European Integration and National Labor Markets -

On the Factor Content of Intra-European Trade Flows

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Abstract

In recent decades, the international division of labor expanded rapidly in course of globalization. In this context, highly developed countries specialized on (human-)capital intensively manufactured goods and increasingly sourced parts and components from low wage countries. Since this should be beneficial for the high-skilled and harmful for the lower-qualified workforce, especially the opening up of Eastern Europe and the international integration of Newly Industrializing Asian economies is considered as a main reason for increasing unemployment of the low-skilled in high-wage countries. The present paper addresses this issue for selected Western European countries by analyzing factor content of trade, which allows inferring on factor demand patterns and adjustment effects resulting from international trade. This is not only done for countries' total, but also for bilateral trade flows. Thereby, differences in factor inputs, production technologies and thus product differentiation are considered. According to the results, bilateral trade between Western European high-wage countries should entail low labor market adjustment, since factor content of exports and imports does hardly differ. However, the results are different for East-West trade, since exports from Western to Eastern Europe are distinctly more human-capital intensively manufactured than imports of Western European high-wage countries from Eastern Europe.

Keywords: European Integration, International Trade, Labor Markets, Input-Output Analysis

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1. Introduction

In recent decades, the international division of labor expanded rapidly in course of globalization. Since 1980, world production grew about 270% in real terms. In contrast, world trade in goods and services more than quintupled in this period. In this context, highly-developed countries did increasingly specialize on (human-)capital-intensively manufactured goods and sourced labor-intensively manufactured products and particularly parts and components from low-wage countries. Hence, especially the opening up of Eastern Europe and the international integration of the Newly Industrializing East Asian Economies is considered as the main reason for increasing unemployment of the lower-qualified in high-wage countries, since international trade should favor the high-skilled in those countries. The present paper addresses this question by analyzing the factor content of total as well as of bilateral, intra-European trade flows of selected EU Member States, where the focus is on two input factors: 'high-skilled' workers on the one hand and 'lower-qualified' labor on the other. Since (human-)capital-abundant countries should, according to the neoclassical Heckscher-Ohlin-model of trade, specialize on and export (human-)capital-intensively manufactured goods and, in reverse, import more labor-intensively manufactured products, exports of these countries should embody more high-skilled factor services than imports. Hence, factor content of trade allows inferring on countries' factor demand patterns resulting from international trade. Thereby, labor market adjustment effects induced by European Integration can be identified for single EU Member States. As the analyses show, the results do largely depend on whether product differentiation is allowed for or not. Whereas adjustment effects emanating from bilateral trade between the Western European countries seem to be quite low even in case of product differentiation, the opposite is the case for East-West trade.

The following section 2 contains a description of the theoretical background and the model used for calculating factor content of trade as well as a review of the literature. In section 3, international trade patterns and factor endowments of selected EU Member States will be analyzed in order to assess specialization patterns and possible adjustment effects induced by international trade. Afterwards, in section 4, factor content of total and bilateral trade flows of five Western European countries are calculated by applying input-output techniques. Additionally, the validity of the theoretical model underlying the calculations is examined. Finally, section 5 closes with some concluding remarks on labor market effects of European integration.

2. Theoretical Background

One of the main theoretical foundations for explaining international trade patterns and their consequences on factor demand and income distribution in trading partner countries is the classical Heckscher-Ohlin (HO) model of trade. According to the latter, international trade flows arise from comparative advantages, resulting from differences in countries' factor endowments. Hence, bilateral trade volumes should be the higher, the more countries differ with respect to factor endowments, since each country will then specialize on and export commodities utilizing its abundant and thus comparatively cheap factors of production. In contrast, goods utilizing a countries' scarce factors of production will be imported. A modification of the traditional HO-Model suggests that, under the assumption of balanced trade, identical production technologies, identical and homothetic preferences across countries, no factor intensity reversals and free trade, international trade accomplishes the task of exchanging the services of production factors embodied in tradable goods (and services). Hence, this Heckscher-Ohlin-Vanek (HOV) version of the classical HO-Model implies that countries should have a net export of relatively abundant factor services and a net import of relatively scarce factor services (Vanek 1968). As a consequence, factor prices should converge in the course of countries' specialization. Whereas prices of countries' scarce production factor(s) should decline, prices of the abundant factor(s) should increase until factor prices are equalized across countries.[1] Thereby, factor content of trade serves as an indicator for adjustment effects on factor markets induced by international trade. For instance, a net export of high-skilled labor services and, as a consequence thereof, a net import of lower-skilled labor services, which is usually the case for high-wage countries, should be beneficial for the higher qualified workforce and harmful for the lower-qualified in the countries concerned. In the following, the HOV-Model shall be formally derived.

