losing Sectors in the Enlarged European Union<sup>1</sup>

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*This paper contributes to the abundant but as yet inconclusive literature on the effect increased openness to trade has on wages by presenting an analysis of industry-level data for 21 service and manufacturing industries in 25 EU countries covering 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. While we are able to identify some – often resource-based – industries as winners of increased trade integration, we find very few and comparatively small effects in general. The relation between trade and wages tends to be weaker in Western European countries (EU-15) than in the EU Member States in Central and Eastern Europe (EU-10). At the same time, greater trade openness appears to have increased the influence wage levels abroad – as opposed to productivity – have on wage setting in the EU-15. By contrast, wages in the EU-10 have become less responsive to foreign wages and more realigned with productivity developments as a result of trade openness.*

## 1 Introduction

Globalization has gained unprecedented momentum in recent decades. Thus, it comes as no surprise that it also features prominently in theoretical and empirical papers that try to investigate or predict its impact. While some effects of globalization (e.g. lower consumer prices) are welcome, other effects generate resistance, given fears that cheap imports or the off-shoring of production to areas with lower input prices will cause firms to relocate and thus negatively affect labor markets by driving down wages and/or driving up unemployment.

The economic literature revolving around such fears is vast, but has delivered mixed results. It is almost impossible to draw general conclusions, as individual countries and regions differ substantially in terms of labor skills, trade and wage structures. Therefore, given the topic's unquestionable relevance, it makes sense to continue with careful analysis for different regions of interest. One such region is the enlarged European Union (EU), whose unprecedented economic integration recently took on a new dimension with the accession of ten (and subsequently two more) countries with distinctly lower average income levels and, therefore, lower wages. At the same time, due to their convergence process, these countries generally experience higher growth than their Western European neighbors, confronting them with enhanced competition in a very open environment.

For these reasons, we explore the effects of increased openness to trade on wages within the enlarged EU. Given the above-mentioned differences between pre- and post-2004 Member States, it appears appropriate to distinguish as often

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as possible between the EU-15 and the EU-10.<sup>3</sup> The fact that trade and wages often evolve differently across industries – as reflected by data at the sectoral level – could imply that the relation 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 specialization patterns followed by different wage reactions in individual economic sectors. In addition, increased trade openness could drive up average wages in more skill-intensive sectors, but exert downward pressure on wages for low-skill activities, which tend to be displaced by imports. Therefore, in this paper we focus on the question whether there is a systematic relation between trade and real wage developments at the industry level in the EU-25. Another purpose of this paper is to identify the relevance of domestic versus international factors in determining sector-specific wage levels. While there is a strong co-movement of domestic and foreign wages in the EU-15, wages appear to respond more strongly to changes in domestic determinants in the EU-10. In this respect, we investigate the role that trade plays in bringing wages more closely into line with domestic productivity developments, which – following Persyn (2008) – we refer to as a disciplining effect of trade on wages.

This paper is structured as follows. Section 2 discusses some of the existing findings in the literature which constitute the background and motivation of our study. Section 3 provides a descriptive analysis of the data set employed, depicting the variables relevant for our analysis. Section 4 presents our econometric estimation, and conclusions are drawn in section 5.

## 2 Insignificant and Small Relation?

### What the Literature Tells Us about Trade and Wages

The wage rate, i.e. the factor price of labor, is a crucial economic variable as it influences both labor supply and demand and therefore affects output, unemployment, consumption and welfare. Accordingly, wage developments may be analyzed from many different angles – a fact which makes the theory of wages rather complex. Taking an international perspective and including openness to trade in the considerations increases this complexity. 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. We do not attempt to provide an exhaustive review of the relevant literature in this section, since it is indeed vast and analyzes these issues from many different perspectives. Instead, we try to concentrate on the directions that are relevant for the focus of this paper.

It is trade theory rather than labor economics that may serve as a starting point for theoretical predictions concerning the trade-wage nexus, since wage equations generally focus on the domestic determinants of wages (e.g. productivity and indi-

<sup>3</sup> The EU-15 include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. The EU-10 comprise the countries which joined the EU on May 1, 2004, namely Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. Finally, the EU-25 include all current Member States with the exception of Bulgaria and Romania.

vidual factors such as education, experience, etc.).<sup>4</sup> Wage-relevant statements in trade theory include the theory of factor-price equalization or the Stolper-Samuelson theorem, which states a positive relation between the relative prices of goods and the relative returns of the factors used more intensively in their production. The locally scarce factor, supposedly capital in developing and labor in developed countries, would thus *ceteris paribus* suffer from trade liberalization in relative terms. It is difficult to apply these theories empirically or as a basis for policy implications because they rely on relatively restrictive assumptions<sup>5</sup> and because the relative intensity of factors in the production of goods cannot be established based on available data. Overall, as opposed to the general perception mentioned above, theoretical statements include no straightforward predictions about the dependence of real wage developments on intensified trade.<sup>6</sup> They deliver complex results depending to a large extent on the assumptions of the models and features that cannot be completely controlled for.

Empirically, the results are also rather mixed, and often it is hard to establish the exact relation to theoretical statements like the Stolper-Samuelson theorem, given that available data do not allow to completely control for factor intensities in production. In recent research, Krugman (2008) 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 states that, with vertical integration, it has become very complicated to judge which sectors are labor-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.”<sup>7</sup>

Nonetheless, more current theoretical papers on wages and trade (based on different general equilibrium models) appear to coincide in the conclusion that international trade increases wage inequality within an economy (across different activities as well as across different skill segments, etc.), which is in line with the Stolper-Samuelson theorem. An earlier example, which focuses on the effects of globalization, is Manasse and Turrini (2001). In the trade model of Egger and Kreickemeier (2008), international trade also increases domestic wage inequality as well as involuntary unemployment. According to Amiti and Davis (2008), trade liberalization (reduction in tariffs) results in increased inequality. However, these papers often treat wage inequality as a rather abstract concept that is not easily adaptable to data. Empirical evidence concerning wage inequality is also ambiguous.

<sup>4</sup> See e.g. Mason (1994), Wolpin (2000) or Belzil (2006).

<sup>5</sup> 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 labor-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.”

<sup>6</sup> In the specific context of off-shoring, 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).

<sup>7</sup> Krugman (2008, p.27). As we said before the quotation, Krugman actually refers to the impact of trade on relative wages in the Stolper-Samuelson sense, and not to the impossibility of testing more straightforward statements, such as the relationship of trade and real wages, as is done in this paper.

Feenstra and Hanson (1996, 1999, 2001) have presented several contributions that focus on the impact of outsourcing on relative wages, generally arguing that outsourcing – and not only technology – is an important explanation behind the rising wage gap in the United States. However, the results of empirical papers on this topic are generally mixed.<sup>8</sup>

For the focus of the current study, it is also interesting to check the literature on European economies, not least because of the substantial differences between labor markets in Europe and in the U.S.A. However, only few studies are available regarding trade and wages, as many papers focus on some related, but distinct aspects.<sup>9</sup> Wage effects are considered in two papers by Onaran that focus on the effect of off-shoring 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 off-shoring to Eastern Europe, which indicates the dominance of scale effects. Empirical evidence on the trade-wage nexus is rather limited also with regard to transition economies. Again, most related papers investigate slightly different questions, such as the effect of foreign direct investment (FDI) on wages or the employment effects of trade.<sup>10</sup> The trade-wage relation in the region is explicitly considered by Onaran and Stockhammer (2006), who analyze the manufacturing sectors in five countries (the Visegrád 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.<sup>11</sup>

Overall, empirical research has delivered ambiguous results so far. The few papers that explicitly consider the relation between trade and wages find that the effects of trade on wages are mostly insignificant and extremely small. Moreover, the literature is characterized by a case study approach, especially when based on microdata. Even papers analyzing 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 two European country groups, namely the EU-15 and EU-10. In the group of Central and Eastern European (CEE) transition countries,

<sup>8</sup> Borjas and Ramey (1995) analyze 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 liberalization has led to decreased wage inequality.

<sup>9</sup> Pula and Skudelny (2008) and Peltonen and Pula (2008) deal primarily with the impact of imports from low-cost countries on the demand for labor in some euro area countries. Rodriguez and Rodrik (2000) analyze the link between trade policy and economic growth. The employment effects of outsourcing to low-wage countries are analyzed by Falk and Wolfmayr (2005).

<sup>10</sup> 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 labor demand equation for some Central and Eastern European countries, using a country-specific panel data analysis.

<sup>11</sup> 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.

trade liberalization in the early 1990s boosted trade volumes with Western Europe. This boom was reinforced by the process of EU accession. This is therefore an interesting case for investigating the consequences of these increased trade flows. Is there any effect on wages, and if so, does it differ for the two country groups in the EU-25? Does the impact of trade differ at the sectoral level? Are there winners and losers among the industries?

We attempt to answer these questions by focusing both on the transition countries and on the group of pre-2004 EU Member States. While these two country groups share many characteristics (especially with regard to labor markets), trade patterns and trade dynamics are clearly different. In our contribution, we also try to assess whether trade raises wage discipline by bringing wages more into line with labor productivity – as stated in Persyn (2008) – or whether it rather leads to an intensified co-movement of domestic and foreign wages.