Beside direct factor inputs, the production of one good in industry *i* does normally require intermediate inputs from other industries in order to produce country *m's* (gross) output $\mathbf{Y}^{\mathbf{m}}_{\mathbf{gross}}$ in industries *i*. These are captured by the (*i* x *i*) input-output-matrix of country *m*, which can be easily transformed into a technical coefficients matrix, denoted as $\mathbf{A^m}$. Each element in $\mathbf{A^m}$ shows the units of input from different industries necessary for producing one unit of output in industry *i*. Hence, under the presence of intermediate inputs, the interrelationship between gross and net output is given by,

$$Y^m_{net} = (I - A^m)Y^m_{gross} \tag{1}$$

where **I** represents the (*i* x *i*) identity matrix. Assuming that $(\mathbf{I}\text{-}\mathbf{A^m})$ is invertible, a (*f* x *i*) matrix of total (direct and indirect) factor input requirements, indicating the required amount of different production factors *f* for producing one unit of output in each industry *i*, of country *m* $\left(\mathbf{B}^{\mathbf{m}}_{\mathbf{total}}\right)$ can be defined as:

[1] Of course, in the real world, factor price equalization is hardly to observe. But even in the absence of factor price equalization as well as homothetic preferences, exports of a capital-abundant country will embody a higher capital-labor ratio than exports of a labor-abundant country (Brecher and Choudhri (1982), Helpman (1984)).

$$B_{total}^{m} = B^{m}\left(I - A^{m}\right)^{-1} \quad (2)$$

Whereas $\mathbf{B^m}$ denotes the (*f* x *i*) direct factor input matrix and $\mathbf{A^m}$ the technical coefficients matrix computed from the input-output table of country *m*, **I** represents again the identity matrix. The matrix $\mathbf{B_{total}^m}$ can either be used to determine the factor content of country *m's* net exports or, alternatively, for calculating the factor content of exports and imports separately.[2] For calculating the factor content of net exports, assume that $\mathbf{Y_{net}^m}$ stands for the (*i* x 1) net output vector of industries *i* in country *m* and $\mathbf{D^m}$ denotes country *m's* (*i* x 1) domestic demand vector for goods of each industry *i*. The difference between domestic production and domestic demand yields the (*i* x 1) net trade vector of country *m* $\left(\mathbf{T_{net}^m}\right)$:

$$T_{net}^{m} = Y_{net}^{m} - D^{m} \quad (3)$$

The factor content of country *m's* net exports $\mathbf{F^m}$ is thus determined by net exports times the (direct and indirect) factor input matrix in production:

$$F^{m} = T_{net}^{m} B_{total}^{m} = T_{net}^{m} B^{m} (I - A^{m})^{-1} \quad (4)$$

On the basis of equation (4), (net) employment effects of international trade can be determined for different factors of production. Thereby, it is assumed that exports are associated with job creation, whereas imports are coming along with domestic job losses, since with increasing imports, domestic production will *ceteris paribus* be reduced.

According to the HO-Model, factor content of trade should be determined by countries' factor endowments. If all countries would share a common technology matrix $\mathbf{B_{total}}$, under the assumption of full employment, factor endowment of country *m* ($\mathbf{V^m}$) should equal factor input in production (left-hand side of equation (5)):

$$B_{total} Y_{net}^{m} = B(I - A)^{-1} Y_{net}^{m} = V^{m} \quad (5)$$

Accordingly, world factor endowment (V^{w}) must equal factor input in world production, as denoted in equation (6):

$$B_{total} Y_{net}^{W} = B(I - A)^{-1} Y_{net}^{W} = V^{W} \quad (6)$$

[2] Thereby, it would be assumed that imports are manufactured with the same production technologies as domestically manufactured import substitutes. This problem will be addressed later on.

If preferences are homothetic across countries, country *m's* vector of final goods demand ($\mathbf{D^m}$), under market equilibrium, equals the world output vector $\left(\mathbf{Y_{net}^W}\right)$ times country *m's* share in total world expenditure (s^m):

$$D^m = s^m Y_{net}^W \qquad (7)$$

By multiplying equation (7) with the common technology matrix $\mathbf{B_{total}}$, it follows that:

$$B_{total} D^m = s^m V^W \qquad (8)$$

Subtracting equation (8) from equation (6) yields the following equation (9) of the HOV-model:

$$B_{total} T_{net}^m = F^m = V^m - s^m V^W \qquad (9)$$

The left-hand side of equation (9) depicts the so called measured factor content of trade ($\mathbf{F^m}$), which consists of a total (direct and indirect) coefficients matrix of factor inputs and a net trade vector of country *m*. The right-hand side of equation (9) represents the predicted factor content of trade of country *m*, resulting from endowment differences between country *m* and total world (Leamer 1980). Hence, according to the HOV-Model, endowment differences should result in (net) exports of factor services.

However, an empirical test of the HOV-model for the United States performed by Leontief (1953) seemed to disprove the hypothesis that countries' patterns of specialization are determined by factor proportions. In a model with two production factors (capital and labor), Leontief disaggregated the U.S. economy into 50 industries, of which 38 produced tradable goods. He showed that in 1947, U.S. imports were 30% more capital-intensive than U.S. exports, although at that time, the U.S. were considered as one of the most capital-abundant countries in the world. For this Leontief paradox, different theoretical explanations were developed. Firstly, it is imaginable that countries' comparative advantages are not only determined by supply-side, but also by demand-side factors. For instance, a home bias of consumers in a capital-abundant country could increase prices of capital-intensively manufactured domestic goods, in which the country would otherwise have comparative advantages (Salvatore 2001). Secondly, the Leontief paradox might be explained by factor intensity reversals. If a good is labor-intensively manufactured in one country, but capital-intensive in another, the labor abundant country should, according to theory, export the labor-intensively manufactured product. However, in the case prescribed above, it must do so in exchange of a good which is labor-intensively manufactured in the other, capital abundant country. Hence, if the first country satisfies the HO-theorem, the other cannot do so. Thirdly, trade barriers might distort international trade flows, leading do a divergence of factor endowments and trade patterns. But probably the most important reason for the Leontief paradox are differences in labor force qualifications. If labor force would have been subdivided into human-capital and lower-qualified labor, the measured factor content of U.S. exports and imports would probably have been in line with the predictions of the HOV-model of trade (Baldwin 1971, Kravis 1956). Additionally, the quality of the labor force determines the effective supply of labor. Although in the U.S., labor was numerically small in relation to the capital stock in the 1950s already, effective labor supply was comparatively large due to higher labor productivity. Hence, the U.S. should have been classified as labor abundant (Trefler 1993). In this context, knowledge capital resulting from R&D is another important factor determining a countries' pattern of trade, since both should increase the value of output at a given stock of material and labor resources. In the meantime, it is widely accepted that, beside trade barriers, the missing distinction between higher- and lower-qualified labor is the main reason for the Leontief paradox.