### 3 Wage and Trade Developments within the Enlarged EU

For our analysis, three main data sources are used and extended by a few data series from different sources. The main data set for all but trade variables is the EU KLEMS database. This database contains inter alia data on output, price developments, productivity, labor compensation and employment at the industry level for all EU-25 countries up to 2005.<sup>12</sup> As eight of the EU-10 countries are transition economies for which pre-1995 data are often lacking and whose economic developments before 1995 were often untypical, we use data for the period from 1995 to 2005 only. We complemented this data set by trade data at the industry level from the UN Comtrade database for the manufacturing sectors and from the Eurostat International Trade in Services (ITS) database for the services sectors.<sup>13</sup> A description of all variables used and their construction is provided in appendix 1. Hence, we arrive at a comprehensive data set that links trade, output and wage data for the manufacturing and the services sectors, namely 15 manufacturing sectors (including agriculture) that are roughly at the two-digit NACE level and 6 services sectors at the one-digit NACE level. In total, our data set comprises information for 25 countries, 11 years and 21 economic activities.

Southeastern European EU candidate countries could not be included in the main analysis due to the incomparability or unavailability of data. Nevertheless, we did undertake a separate and smaller-scale examination of Croatia and the former Yugoslav Republic of Macedonia (FYR Macedonia).<sup>14</sup> We used the same above-mentioned sources for the trade data of these two countries, while all other data series were provided by the respective central banks.

<sup>12</sup> The EU KLEMS database was established by a consortium led by the Groningen Growth and Development Centre. The time series start in 1970 and have currently been updated to include 2006 (2006 data were not yet available for this study, however). See Timmer et al. (2008).

<sup>13</sup> Merchandise trade data were converted from five-digit SITC codes to two-digit NACE Revision 1 industries by using the correspondence keys implemented in the World Bank and UNCTAD WITS software. Services trade data were converted to match closely NACE Revision 1 one-digit codes following the UN Manual on Services recommendations.

<sup>14</sup> There are currently three EU candidate countries. However, wages at the industry level could not be calculated for Turkey because available industry-level data only cover compensation of employees, but not the number of employees (or hours worked).

### 3.1 Wages and Productivity

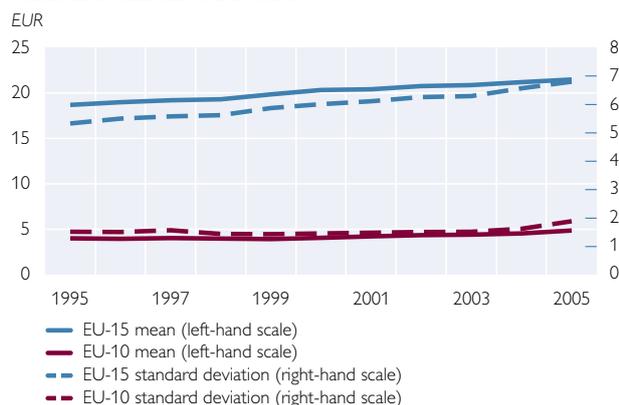
We calculate hourly wages (compensation of employees divided by hours worked) and hourly productivity (value added divided by hours worked) for each observation in our three dimensions (country, industry and year) from the EU KLEMS database. We decided to use hourly wages for three reasons. First, in terms of the skill composition of labor, we only have information on the hours worked. Second, if reliable, hours worked give a clearer picture of labor used in the production process than the number of employees. Last, 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 employees would produce a more reliable comparison.

What do the data tell us? In terms of average hourly wages of the economy (i.e. averaged across industries and countries), one can see a significant level difference between the EU-15 and the EU-10. This is obvious from chart 1, where we took simple averages of the mean hourly wages in the respective countries. Both the mean and the standard deviation show a steady, but moderate upward trend in both country groups.<sup>15</sup> Since the standard deviation is not dimensionless, cross-country comparisons are often based on the coefficient of variation, which is a normalized measure of dispersion. Here, we can see that 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.<sup>16</sup> But while it continuously increased in the EU-15, it actually declined in the EU-10 until roughly the time when these countries joined the EU, and subsequently rose to its highest level in 2005, which means that in these countries wage dispersion (across industries) went up significantly since their accession to the EU.

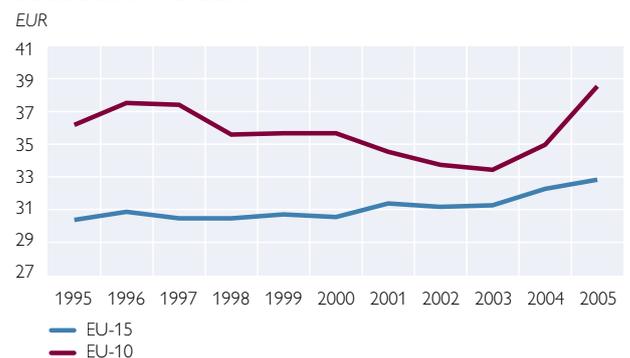
Chart 1

#### Evolution of Average Hourly Wage Levels in the EU-25 (1995–2005)

Mean and Standard Deviation



Coefficient of Variation



Source: Authors' calculations based on EU KLEMS.

Note: Hourly wages in EUR, CPI-deflated.

Source: EU KLEMS.

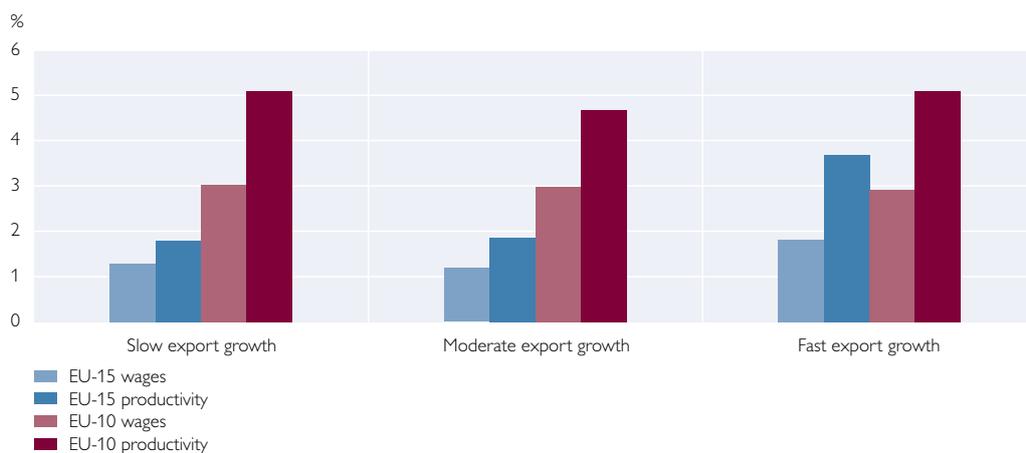
<sup>15</sup> The only countries where the mean declined over time are Spain (EU-15) and Hungary and Slovenia (EU-10). It increased very significantly in the United Kingdom, the Baltic countries and the Czech Republic. However, average wages in Slovenia remained the highest in the EU-10 despite the decline, while the Baltic States still belonged to the lower half of the group in 2005. It is also worth mentioning that hours worked remained remarkably stable over time in most countries. The increase in wages is therefore due to the rising compensation of employees.

<sup>16</sup> In the full sample, this figure is highest in Portugal and Hungary and lowest in Sweden and Denmark.

To take a different perspective, we calculated averages, standard deviations and coefficients of variation over time in all industries and for all countries. Since the EU-15 and the EU-10 retain distinct comparative advantages, the export performance of individual industries also differs greatly between the two country groups. To reflect this phenomenon, we identified slowly, moderately and fast growing industries separately for each group.<sup>17</sup> For the EU-15, we identified chemicals, electrical and optical equipment, communication and financial services and utilities as industries with fast export growth. Their joint share in total exports averaged around 40% for the region over the past decade. For the EU-10, mechanical machinery, other manufacturing, paper, rubber, wood and transport equipment as well as electrical and optical equipment and utilities emerged as the industries with high export growth by international standards. In fact, the EU-10 were in general characterized by much stronger export growth than the EU-15 and most other world regions. On average, the fast growing industries accounted for nearly 50% of all exports in the EU-10.

Chart 2

### Average Growth Rate of Hourly Wages and of Hourly Productivity by Industries' Export Performance



Source: Authors' calculations based on EU KLEMS.

Across all industries, the EU-15 average wages were higher than those in the EU-10 group; for the coefficient of variation this relation was inverted. Moreover, we did not find much variability across the industry groups, except for the average real hourly wage in the EU-15, which was substantially higher in the group with the fastest export growth than in the other industry groups. To get a clearer picture of the dynamics, we calculated the average annual growth rate of our main variables in all industries and countries over the entire period. Chart 2 shows the average annual growth rate of hourly wages together with that of hourly productivity. Both wages and productivity have generally increased at a higher rate in the EU-10 than in the EU-15. Productivity growth exceeded wage growth in all industry and country groups.

<sup>17</sup> The definition of these three groups and a complete list of industries are given in appendix 2.

The correlation of average hourly wages and productivity was generally very high, except for the oil sector, and typically somewhat higher in the EU-15 countries than in the other group. The opposite holds for the correlation of the growth rates of these variables, which was also generally lower than the correlation in levels. The two groups of countries differed substantially with regard to the distribution of wages and productivity. The distributions of both variables generally have a positive skew in both regions; in the EU-10, they are very dense whereas the EU-15 show a wide range of higher values for both variables in the data reflecting much higher wages and much higher productivity values than in the EU-10.

For Croatia and FYR Macedonia, we do not have fully comparable data. Therefore, it was not possible to calculate hourly wages; instead, monthly gross wages (for a shorter period) were used. Average real wages across industries in Croatia are at a level comparable to average monthly wages in the EU-10, while wages in FYR Macedonia are approximately half as high. While the average monthly wage jumped by about 31% in Croatia between 1996 and 2006, it even declined slightly in FYR Macedonia in this period. The dispersion of wages, as measured by the standard deviation, increased in both countries. This also holds for the coefficient of variation, but the increase was more pronounced in FYR Macedonia, where wages vary more across industries than in Croatia.

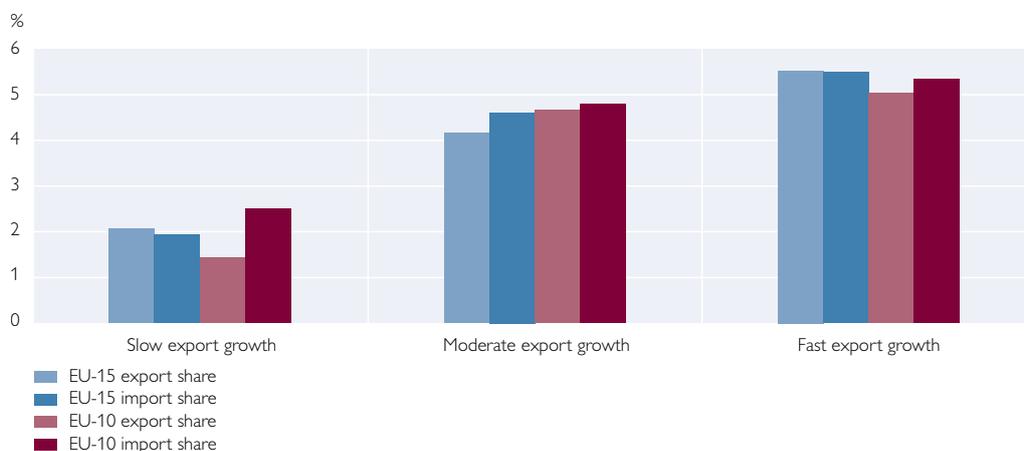
### 3.2 Trade Variables and the Openness of the Economy

Total exports and imports of goods and services (taken from the IMF World Economic Outlook – WEO) have risen substantially over time, with France, Germany and the United Kingdom as well as the Czech Republic, Hungary and Poland showing the highest rates of growth in the two country groups. Both the ratios of exports and imports to value added and trade openness increased moderately in the economies in general, as we would expect given the greater economic integration of these countries over the ten-year period. Export and import patterns are highly similar, reflecting the strong correlation between exports and imports. There is less dispersion across industries in the trade measures than in wages and labor productivity. Between the two country groups, we can observe highly diverse developments over time at the industry level; these developments are in line with distinct patterns of specialization in the two regions.

Given the paper's focus on individual industries, let us highlight some main features of the industry groups under observation with respect to trade. The share of an industry's exports/imports in total national exports/imports indicates the industry's relevance for the overall trade performance of the respective national economy. The industries with the highest (export as well as import) shares are electrical and optical equipment, chemicals and transport equipment. Among the sectors with somewhat lower but still significant trade shares, export performance typically matches import performance, except for mining and quarrying (which reveals high import shares only) and transportation and storage services (which is characterized by significant export shares only). The two country groups differ substantially when it comes to exports of chemicals and real estate and business services (where the shares are higher in the EU-15) and in electrical and optical equipment (which is more relevant in the EU-10). This also holds for imports, except for chemicals, where the difference is much smaller.

Chart 3a

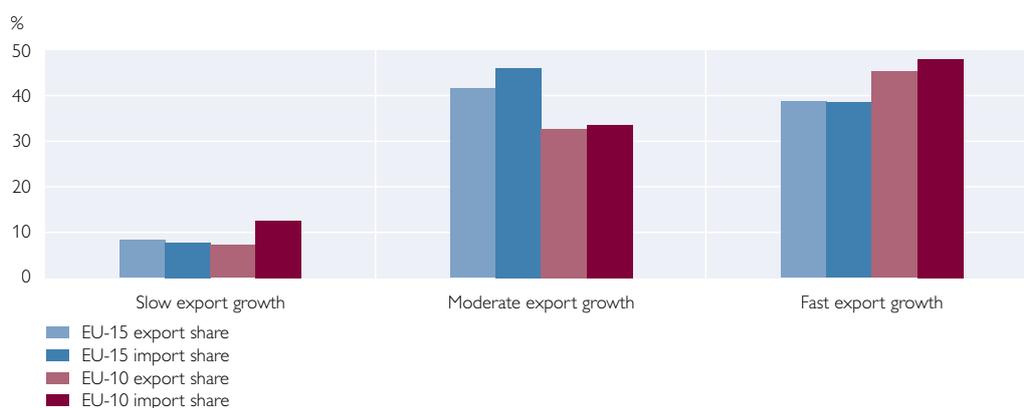
### Average Share of Exports and Imports in Total Trade



Source: Authors' calculations based on UN Comtrade and Eurostat ITS.

Chart 3b

### Cumulated Share of Exports and Imports in Total Trade



Source: Authors' calculations based on UN Comtrade and Eurostat ITS.

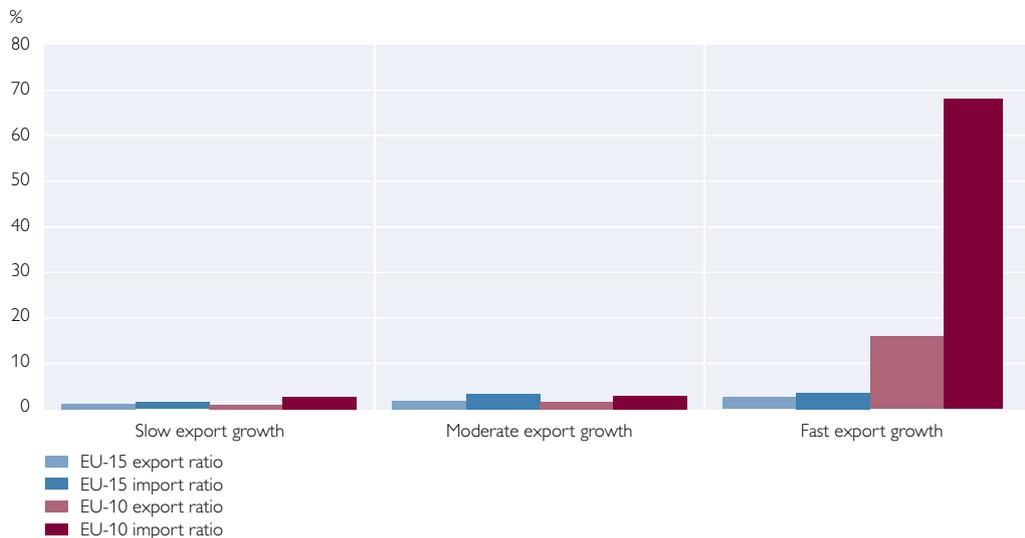
Chart 3a shows that by 2005, on average, the industries with more rapid export growth had grown to become the most important sectors in terms of both imports and exports. In the EU-10, this is also true for cumulated trade shares, while in the EU-15 – due to their larger weight – the moderately growing industries are dominant (chart 3b).<sup>18</sup> In the EU-15, import shares are higher than export shares only in the sectors with moderate export growth, while the EU-10 are net importers in all industry groups.

Ratios of imports and exports to value added as well as trade openness (measured as the sum of imports and exports divided by gross output) reflect how important trade is for a specific sector, while the shares described above indicate the relevance of the respective sectors in trade. In the EU-15, the sectors with slow export growth are generally the most open industries, while in the EU-10,

<sup>18</sup> The trade shares reported in charts 3a and 3b do not sum exactly to one, since two important sectors (hotels and restaurants and public services) are left out of the analysis given the lack of trade data.

Chart 4a

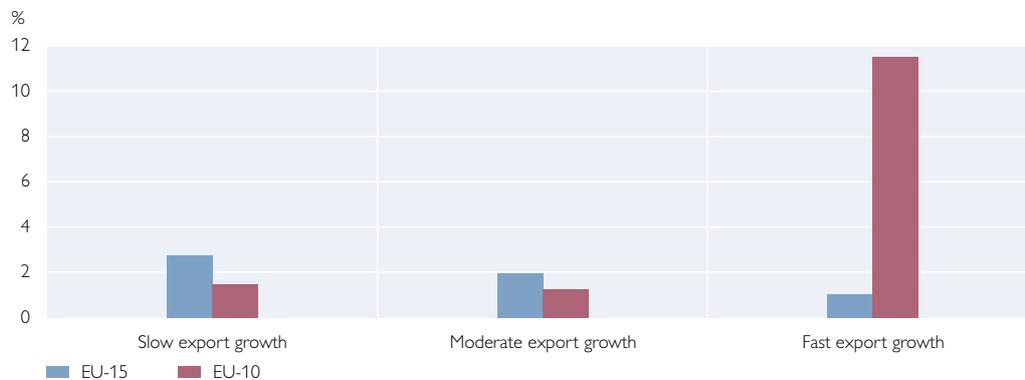
### Average Ratio of Exports and Imports to Value Added



Source: Authors' calculations based on UN Comtrade and Eurostat ITS.