So far, several analyses investigating the factor content of trade for different countries exist, whereof many are mainly focused on testing the HOV-theorem. However, a critical concern could be that the bulk of these studies assume identical production technologies and factor inputs across countries for calculating factor content of countries' net trade, as e.g. Engelbrecht (1996) for Germany, Webster (1993) for the UK, Wicksell (2005) for Sweden or Dasgupta et al. (2009) for India. Actually, production technologies between trading partner countries might differ considerably, especially with respect to North-South or, in Europe, East-West trade. More recent empirical analyses investigating factor content of trade on a bilateral level are using technology matrices of both, the exporting and the importing countries (e.g. Lundberg and Wiker (1997), Torstensson (1998), Davis and Weinstein (2003), Choi and Krishna (2004) or Nishioka (2006)). However, all of these analyses are restricted to highly developed OECD countries, which do probably share quite similar production technologies and factor endowments. The same holds for the few analyses focused on EU Member States. Consequently, the degree of specialization and the adjustment effects resulting from bilateral trade of these countries should be rather low. Although Hakura (1999) found for EU Member States that the HOV-model performs quite well if different technology matrices are used for the countries regarded, only bilateral trade relations between the Western European countries Belgium, Germany, France, Italy, and the Netherlands were considered. Only Cabral et al. (2006 and 2009) focused on trade between high-income countries (the U.K. and others, respectively) and middle-income countries. However, for the former, only the United Kingdoms' and for the latter, only the Portuguese technology matrix were used and considered as representative. Nevertheless, the results show that with different technology matrices, factor contents of exports and imports differ quite reasonably.

Against this background, the present study will analyze the factor content of intra-European trade flows between selected Western, but also between Western and Eastern European countries. Thereby, total labor force is subdivided into human-capital and lower-qualified labor in order to determine possible adjustment effects on labor markets arising from international trade between EU Member States, for both, the high-skilled and the lower-qualified workforce.

3. International Trade Patterns and Factor Endowments of EU Member States

Before analyzing the factor content of intra-European trade flows, international trade patterns and factor endowments of EU Member States shall be regarded. Theoretically, international trade can be subdivided into inter- and intra-industry trade. Inter-industry trade is, according to traditional trade theories, mainly traced back to differences in relative prices emerging either from different factor productivities (Ricardo) or factor endowments between countries (Heckscher-Ohlin), or to different patterns of demand. As described above, countries will specialize on commodities manufactured with the domestically abundant production factors and will thus exchange goods emanating from different industries. As a consequence, trade-induced reallocation will divert resources between sectors. Thereby, in each country income will be re-distributed from the scarce to the abundant factors of production (Stolper and Samuelson 1941). In contrast, intra-industry trade (IIT), i.e. the exchange of products emerging from the same industries, was for a long time supposed to involve little labor market adjustment (*smooth adjustment hypothesis*, Balassa 1966). Initially, monopolistically competitive markets and increasing returns to scale, offering especially producers in larger countries the opportunity to realize competitive advantages through specialization, served as the theoretical basis for IIT (Krugman (1979), Lancaster (1980) and Helpman (1981)). Further analysis about the impact of product differentiation on foreign trade goes back to Linder (1961). Accordingly, there is a positive correlation between product-quality, prices and the income levels of consumers. Consequently, international differences in per capita incomes and income distributions between countries would imply diverging consumer preferences with respect to quality and prices and should thus reduce the exchange of homogenous goods. Therefore, international trade between high-income countries with similar levels of development should be mainly intra-industry.

Over time, intra-industry trade was subdivided into the above prescribed *horizontal* IIT on the one hand and *vertical* IIT on the other. Especially the latter kind of IIT gained more and more interest in recent years. In the approach of Falvey (1981) and Falvey and Kierzkowski (1987), vertical IIT basically follows traditional endowment-based models. Other than in the Heckscher-Ohlin approach, capital is sector-specific, whereas labor is assumed to be mobile between sectors. In the two-country-two-goods case where each country produces a capital-intensive and a labor-intensive good, the capital-intensive good is vertically differentiated, i.e. produced in different qualitative varieties, whereas the labor-intensive good is homogeneous. The model suggests that higher-quality varieties of a product require comparatively high (human-)capital-intensities in production, whereas lower-quality varieties of a product are manufactured more labor-intensive. As a consequence, (human-)capital abundant countries will produce and export high-quality varieties of the (human-)capital-intensive good and in return import lower-quality varieties of the capital-intensive as well as the labor-intensive good. Subsequently, even parts of intra-industry trade might be explained by differences in factor endowments between trading partner countries and could thus entail labor market adjustment just as inter-industry trade (Cabral et al. 2006).[3]

On the basis of countries' international trade patterns, it is possible to identify the share of international trade (in total trade) probably resulting from endowment differences and involving adjustment effects on factor markets. This kind of trade should be characterized by divergent factor contents of exports and imports and hence divergent patterns of factor demand in trading partner countries. Empirically, the Grubel-Lloyd-Index (Grubel and Lloyd 1975) depicted in equation (10) is used to determine the share of inter- and intra-industry trade in country *m's* total trade:

$$IIT_m = \frac{\sum_{i=1}^{I}\left(X_{im} + M_{im}\right) - \sum_{i=1}^{I}\left|X_{im} - M_{im}\right|}{\sum_{i=1}^{I} X_{im} + M_{im}} \qquad (10)$$

Whereas IIT_m depicts intra-industry trade coefficient of country *m*, X_{im} stands for exports in product groups *i* of country *m* to the rest of the world and M_{im} represents country *m's* imports in product group *i* from the rest of the world. If all trade between country *m* and the rest of the world would be intra-industry, the Grubel-Lloyd index would equal one, and if all trade would be inter-industry, the index would equal zero. As described above, intra-industry trade can be further subdivided into horizontal and vertical IIT. Again, the first component represents the exchange of commodities originating from the same product group and differentiated at best by attributes, whilst the latter represents trade in commodities of different quality, requiring different factor intensities in production. It is assumed that differences in quality are reflected by differences in prices, which can be proxied by unit values. The generally applied indicator for quality differences are thus unit values calculated per ton (Abd-el-Rahman 1991, Greenaway, Hine and Milner 1994). In the following, horizontal intra-industry trade will be defined as the simultaneous export and import of a 4-digit-HS (*Harmonized System*) item where the unit value of exports relative to the unit value of imports is within a range of ±15%, denoted as α. This range is generally used for disentangling horizontal and vertical intra-industry trade, because it seems to be feasible that other factors than quality differences, like for instance transportation and other freight costs,

[3] Another vertical intra-industry trade model developed by Flam and Helpman (1987) is in line with the Ricardo approach for inter-industry trade and says that the source of quality differentiation is not the (human-)capital-intensity of production, but the technology used. Consequently, technologically advanced countries have comparative advantages in higher-quality varieties of a product.

are unlikely to account for a difference in unit values of more than 15% (Blanes and Martin 2000). Hence, the formula for identifying horizontal IIT takes the following form:

$$1-\alpha \leq \frac{UV_{im}^{X}}{UV_{im}^{M}} \leq 1+\alpha \tag{11}$$

Whereas UV_{im}^{X} denotes unit value (Euro per ton) of country *m's* exports in product group *i* to the rest of the world, UV_{im}^{M} stands for unit value of country *m's* imports in product group *i*. All intra-industry trade not classified as horizontal by equation (11) is then considered as vertical IIT.