Chart 4b

### Average Trade Openness of Industry Groups



Source: Authors' calculations based on UN Comtrade and Eurostat ITS.

trade ratios are by far the highest in the group with the most dynamic export growth (this is especially true for the import ratio, see chart 4a), reflecting the high trade (particularly import) penetration of the oil sector in the EU-10. Mining and quarrying is the only sector where both ratios are substantially higher in the EU-15 than in the EU-10, which means that only the industry group recording the fastest export growth is more open in the EU-10 than in the EU-15. In the EU-15, the ratio of oil imports does not seem to matter to this extent, and trade openness is lower, on average, in the fast growing sectors than in the other sectors (chart 4b).

Turning to Croatia and FYR Macedonia, trade ratios and openness have been increasing due to enhanced economic integration, but the export base is narrow. In absolute terms, total exports and imports of goods and services have risen

substantially over time in Croatia and less strongly in FYR Macedonia. Both the ratios of exports and imports to value added and trade openness went up in the economies in general, as we would expect given the increased economic integration of these countries especially with the EU economies. Interestingly, developments have been more diverse at the industry level. In terms of exports, the industries with the highest shares in total exports are hotels and restaurants in Croatia (over 30%) and textiles and metals in FYR Macedonia (over 25% and 20%, respectively). The dominance of these sectors reflects that the export base is very narrow in these countries, especially in manufacturing, and performance is highly dependent on developments in tourism (Croatia) or metal prices (FYR Macedonia).<sup>19</sup> Imports are more broadly based, with transportation (over 10%) and electrical and optical equipment, machinery and chemicals accounting for the highest shares in Croatia, and food (over 10%), chemicals and metals in FYR Macedonia.

Trade seems to have been driven to a large extent by low production costs. On average and cumulatively, the low-wage sectors have the highest share in both countries. Both in terms of export and import ratios, as well as trade openness, the high-wage sectors show negligible trade penetration. This is in stark contrast to both EU-10 and EU-15 averages, where trade actually plays the greatest role in this industry group. Therefore, it seems that, as expected, in these countries exports are driven more strongly by low production costs than in the EU-10 or EU-15. Moreover, all industries are significantly more open in Croatia, where food leads in terms of imports and hotels and restaurants lead in terms of exports. However, trade augmented most in the medium-wage sectors, as a first sign for a changing composition of trade in the candidate countries.

#### **4 The Trade-Wage Relation in the Enlarged EU – Some Econometric Evidence**

We empirically test the relation of wage developments and trade at the sectoral level in the EU-25 for the period from 1995 to 2005. Using a panel data approach, we take both the cross-sectional and the time series components of the data set into account, whereas earlier studies generally analyze countries separately, often using more detailed national information. Given the European-wide coverage of our study, we do not provide these details on work force 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. By using country-specific fixed effects in the regression, we control for the unobserved heterogeneity of countries in the regression, avoiding biased results where idiosyncrasies such as geographic location, institutional differences in national systems of labor relations and collective bargaining are relevant. Econometrically we thus exploit only 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. We also group

<sup>19</sup> For comparison, the highest export share in the EU-10 is 14% (electrical machinery). This is also the sector with the highest import share (16%).

industries according to their export performance, which allows us to identify certain common characteristics of individual activities concerning the trade-wage relation.

We follow a very general approach, which can be grounded on both a labor market and a trade background. We test the following equation:

$$\ln(\text{wage}_{c,i,t}) = \alpha + \beta_1 * ur_{c,t} + \beta_2 * lprod_{c,i,t} + \beta_3 * trade_{c,i,t} + \beta_4 * trade\_other_{c,i,t} + \beta_5 * open_{c,t} + \gamma_c + \varepsilon_{c,i,t} \quad (1)$$

The dependent variable is the natural logarithm of the real hourly wage in country  $c$ , industry  $i$  and year  $t$  (see appendix 1 for a description of the exact calculation of all variables). We regress hourly wages on the unemployment rate and hourly labor productivity of the respective sector. Since we do not have sector-specific unemployment data, we use the country-wide unemployment rate to reflect the relative scarcity of the factor labor. We are aware that this is a rather restricted set of real economy- and labor market-relevant variables. Yet other variables, such as sector-specific employment (a very crude proxy at the sectoral level for labor supply conditions), GDP growth as well as a time trend were either insignificant or did not change the results. Furthermore, this simple specification already gave a relatively good fit. We expect a negative coefficient on unemployment, arguing that high unemployment – meaning an abundance of labor – should exert downward pressure on wages. The advantage of using the economy-wide unemployment rate is that it already incorporates changes in sector-specific unemployment levels attributable to intersectoral mobility. We find that wage growth in countries with high unemployment rates tends to be lower irrespective of the particular sector under consideration. This is a nonnegligible factor in wage formation.<sup>20</sup> As for labor productivity, we clearly expect a positive coefficient, since wages should equal the marginal product of labor. Working with data at the industry level, as we do here, also means that we cannot include variables that reflect workers' characteristics (such as age, experience, education or gender), as is common in micro-based wage equations.

Next, we include a set of trade variables. Trade can influence domestic wages on both the import and the export side. Imports affect wages by displacing otherwise domestically produced goods and services. However, the relation between imports and domestic wages depends on whether imports replace products involving 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 case we may well observe a negative relation between imports and wages on average. Thus, our expectation of the sign of the import variable is in fact open. Yet, as we expect the first effect to occur more often in more sophisticated activities, we rather expect a positive relationship in more technology- and skill-intensive industries. Turning to exports, we argue that greater exposure to the global market through exports would introduce more competition in a sector and hence again work in a positive

<sup>20</sup> We thank the referees for pointing this out. Of course, we are not able to capture intersectoral mobility explicitly in our approach, which is based on separate estimation of individual industries.

and a negative way: the quality of the products produced will have to rise with a subsequent positive effect on wages. Another positive relation between trade and wages can be an increase in product demand that arises from strong export demand. Resulting higher prices would also allow for higher wages. At the same time, more competition may exert stronger pressure on wages and reduce trade union power, thus driving wages down. Which effect dominates, remains an empirical question.

For the trade variables, we used the ratio of imports (and exports) to value added. Using trade shares (i.e. imports as a share of economy-wide imports) would give a different flavor to the analysis, especially since a rise in one sector's trade share must, by definition, imply a decline in another sector's trade share. Wages in a specific industry within a country are likely to be influenced by trade developments in other sectors. Therefore, we include two additional controls in the model: the trade ratio measured for the rest of the specific country's economy – i.e. in all sectors other than the one analyzed – to account for an influence of trade on wages in a specific sector (which occurs through trade in upstream or downstream industries) and general trade openness of the country as such. 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 one sector in other sectors of the economy. For instance, in the case where imports in the same industry affect wages negatively due to higher competition pressures, higher imports by upstream industries could nevertheless boost wages to higher levels, not only by increasing productivity via cheaper and possibly also higher-quality inputs into production, but also through the composition effect mentioned above.

We also control for the general trade openness of a country by including the ratio of country-wide exports plus imports to GDP. By doing so, we allow for a differential impact of trade in very open economies as opposed to rather closed markets. Since we never include sector-specific import and export ratios simultaneously in a single specification in order to avoid a possible bias arising from the high correlation between the two series, controlling for a country's openness to trade seems adequate given that trade is always a two-way phenomenon. Moreover, rising trade openness may induce an entirely new pattern of specialization, which indirectly impacts again on the average wage level through changes in the composition of low- and high-wage tasks in the economy. We have also experimented with other trade variables – net exports, openness and import penetration in each industry – but these had low explanatory power and the results were mostly insignificant.

Our specification is similar to specifications often used in the empirical literature.<sup>21</sup> However, we estimate the above model for a panel of countries, but separately for each industry, thus allowing for a different reaction of wages on trade in each sector. First results, based on a fixed effects estimation with clustered standard errors, showed that there was considerable autocorrelation left in the

<sup>21</sup> See e.g. *Winter-Ebmer and Zimmermann (1998)*, *Hofer and Huber (2003)* or *Onaran and Stockhammer (2006)*.

residuals (as evidenced by the Wooldridge test for panel data models). Therefore we chose to estimate our model in a dynamic setting, using the general method of moments (GMM) estimator proposed by Arellano and Bond (1991).<sup>22</sup>

#### 4.1 Winning and Losing Industries in the EU-15 and EU-10

The coefficients on the domestic variables are highly robust across sectors and yield the expected signs. Wages show a modest, but statistically significant and positive autocorrelation, justifying the use of the Arellano and Bond (1991) estimator. Unemployment correlates negatively with wages in all sectors, the regression coefficient is statistically significant in 10 out of the 21 sectors. An increase in the unemployment rate by 1 percentage point translates into a decrease in average wage levels of between 0.5% in communication services and 1.8% in construction services, with most sectors experiencing a decrease by roughly 1%. Also the productivity level exhibits the expected sign. Wages respond positively to higher labor productivity; the coefficient is almost always statistically significant. Increases in productivity are only partly reflected in higher wages. The elasticity between labor productivity and wages is far below 1, ranging between 0.14 (electrical and optical equipment) and 0.6 (other business services).