Table 1: Trade Patterns of selected EU Member States

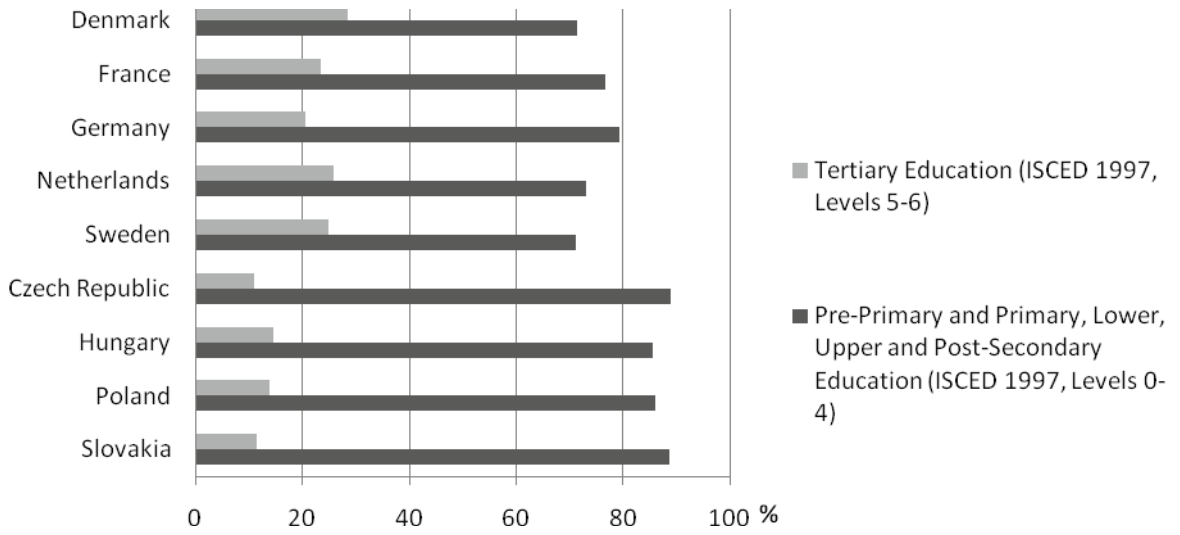
	Inter-industry trade coefficient	*Intra-industry trade coefficient (IIT)*	*Horizontal IIT coefficient*	*Vertical IIT coefficient*
Denmark	0,40	0,60	0,15	0,45
France	0,31	0,69	0,35	0,34
Germany	0,34	0,66	0,22	0,44
Netherlands	0,27	0,73	0,19	0,54
Sweden	0,42	0,58	0,20	0,38

Sources: EUROSTAT, own calculations

Table 1 depicts international trade patterns of five selected Western European countries. As could be expected for highly developed countries, international trade is largely intra-industry. With the exception of Denmark and Sweden, this is the case for two thirds up to three quarters of countries' international trade. However, for all countries, intra-industry trade is mainly vertical in nature. Hence, the bulk of intra-industry trade might be, similarly like inter-industry trade, due to different factor endowments, which should favor the higher-skilled workforce in (human-)capital-abundant countries. In contrast, classical horizontal IIT, for which the smooth adjustment hypothesis should hold, accounts for less than one fourth in countries' total trade, France being the only exception.

Against this background, the question arises which patterns of specialization countries will choose in inter- and vertical intra-industry trade. These should be mainly determined by (differences) in factor endowments. Since in the present paper, the effects of international trade on demand for high-skilled and lower-qualified labor shall be investigated, especially countries' endowments with the latter two production factors is of particular importance. Figure 1 depicts the shares of high-skilled (persons with tertiary education) and lower-qualified in countries' total population in 2005. In addition to the Western European countries contained in table 1, some Eastern European economies are added for comparison. As can be seen from figure 1, the share of human- capital in total population is, as expected, higher in Western than in Eastern European countries. Interestingly, in Germany, the share of high-skilled in total population is comparatively low compared to the other four Western European countries, and not much higher than in Poland and Hungary. However, the figures indicate that Western European countries are supposed to specialize on (human-)capital-intensively manufactured goods. This should hold for inter- as well as for vertical intra-industry trade

Figure 1: Shares of High-Skilled and Lower-Qualified in Total Population in 2005



Sources: EUROSTAT, own calculations.

relations. In contrast, Eastern European countries, which became increasingly important trading partners for Western European countries in the last two decades, should rather specialize on more labor-intensively manufactured goods or product varieties. Hence, it must be assumed that East-West trade is harmful for the lower-qualified in Western European countries. In the following empirical analyses, these specialization patterns (and possible backlashes on factor demand) shall be identified by investigating the factor content of trade flows of selected countries in more detail.