For the EU-25, only few industries actually show a statistically significant relation between wages and our trade variables, which are listed in table 1 below.<sup>23</sup> The relation is negative in the case of wood and oil products and positive in the remaining four activities (chemicals, metals, utilities and financial intermediation). However, economic significance is small on average, although it varies greatly from sector to sector. For the oil industry, the effect is negligible, and it is also very small in chemicals and metals. In the wood industry, a 10 percentage point increase in the import ratio is associated with a 0.7% decrease in the wage level, while it corresponds to a 5% rise in the wage level in electricity, gas and water supply. In some industries (i.e. oil and metals), the effects from increased imports within the sector are overcompensated by opposing effects from increased trade in the remaining sectors of the economy. The results for exports, though not reported here, are highly similar. To summarize, we can identify only a handful of industries that exhibit a statistically significant relation between trade and wages and even fewer sectors where this relation is also economically significant. Furthermore, the industries presented in table 1 do not appear to share many characteristics, except that they are mostly resource-based activities. Finally, although the general openness of the economy often shows a small, albeit negative effect on wages, this relationship is more often found in low-skill and labor-intensive industries (such as wood, paper, rubber, other manufacturing not included elsewhere, transport equipment and transportation services) and never in industries which exhibit a positive correlation with imports (or exports) in the same industry.

<sup>22</sup> This dynamic, instrumental variable approach uses a large instrument matrix consisting of lags of the dependent variable as well as first differences of the exogenous variables. We use the two-step, robust estimator, applying the Windmeijer (2005) bias correction.

<sup>23</sup> Due to space limitations, we only present the results for selected industries in this paper. The full set of results for all industries is available from the authors upon request.

Table 1

**Effects of Trade on Wages in the EU-25 – Breakdown by Individual Sectors**

	Wood	Oil	Chemicals	Metals	Utilities	Finance
Lagged wages	0.309 *** 3.21	0.653 *** 3.97	0.1877 *** 2.80	0.2416 *** 5.00	0.2855 *** 2.71	0.2034 0.92
Unemployment	-0.0117 *** -2.59	-0.0086 -1.40	-0.0094 * -1.65	-0.0029 -0.47	0.0074 1.54	-0.012 *** -2.77
Productivity	0.3689 *** 4.21	-0.0213 -0.69	0.4507 *** 4.26	0.5086 *** 5.57	0.2357 *** 3.35	0.4848 *** 4.75
Import ratio	-0.0778 *** -11.88	-0.0001 *** -2.95	0.0113 ** 2.38	0.0227 *** 3.93	0.4965 * 1.66	0.1079 ** 2.52
Import ratio/ rest of the economy	0.0024 0.16	0.0727 *** 2.74	-0.0587 -1.41	-0.0932 *** -3.93	0.0146 1.53	-0.0168 -1.23
Trade openness	-0.1609 ** -2.34	-0.0529 -0.39	-0.1106 -1.07	-0.1335 * -1.69	0.0187 0.42	-0.0256 -0.45
Constant	0.7588 *** 4.79	1.0621 * 1.77	0.7516 ** 2.21	0.5026 *** 2.80	0.9165 *** 3.96	0.7524 1.64
Number of observations	213	190	213	213	197	216
Number of countries	24	22	24	24	24	24
Chi <sup>2</sup>	1530.08	54.98	37.96	226.96	117.04	240.25
z-value (AR-1)	-2.59	-2.35	-1.10	-1.98	-1.61	-0.51
z-value (AR-2)	-0.82	1.48	-0.81	-0.58	0.19	1.51

Source: Authors' estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed [1.96] and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

Although we explicitly control for country-specific effects, it still seems inappropriate to impose the same model on all EU Member States. Therefore, we separated the sample into two groups: the smaller and considerably more open economies that joined the EU in 2004 (EU-10), and the remaining EU-15. The results for the EU-15 are displayed in table 2, the results for the EU-10 in table 3. In each subsample, a larger number of sectors emerges with a statistically significant relationship between trade and wages. Let us briefly discuss the domestic variables first. The relation between unemployment and wages remains negative; however, we see a stronger effect in the EU-10 (the coefficient ranges between 1% and 2%) as compared to the EU-15 (where the coefficient ranges between 0.5% and 1%). Also, productivity developments translate more strongly into wage developments in the EU-10, where a productivity increase by 1% is often associated with a 0.5% rise in wages and as much as 0.8% in other business services. In the EU-15, the wage elasticity to productivity is noticeably lower and lies between 0.1 and 0.45.

Turning to the variables of major interest, we find mixed results again in many respects. First of all, we observe positive and negative correlations between imports and wages. Second, the magnitude of the import coefficient varies greatly across individual sectors. What is most striking is that the results for the EU-25 were mostly driven by the EU-10. In particular, the large coefficient on imports in the electricity and gas sector arises from these countries. By contrast, the variation between industries is also much higher in the EU-10 when referring to the

Table 2

**Effects of Trade on Wages in the EU-15 – Breakdown by Individual Sectors**

	Agriculture	Food	Chemicals	Rubber	Minerals
Lagged wages	0.4211 * 1.67	0.3712 *** 2.88	0.404 *** 3.15	0.3994 *** 6.29	0.2022 *** 3.07
Unemployment	-0.0103 *** -3.18	-0.0054 -1.64	-0.0111 *** -3.50	-0.0052 -1.62	-0.003 -1.02
Productivity	0.4018 *** 2.69	0.1981 ** 2.26	0.1786 *** 2.73	0.271 ** 2.46	0.4559 *** 6.13
Import ratio	0.1322 * 1.92	0.0927 ** 2.37	0.0175 * 1.73	0.0956 *** 2.59	0.1673 ** 2.26
Import ratio/ rest of the economy	0.0882 0.60	-0.0284 -0.29	-0.0603 -0.53	-0.0952 -0.68	-0.2018 ** -2.42
Trade openness	-0.235 *** -2.95	-0.0466 -0.77	-0.1063 -1.26	-0.049 -0.71	0.0461 0.74
Constant	-0.1958 -0.40	1.0815 ** 2.47	1.3406 *** 4.08	0.8083 ** 2.37	0.8083 *** 3.91
Number of observations	123	123	123	123	123
Number of countries	14	14	14	14	14
Chi <sup>2</sup>	364.87	135.29	146.23	207.56	211.17
z-value (AR-1)	-2.34	-1.82	-1.75	-1.82	-2.50
z-value (AR-2)	-1.44	0.69	0.31	0.98	1.80

	Metals	Electrical and optical equipment	Other manufacturing n.i.e.	Communica- tion services	Other services
Lagged wages	0.0785 0.84	0.4394 *** 5.39	0.3881 *** 3.42	0.3618 *** 4.45	0.7388 *** 9.46
Unemployment	-0.0081 *** -3.40	-0.0091 * -1.89	-0.0053 * -1.94	-0.0099 -1.59	-0.0132 *** -2.63
Productivity	0.3918 *** 3.23	0.1314 *** 4.17	0.1547 *** 2.86	0.0928 ** 2.19	0.2456 1.55
Import ratio	0.0505 * 1.78	0.0172 * 1.76	0.0452 *** 3.13	-0.2022 * -1.69	-0.0516 *** -2.66
Import ratio/ rest of the economy	-0.059 -0.67	-0.2224 -1.59	0.1326 ** 2.16	-0.0195 -0.25	0.051 1.26
Trade openness	-0.0303 -0.45	-0.0252 -0.30	-0.1778 *** -4.37	0.1433 1.11	-0.0471 -0.80
Constant	1.4036 *** 5.64	1.3623 *** 6.06	1.1476 *** 4.51	1.6131 *** 10.10	-0.1124 -0.21
Number of observations	123	123	123	126	126
Number of countries	14	14	14	14	14
Chi <sup>2</sup>	66.73	117.90	328.09	401.27	606.94
z-value (AR-1)	-0.61	-2.31	-2.55	-1.94	-1.61
z-value (AR-2)	1.78	1.83	-0.40	-0.73	0.81

Source: Authors' estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed |1.96| and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

economic impact of trade on wages with a very low wage response to imports in some sectors. In the EU-15, the import coefficients are often around 0.1. This means that a 10 percentage point increase in the import ratio in one sector (e.g. a rise in the import ratio from 4.5% to roughly 14.5% for the production of

Table 3

**Effects of Trade on Wages in the EU-10 – Breakdown by Individual Sectors**

	Wood	Chemicals	Metals	Electrical and optical equipment
Lagged wages	0.2932*** 3.13	0.1861*** 3.09	0.2735*** 4.50	0.4949*** 3.17
Unemployment	-0.0178*** -3.71	-0.0185** -2.21	0.0031 0.26	-0.0049 -0.94
Productivity	0.439*** 3.88	0.5403*** 4.85	0.5248*** 4.73	0.2327*** 4.76
Import ratio	-0.0745*** -8.65	0.0122** 2.47	0.03*** 2.79	-0.0011 -0.84
Import ratio/rest of the economy	-0.0012 -0.09	-0.053 -1.33	-0.1309*** -3.09	0.0359*** 2.81
Trade openness	-0.2365*** -2.92	-0.0124 -0.08	-0.1873* -1.69	-0.0381 -0.65
Constant	0.6386*** 4.36	0.2978 0.95	0.285 1.29	0.3302 1.58
Number of observations	90	90	90	90
Number of countries	10	10	10	10
Chi <sup>2</sup>	1765.03	61.4164	211.3204	105.0135
z-value (AR-1)	-2.0349	-0.712	-2.2323	-1.3394
z-value (AR-2)	-1.0719	-1.0121	-0.545	0.2945
	Utilities	Communication services	Finance	Other services
Lagged wages	0.2363 1.41	0.436*** 3.76	0.3806 1.43	0.3607*** 3.18
Unemployment	0.0111*** 2.15	0.0042 1.06	-0.003 -0.63	-0.0045 -1.06
Productivity	0.2655** 2.38	0.283*** 3.68	0.5539*** 4.33	0.7952*** 9.86
Import ratio	0.8499** 2.25	0.0509 0.71	0.2302** 2.21	-0.2945 -1.21
Import ratio/rest of the economy	0.0135 0.91	0.0125** 2.38	-0.0024 -0.15	0.054*** 4.00
Trade openness	0.0099 0.09	0.0931*** 3.59	0.0842 0.92	0.4064*** 4.04
Constant	0.4283* 1.82	0.1106 1.37	-0.1099 -0.28	-1.3796*** -5.91
Number of observations	74	90	90	90
Number of countries	10	10	10	10
Chi <sup>2</sup>	913.06	726.51	98.16	1054.46
z-value (AR-1)	-1.47	-1.70	-1.45	-2.20
z-value (AR-2)	0.53	-1.60	0.59	1.57

Source: Authors' estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed |1.96| and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

transport equipment – the second most open sector after the oil industry) is associated with a roughly 1% rise in wages. In the EU-10, this coefficient ranges between 0.03 and 0.85, meaning that a 10 percentage point rise in the import ratio of the metal industry would ceteris paribus imply a 0.3% rise in the wage level, while this effect would be 8.5% in the supply of electricity, gas and water.