4. Empirical Analyses

4.1 Methodological Issues

In the following section, factor content of country *m's* trade shall be determined in two different ways. Initially, equation (4) will be taken as a basis for calculating country *m's* factor content of trade. However, unlike in equation (4), factor content of exports and imports shall be calculated separately.[4] Thereby, it is possible to estimate possible adjustment effects for different skill groups induced by imports on the one hand and on factor demand for export production on the other. Therefore, total (direct and indirect) factor input matrix $\mathbf{B}^{\mathbf{m}}_{\mathbf{total}}$ will be multiplied with the (i x 1) export ($\mathbf{Ex^m}$) and import ($\mathbf{Im^m}$) vectors of country m, depicting country *m's* total exports and imports, respectively, in industries i. Hence, factor content of country *m*'s exports (F^m_{Ex}) is calculated by the following formula (12):

$$F^m_{Ex} = Ex^m B^m_{total} = Ex^m B^m \left(I - A^m\right)^{-1} \tag{12}$$

Likewise, factor content of imports ($\mathbf{F}^{\mathbf{m}}_{\mathbf{Im}}$) will be calculated by multiplying the total factor input matrix $\mathbf{B}^{\mathbf{m}}_{\mathbf{total}}$ with country *m's* import vector:

$$F^m_{\mathrm{Im}} = \mathrm{Im}^m B^m_{total} = \mathrm{Im}^m B^m \left(I - A^m\right)^{-1} \tag{13}$$

Of course, the methodology described above rests upon the assumption that imported commodities are manufactured abroad with the same technology and factor inputs as domestic import substitutes. In this case, imports would be perfectly homogeneous to domestically manufactured goods. However, in the real world, product differentiation became increasingly important in the course of globalization. Thus, quantifying domestic job losses for different skill groups induced by imports requires calculating factor content of imports by using technology as well as factor input matrices of trading partner countries. However, data on factor endowments and input-output matrices for the aggregate world or trading partner country aggregates are hardly available. Hence, in order to abandon the critical assumption of similar production technologies across countries, factor content of country *m's* exports and imports can only be calculated on a bilateral level. Therefore, in a second step, equations (14) and (15) will be used:

$$F^{mn}_{Ex} = Ex^{mn} B^m_{total} = Ex^{mn} B^m \left(I - A^m\right)^{-1} \tag{14}$$

Whereas in equation (14), $\mathbf{F}^{\mathbf{mn}}_{\mathbf{Ex}}$ depicts factor content of country *m's* exports to country n, $\mathbf{Ex^{mn}}$ stands for country *m's* (i x 1) export vector to country n. $\mathbf{B}^{\mathbf{m}}_{\mathbf{total}}$ represents, as above,

[4] Equation (4) would yield the absolute factor content of country *m*'s net trade, i.e. the difference between factor services exports and imports. Of course, the latter depends on countries trade balances. The higher a countries' export surplus, the more factor services should be exported, independent from the pattern of specialization. Hence, this approach would be misleading in the present context, since the results for several countries are difficult to compare if countries' trade balances differ.

total factor input matrix of country *m*, consisting of direct factor input matrix $\mathbf{B^m}$ and technology matrix $\mathbf{A^m}$. Respectively, for country *m's* imports from country *n*, the equation takes the following form:

$$F_{\text{Im}}^{mn} = \text{Im}^{mn} B_{total}^{n} = \text{Im}^{mn} B^{n}\left(I - A^{n}\right)^{-1} \tag{15}$$

According to equation (15), factor content of country *m's* imports from country *n* ($\mathbf{F_{Im}^{mn}}$) is determined by country *m's* (i x 1) import vector from country *n* ($\mathbf{Im^{mn}}$) times country *n's* total factor input matrix $\mathbf{B_{total}^{m}}$. The latter is calculated from direct factor input matrix ($\mathbf{B^n}$) and technology matrix ($\mathbf{A^n}$) of country *n*. In the following section, the data basis used to calculate factor content of trade of selected EU Member States is presented.