Another interesting observation relates to the sector mix. The only services sectors yielding a significant coefficient between wages and imports in the EU-15 are communication and other business services. In both cases, we observe a negative relation, which is economically meaningful in communication services. For the EU-10, again communication, other business services, but also financial services show a statistically significant wage response to trade. However, here we observe a positive correlation between trade and wages. Overall, country trade openness also shows a positive sign. Thus, openness, especially on the import side, to trade in the services sectors is often associated with a positive wage effect in the EU-10.

Nevertheless, the composition of the group of industries with a significant correlation between trade and wages still seems to be rather coincidental. In the next section, we try to group industries by their export performance. Industries with higher export growth are more exposed to international markets and hence to international competition. As a result, we would also expect to see more significant results emerge in these industries.

#### **4.2 Positive Wage Effects from Increased Trade in Industries with Strong Export Performance**

Table 4 below shows the results we obtain for the EU-15 when we pool industries by their export growth performance into fast, moderately and slowly growing sectors. We now see very clearly that those industries which experienced fast export growth over the past decade (and hence are subject to the greatest trade exposure) also exhibit a positive correlation between trade and wages at the sectoral level. Both directly, through imports or exports within the same industry, and indirectly, through imports or exports in other industries, we can observe a statistically significant, albeit weak, positive correlation. At the same time, we observe a strong negative effect from the respective country's general openness. This latter effect is considerably stronger in economic terms than the direct impact of imports in the same industry on wages, and is manifest in all three industry groups. When interpreting the relative magnitude of the trade openness coefficients, it has to be kept in mind that the trade openness of a country as such is likely to change by a much smaller degree than the import or export ratios of individual sectors. Nevertheless, we find that the marginal effect for more open countries is negative and greater than the positive marginal effect of increased imports (or exports) at the sectoral level. A 10 percentage point rise in a country's trade openness (a rare phenomenon over the time period considered) would translate into a 1% decrease in wages, while a 10 percentage point rise in the import ratio of a fast growing sector would correspond to an increase in average wages of the sector by 0.01%. Similar results are obtained for export ratios. How can we reconcile these contradicting results? In general, greater trade openness is clearly associated with a lower general wage level. This was also an outcome of the industry-specific results above, when we often obtained a negative and statistically significant coefficient on country trade openness, even if no other trade variables proved to be significant. However, in the industries with a strong trade performance (and hence the industries that are able to compete successfully in international markets) this negative effect is partly offset by positive effects from trade.

Table 4

**Effects of Trade on Wages in the EU-15 – Breakdown by Industries’ Export Performance**

	Import ratios			Export ratios		
	Export growth performance			Export growth performance		
	fast	moderate	slow	fast	moderate	slow
Lagged wages	0.4518 *** 5.77	0.3518 *** 7.06	0.4078 *** 4.52	0.4322 *** 5.48	0.3444 *** 7.05	0.4377 *** 5.42
Unemployment	-0.01 *** -4.62	-0.0073 *** -5.11	-0.0067 *** -3.03	-0.0102 *** -4.68	-0.0075 *** -5.41	-0.0067 *** -3.25
Productivity	0.0926 ** 2.35	0.2399 *** 7.65	0.274 *** 5.94	0.0947 ** 2.4	0.2414 *** 7.41	0.2762 *** 5.72
Trade ratio	0.0017 *** 3.17	0.0011 0.73	0.0106 1.12	0.0028 *** 2.72	0.0076 1.59	0.0012 0.22
Trade ratio/rest of the economy	0.06 * 1.87	0.031 * 1.76	-0.0167 -0.53	0.0604 ** 2.1	0.0137 0.66	-0.014 -0.51
Trade openness	-0.1018 *** -2.79	-0.1097 *** -4.9	-0.0527 -1.48	-0.0969 *** -2.72	-0.1026 *** -4.48	-0.0558 -1.55
Constant	1.4516 *** 8.37	1.0838 *** 8.45	0.8533 *** 4.26	1.5023 *** 8.55	1.1012 *** 8.16	0.7741 *** 4.42
Number of observations	861	1233	495	861	1233	495
Number of countries/industries	97	140	56	97	140	56
Chi <sup>2</sup>	268.7419	270.5056	188.5845	260.629	259.1584	198.791
z-value (AR-1)	-4.2673	-5.1235	-3.3057	-4.199	-4.8948	-3.4766
z-value (AR-2)	-0.8348	1.7459	2.1277	-0.8754	1.7077	2.0493

Source: Authors’ estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed |1.96| and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

For the EU-10 (see table 5), we cannot identify this general negative relation between country trade openness and wages. The EU-10 are characterized by a higher degree of openness, on average, and also by stronger trade growth over the past decade. Thus, even though these countries are more exposed to trade, we cannot identify a general negative relation between trade and wages. In particular, fast growing industries (in terms of exports) show positive indirect effects from trade (both through imports and exports in other sectors in the economy). The positive, even though economically small, coefficient on imports in the moderately growing industries, however, is more than offset by a negative coefficient on both other trade variables (imports in the rest of the economy and country trade openness), suggesting a negative net relationship in this segment.

Table 5 shows other interesting results as well. In both country groups (see also table 4), wage persistence is most pronounced in the most strongly growing export industries. In this industry group, the EU-10 show stronger wage persistence than the EU-15, while in all other industry groups the EU-15 are characterized by higher wage persistence. This means that wages in moderately and slowly growing export sectors in the EU-10 are more strongly determined by other factors than their EU-15 counterparts. One such factor is labor productivity. Productivity developments are more strongly reflected in wage developments in the EU-10. In the next subsection, we will look at the impact of trade on

Table 5

**Effects of Trade on Wages in the EU-10 – Breakdown by Industries’ Export Performance**

	Import ratios			Export ratios		
	Export growth performance			Export growth performance		
	fast	moderate	slow	fast	moderate	slow
Lagged wages	0.6786*** 5.67	0.2337** 2.19	0.0668 0.54	0.7053*** 5.68	0.2599** 2.42	0.062 0.5
Unemployment	-0.0052* -1.87	-0.0079** -2.14	-0.002 -0.55	-0.0065** -2.41	-0.0073** -2.02	-0.0024 -0.7
Productivity	0.1555** 2.34	0.577*** 9.01	0.6024*** 14.31	0.1478** 2.17	0.564*** 8.67	0.6052*** 13.42
Trade ratio	0.0 -0.3	0.0131*** 3.19	0.0082 1.21	-0.0001** -2.22	0.013 1.64	0.0168 1.09
Trade ratio/rest of the economy	0.0289*** 2.76	-0.0205* -1.91	-0.0031 -0.4	0.0496*** 3.41	-0.0189 -1.07	-0.0068 -0.5
Trade openness	0.0624 1.45	-0.0934* -1.72	-0.0573 -1.08	0.0523 1.28	-0.0744 -1.37	-0.0445 -0.87
Constant	0.1278 0.94	0.0709 0.37	0.3193* 1.65	0.1146 0.88	0.0471 0.26	0.3215* 1.72
Number of observations	780	630	450	780	630	450
Number of countries/industries	89	70	50	89	70	50
Chi <sup>2</sup>	164.6839	158.2713	215.3288	192.3972	195.6902	193.3466
z-value (AR-1)	-3.4345	-1.7768	-1.1206	-3.4409	-2.0861	-1.0794
z-value (AR-2)	-0.474	-0.0469	1.7874	-0.4252	0.0327	1.8942

Source: Authors' estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed |1.96| and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

this mechanism, i.e. whether increased trade implies that developments of wages and labor productivity are more clearly decoupled or whether trade is able to reinforce the link between productivity and the theoretically predicted return to labor. If the latter is the case, we speak of a wage-disciplining effect of trade.

**4.3 Does Trade Bring More Wage Discipline?**

In the previous subsection, we tested for a direct relation 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 aids the equalization 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 where foreign wages and terms interacting trade openness with both foreign wages and productivity are added to a wage equation. In general, Persyn finds that trade enhances wage discipline in the sense that wages become more aligned with the marginal product of labor as expressed in the level of labor productivity. If this is the case and wages are set according to their domestic fundamentals, we may speak of

enhanced wage discipline. This corresponds to a lower impact of foreign wages on wage setting, with productivity becoming more important as trade costs decrease.<sup>24</sup>

$$\begin{aligned} \ln(\text{wage}_{c,i,t}) = & \alpha + \beta_1 * ur_{c,t} + \beta_2 * lprod_{c,i,t} + \beta_3 * trade_{c,i,t} + \beta_4 * trade\_other_{c,i,t} + \\ & + \beta_5 * open_{c,t} + \beta_6 * foreignwages_{i,c,t} + \beta_7 * foreignwages_{i,c,t} * open_{i,c,t} + \\ & + \beta_8 * lprod_{i,c,t} * open_{c,i,t} + \gamma_c + \varepsilon_{c,i,t} \end{aligned} \quad (2)$$

We tried to integrate this idea in our framework by adding three variables to the model specified in equation 2, namely foreign wages (i.e. the average hourly real wage in the respective sector in all other EU-25 countries<sup>25</sup>) and two terms interacting the openness of the industry with foreign wages and productivity. The results (see tables 6 and 7) are robust for the variables in the earlier specification – productivity is significant and positive, its economic influence is higher in moderately and slowly growing export industries. Higher unemployment is associated with marginally lower wages (but the effect is again very small in economic terms).

For the EU-15, we again find a nonnegligible negative correlation between wages and openness, but import and export ratios within the same sector are more often associated with higher wage levels. There is also some evidence for positive effects through imports or exports in all remaining sectors, at least in industries with reasonably strong export growth. For the EU-10, we now find a positive (but again economically small) relation between imports and wages. This correlation is stronger for slowly growing export industries. More importantly, the negative coefficient on country trade openness cannot be confirmed for this region.

There is no evidence of a wage-disciplining effect of trade in the EU-15. In the EU-15, foreign wages are significant in twice as many sectors as in the EU-10 and have a positive sign in all cases, thus confirming the co-movement of wages. This might reflect a greater alignment of business cycles in the EU-15, which have shared a common market for much longer than the EU-10. The two interaction terms generally have opposite signs in each country group. While wages in the EU-15 seem to broadly reflect wage levels abroad (at least in the most successful export industries), this is also the case for a number of EU-10 industries (namely agriculture, mining, wood, mechanical machinery, transport equipment and financial intermediation). Here, wages are strongly aligned with labor productivity – a channel which is reinforced by increased trade openness. Many of the above-mentioned industries also exhibit a strong export growth performance, and this alignment effect is also evident in the slowly growing export industries. All in all, we find more evidence in the EU-10 for wage setting being in line with domestic productivity levels rather than with wage levels abroad. Finally, while foreign wages are rarely significant for the wage level, except in the fast growing

<sup>24</sup> 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.

<sup>25</sup> One of the referees suggested weighting foreign wages by import shares. This would require bilateral trade data, which were only available for trade in goods, but not for services.

Table 6

**Wage-Disciplining Effect of Trade in the EU-15 - Breakdown by Industries' Export Performance**

	Import ratios			Export ratios		
	Export growth performance			Export growth performance		
	fast	moderate	slow	fast	moderate	slow
Lagged wages	0.4334 *** 6.26	0.363 *** 7.41	0.4031 *** 4.66	0.4107 *** 5.74	0.3402 *** 7.1	0.4438 *** 5.57
Unemployment	-0.0071 *** -3.12	-0.0056 *** -3.59	-0.0043 ** -2.13	-0.0073 *** -3.18	-0.0059 *** -3.89	-0.0045 ** -2.52
Productivity	0.1079 *** 2.28	0.217 *** 7.06	0.2825 *** 5.65	0.1118 ** 2.31	0.2342 *** 7.3	0.2701 *** 4.98
Trade ratio	0.0013 *** 2.57	0.0009 0.12	0.046 ** 2.34	0.0026 ** 2.32	0.0218 *** 2.86	-0.0062 -0.76
Trade ratio/rest of the economy	0.0463 * 1.89	0.0414 ** 2.05	-0.0074 -0.3	0.0498 ** 2.16	0.0229 1.19	-0.0059 -0.26
Trade openness	-0.2533 *** -2.88	-0.238 *** -5.34	-0.1898 *** -3.16	-0.2442 *** -2.74	-0.2348 *** -5.28	-0.2014 *** -3.28
Wage (EU)	0.1726 ** 2.48	0.1482 *** 3.97	0.1602 *** 3.11	0.1666 ** 2.36	0.1416 *** 3.81	0.158 *** 3.09
Wage (EU) * trade openness	0.0127 *** 3.68	-0.0005 -0.08	0.0124 0.43	0.0134 *** 3.64	0.0067 1.58	0.0317 0.98
Productivity * trade openness	-0.0148 *** -3.07	0 0.01	-0.0257 -1.13	-0.0153 *** -3.12	-0.0085 ** -2.39	-0.0181 -0.79
Constant	0.9443 *** 3.78	0.7481 *** 4.42	0.4278 1.61	1.0127 *** 3.92	0.768 *** 4.24	0.3716 1.49
Number of observations	861	1233	495	861	1233	495
Number of countries/industries	97	140	56	97	140	56
Chi <sup>2</sup>	403.5781	289.227	231.1303	380.3538	275.1158	290.6724
z-value (AR-1)	-3.9228	-5.2014	-3.169	-3.8094	-4.937	-3.4469
z-value (AR-2)	-0.7138	1.7024	2.3401	-0.7769	1.5762	2.3761

Source: Authors' estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed |1.96| and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

industries, the interaction terms often are so – an observation which generally confirms the assumption that productivity gains in relevance against foreign wages when trade intensifies.<sup>26</sup>

Thus, our results confirm Persyn's (2008) hypothesis that trade acts as a disciplining force on wages in the EU-10; but this does not hold for the EU-15. In the Western European countries, productivity seems to matter less – and foreign wages seem to matter more – for wage setting when the degree of trade openness rises. This is interesting, as we analyzed broadly the same group of countries as Persyn, although for different periods of time (1980–2001 versus 1995–2005), but came up with opposite results.<sup>27</sup> Also, our model applied to the EU-25 again

<sup>26</sup> Again, all individual sector results are available upon request.

<sup>27</sup> This difference remains valid when we replicate Persyn's analysis, using exactly the same variables as he does (i.e. building his measure of "trade freeness"), but applying a different estimation method (for the longer sample period, Persyn estimates an error correction model while we use a dynamic panel estimation as the time dimension in our sample is smaller).

Table 7

**Wage-Disciplining Effect of Trade in the EU-10 – Breakdown by Industries' Export Performance**

	Import ratios			Export ratios		
	Export growth performance			Export growth performance		
	fast	moderate	slow	fast	moderate	slow
Lagged wages	0.6613 *** 5.19	0.2574 ** 2.51	0.1291 1.1	0.7075 *** 5.56	0.2628 *** 2.58	0.1053 0.87
Unemployment	-0.0098 *** -3.55	-0.0086 ** -2.14	-0.0024 -0.75	-0.0086 *** -3.18	-0.0084 ** -2.16	-0.0025 -0.8
Productivity	0.1756 *** 2.77	0.5617 *** 6.48	0.5488 *** 12.42	0.1597 ** 2.5	0.5811 *** 6.64	0.552 *** 12.89
Trade ratio	0.0003 *** 4.21	0.0122 ** 2.38	0.034 *** 2.7	0.0008 1.61	0.0086 1.18	0.0171 1.09
Trade ratio/rest of the economy	0.0046 0.4	-0.0243 * -1.92	-0.0071 -0.55	0.0244 * 1.76	-0.0241 -1.3	0.0046 0.3
Trade openness	-0.0841 -1.41	-0.1437 * -1.83	-0.0011 -0.01	-0.048 -0.87	-0.1435 * -1.85	0.0109 0.14
Wage (EU)	0.2769 *** 2.98	0.1177 0.95	-0.0287 -0.26	0.221 ** 2.51	0.118 0.95	-0.0756 -0.69
Wage (EU) * trade openness	-0.0002 *** -3.29	-0.0006 -0.05	-0.0367 *** -3.25	-0.0001 ** -2.32	0.0122 1.19	-0.0115 -1.66
Productivity * trade openness	-0.0001 -0.42	0.0024 0.11	0.0261 *** 3.03	-0.0007 -1.38	-0.0142 -0.73	0.0192 ** 2.22
Constant	-0.5059 * -1.94	-0.2086 -0.81	0.392 * 1.8	-0.4313 -1.63	-0.2533 -0.97	0.5167 ** 2.11
Number of observations	780	630	450	780	630	450
Number of countries/industries	89	70	50	89	70	50
Chi <sup>2</sup>	434.2955	215.9168	361.4122	576.9414	270.8576	257.8177
z-value (AR-1)	-3.1626	-2.0837	-1.6883	-3.5052	-2.2047	-1.4837
z-value (AR-2)	-0.1269	-0.0146	1.362	-0.0833	0.1069	1.7072

Source: Authors' estimates.

Note: The dependent variable is the log real hourly wage, deflated by the CPI. t-ratios are reported below each coefficient, \*(\*\*)[\*\*\*] indicate significance at the 10% (5%) [1%] level or below. z-values indicate the significance of a test on autocorrelation (AR) in the residuals, whereby the first order z-value should exceed |1.96| and the second order z-value should be below this level in order to indicate that the dynamic estimation is appropriate.

reflects more closely the behavior in the EU-10, as in our previous trade-only model. This may be related to the generally greater trade openness of the EU-10, which makes them more responsive to trade developments.

To conclude, trade seems to strengthen wage discipline primarily in Eastern Europe by forcing wage setters to align wages with productivity rather than with wage developments recorded by the main trading partners. In other words, we find little support for factor price equalization. In fact, greater trade openness actually enhances wage discipline in the countries concerned. In contrast, no such evidence is found for the EU-15, where wages are strongly positively influenced by foreign wages, an effect which is reinforced by trade in the fastest growing industries.

In order to draw any conclusions from the above results for the two candidate countries Croatia and FYR Macedonia, we base our assessment on the results for the EU-10, given their greater structural similarity. Given the stylized facts for these countries obtained from section 3 and the wage response we can expect on the basis of the general results in this section, we cannot say much about how wages in Croatia might react to increased trade openness. Due to difficulties in

matching trade data to output data for the tourism sector, we have not included this sector in our analysis. However, the comparatively high wage increase in Croatia over the past decade, coupled with strongly increasing travel exports, suggests a rather positive relationship in this particular case. For FYR Macedonia, the picture is rather mixed: We would expect some positive effects on wages from opening up to trade in the metal industry, where a positive direct correlation could be observed in both subsamples (EU-10 and EU-15). However, trade openness in other economic sectors was often associated with downward pressure on wages in the same industry. Hence, the overall effect of a more open trade environment might well lead to a negative wage response in FYR Macedonia with its high export concentration on metals and textiles.

Furthermore, FYR Macedonia is heavily specialized in slow and moderately growing export industries that feature no significant relation between trade and wages (in the slowly growing sectors) or a negative net effect (in moderately growing sectors). Hence, increased trade openness most likely implies a challenge to redistribution policies and the need for successfully managing structural change in FYR Macedonia. The picture for Croatia is entirely different, given its completely different specialization patterns and the much higher importance of service activities.

## 5 Summary and Conclusions

In this paper we investigate the effects of increased economic integration on the labor market. More specifically, we examine the impact of higher import and export ratios on average wage levels in the EU-25, distinguishing between pre- and post-2004 Member States (i.e. EU-15 and EU-10). The literature on this topic is vast and, as a whole, inconclusive, pointing toward specific factors that condition the wage response to increased economic openness. Two large strands of empirical research can be distinguished. The first relies on microdata and is able to incorporate many individual-specific wage determinants, while the results often cannot be generalized to apply to countries other than the one under review. The second approach focuses largely on macroeconomic effects and may thus hide different relations within individual activities of an economy. In this paper, we investigate the relation 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. A novelty of the present paper is that it takes a comprehensive view on all sectors of the economy, treating manufacturing and service activities alike. This adds value to the analysis as services sectors often turn out to exhibit a more positive relation between trade and wages in the EU-10. Furthermore, we work with a greater level of disaggregation at the macro level than many previous studies. Previous literature has often limited its focus to manufacturing industries as trade data are more easily available. At the same time, the inclusion of data on the services sectors in this paper likewise implies a limitation as good bilateral trade data for services are not available and it is thus not possible to investigate the differential impact of trade with specific trading partners (i.e. high-wage versus low-wage countries) on wages.

Given a certain inconclusiveness of both the theoretical and empirical literature, we take an agnostic view and use a simple model, which encompasses domestic wage determinants together with various measures of trade penetration. We find considerable differences in the relation between wages and trade in individual economic activities, which are not easy to generalize.

As a first result, trade often cannot be identified as a decisive factor in determining wage levels. What may appear to be a non-result is actually quite positive, since in public opinion, trade – and more generally “globalization” – is often associated with having a negative influence on the labor market. Resource-based industries appear to exhibit a statistically significant correlation between trade and wages more frequently than most other industries. However, a few exceptions aside, the economic impact of trade on wages is rather small.

Considerable differences exist between the EU-15 and the EU-10. First, the CEE Member States appear to have been dominating the average results for the EU-25 – which is less surprising when we consider that, in general, these countries are smaller economies and therefore more open to trade. In addition, the EU-10 have undergone a dynamic phase of restructuring accompanied by often high and persistent unemployment rates – all these factors would make wages more responsive to changes in the economic environment. Second, the aggregate net effect of trade on wages seems to be negative in a range of mostly labor-intensive and low-skill industries for the EU-15, since greater openness (at the macro-economic level) is usually associated with lower wage levels in this group. On average, an increase in openness by 10 percentage points would relate to a 1% decrease in wages. While this is certainly a negative, albeit minor effect, no such generally negative relation was observed in the EU-10 industries. Third, wages in fast growing industries (in terms of export performance) seem to profit from increased imports and exports in other sectors of the economy. In this respect, no discernible effects from intra-industry trade could be identified for the EU-10, whereas the EU-15 clearly show a positive – albeit very small – effect from both imports and exports in the respective industry in addition to positive cross-industry effects.

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 labor and become less strongly aligned with foreign wages. We observe little evidence of wage co-movement in the sense of foreign wages having a strong impact on domestic wages in the EU-10, while in Western Europe wages tend to move together in many sectors across countries. Moreover, trade can enhance wage discipline, as with a higher degree of trade openness wages are set in line with productivity rather than with foreign wages. This observation only holds for the EU-10, however, while in the EU-15 we find opposite results.

Overall, we find that increased trade has both negative and positive effects on wages. Yet most of these effects are extremely small, which is why trade cannot be seen as a decisive factor in wage formation. This is in line with the results of previous studies. Furthermore, we can identify certain sectors where the significant effects prevail even when more sophisticated estimation techniques based on instrumental variables are used. In many studies, all trade effects vanish when instruments are used in the estimation. We would like to stress that even though the effects of trade on wages are small and specific to certain sectors only, more

openness to trade cannot generally be associated with lower wages. In particular for the EU-10, but also in the results for the EU-25 and the EU-15, the number of sectors exhibiting positive direct wage effects from trade exceeds the number of sectors exhibiting negative effects. In many sectors (especially in those where no direct relation between trade and the wage level in the respective industry could be established), we note a generally negative relation between country openness and wages, however. Therefore, economic policy has to be carefully designed when addressing questions of increased trade integration and its wage effects. In particular, resource-based and network industries often emerge as winners from increased trade. However, losers emerge as well, especially when calculating the net effect from increased openness and sector-specific effects. Moreover, wage inequality across activities within a country is possibly reinforced by trade. This is to be expected as in general, sectors that are booming and are thus paying better wages are more likely to profit from increased trade integration, while stagnating and hence low-wage sectors are more likely to come under wage pressure.

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, etc. For instance, a useful distinction is often made between wages of low- and high-skilled workers. 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 labor force – and therefore we did not elaborate further on this issue, but this might be worth investigating further. Overall, before drawing detailed policy conclusions, we see a need for continued careful research as well as for an improvement of the available statistics to provide researchers with meaningful input for comparative analyses.

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## 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 first, using annual exchange rates from the IMF WEO database. Trade data as obtained from UN Comtrade and Eurostat ITS were reported in U.S. dollars and converted into euro by using the annual ECU-EUR/USD exchange rates from the Main Economic Indicators database of the OECD, since no conversion USD/ECU 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, CPI-deflated	EUR
Productivity	EU KLEMS	Labor productivity = gross value added (GVA) in the respective sector deflated by the GVA price index and divided by hours worked	EUR
Import ratio	UN Comtrade/EU KLEMS	Imports from the world deflated by the gross output price index and divided by the gross value added deflated by the GVA price index	ratio
Import ratio/rest of the economy	UN 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	UN Comtrade/EU KLEMS	Same as import ratio, using exports	ratio
Export ratio/rest of the economy	UN Comtrade/EU KLEMS	Same as import ratio/rest of the economy, using exports	ratio
Trade openness	IMF WEO/ EU KLEMS	Total export plus import volume vis-à-vis the world, divided by the GVA-deflated gross value added of all sectors	ratio
Wage (EU)	EU KLEMS	Sum of CPI-deflated labor compensation in all countries except the respective country, divided by hours worked	EUR
Unemployment	WEO	Unemployment rate	%
CPI	WEO	Consumer price index	2000=100

## Appendix 2: Grouping of Industries by Export Performance

In order to classify industries as slowly, moderately and fast growing industries in terms of exports, we referred to the average growth of world trade volume in our observation period. Accordingly, our upper limit for slow growth was 30%, the rate at which real world exports grew cumulatively between 1995 and 2005 according to WTO figures, while anything beyond 100% was defined as fast growth performance. Consequently, growth figures of above 30% and below 100% were defined as moderate. The full list of individual industries and their growth performance within the regional average is given in table A2 below.

Table A2

### Grouping of Industries by Export Performance

EU-15		EU-10	
NACE code	Industry	NACE code	Industry
<b>Fast growing exports</b>			
23	Oil refining and products	30t33	Electrical and optical equipment
64	Communication	34t35	Transport equipment
K	Other business services	25	Rubber
J	Financial intermediation	E	Utilities
24	Chemicals	29	Mechanical machinery
E	Utilities	36t37	Other manufacturing
30t33	Electrical and optical equipment	23	Oil refining and products
		21t22	Paper and printing
		20	Wood
<b>Moderately growing exports</b>			
34t35	Transport equipment	26	Minerals
C	Mining	15t16	Food products
25	Rubber	24	Chemicals
60t63	Transportation	K	Other business services
20	Wood	27t28	Metals
27t28	Metals	60t63	Transportation
36t37	Other manufacturing	AtB	Agriculture
29	Mechanical machinery		
AtB	Agriculture		
15t16	Food products		
<b>Slowly growing exports</b>			
21t22	Paper and printing	17t19	Textiles and clothing
26	Minerals	J	Financial intermediation
17t19	Textiles and clothing	64	Communication
F	Construction	C	Mining
		F	Construction