4.2 Description of the Data

The following empirical analyses draw on equations (12) to (15) depicted in section 4.1. Hence, factor content of exports and imports of the five Western European countries Denmark, France, Germany, the Netherlands and Sweden shall be analyzed. Whereas in a first step, factor content of total exports and imports will be regarded, in a second step, factor content of bilateral exports shall be examined. This allows to consider different production technologies in trading partner countries. In these bilateral analyses, reciprocal trade of the above mentioned countries as well as trade of these countries with the Eastern European countries Hungary, Poland, Slovakia and the Czech Republic, already shown in figure 1, shall be analyzed.[5]

According to equations (12) to (15), identifying factor content of exports and imports requires the following data: Firstly, the (f x i) direct factor input matrices of countries *m* ($\mathbf{B^m}$) and *n* ($\mathbf{B^n}$), containing the inputs of production factors, in this case labor input by qualifications, in each industry *i*. Secondly, in order to capture intermediate inputs, it is necessary to calculate input coefficients between industries *i* from input-output tables of countries $\mathbf{A^m}$ and $\mathbf{A^n}$, respectively. Finally, export and import vectors over industries *i* are needed for determining factor content of export production and imports. If factor content of total exports and imports are calculated according to equations (12) and (13), total export and import vectors can be drawn from country *m*'s supply and use tables provided together with the input-output tables. If factor content in bilateral trade is considered, bilateral export and import vectors have to be applied. Therefore, bilateral trade data of the Harmonized System were drawn from the EUROSTAT database and assigned to industries following United Nations correspondence tables. Similarly like bilateral trade data, input-output tables (together

[5] The selection of countries is based on data availability.

with supply and use tables) for countries *m* required for calculating intermediate factor input coefficient matrices were drawn from EUROSTAT.

In order to compare estimation results for different countries/country pairs, data should be drawn from a sole data source. Direct factor input matrices for different EU Member States are provided by EU KLEMS, offering data on total hours worked (per year) in 31 industries (manufacturing *and* services) as well as a subdivision of working hours on high-, medium- and low-skilled employees. These data allow calculating total working hours of all three skill groups by industry. Since it is generally accepted that transitions between the two groups 'medium-' and 'low-skilled' are quite smooth, these groups are summarized to one group, henceforth referred to as 'lower-qualified'. However, according to EU KLEMS, even the cross-country comparability of data on high-skilled employees is not ensured (Kangasniemi et al. 2007). For instance, for some countries, data are retracted from labor force surveys, whereas in other cases, use has been made of establishment surveys or a social-security database or a mix of sources (O'Mahony et al. 2007). To overcome this deficiency, EUROSTAT Labor Force Surveys were taken into account, whose international comparability is, according to EUROSTAT, "*….considerably higher than that of any other existing set of statistics on employment and unemployment for EU Member States*".[6] However, EUROSTAT Labor Force Surveys do only provide data on the number of employees by qualification for the economy as a whole. Against this background, for EUROSTAT Labor Force Surveys, the shares of persons with tertiary education on the one hand and lower education (primary and secondary) on the other were calculated and compared to the shares of the two skill groups in total working hours displayed by EU KLEMS. According to EU KLEMS, the group of the high-skilled contains persons holding bachelor or higher educational degrees. Hence, the group of the high-skilled in EU KLEMS should be comparable to persons with tertiary education in EUROSTAT labor force surveys. Consequently, the lower-qualified (i.e. 'medium-' and 'low-skilled') employees in EU KLEMS should be coincident with employees with primary and secondary education in EUROSTAT.

Afterwards, for each skill group, the relation of the share in total employment obtained from EUROSTAT data to the one obtained from EU KLEMS was determined. Finally, these quotients were taken as a multiplier to adjust the shares of skill groups (in total working hours) in each industry of the EU KLEMS tables.[7] With these 'adjusted' shares, total working

[6] This is due to the recording of the same set of characteristics in each country, a close correspondence between the EU list of questions and the national questionnaires, the use of the same definitions for all countries, the use of common classifications and the data being centrally processed by EUROSTAT (European Commission 2003, p.11).

[7] The circumstance that EUROSTAT reports the number of employees and EU KLEMS working hours for each skill group would only cause problems if working hours of high-skilled and working hours of the lower qualified would differ from country to country in opposite directions. In this case, the original data in the EU KLEMS tables in working hours by level of qualification could be distorted by this adjustment procedure. But this is seemingly not the case. Unfortunately, EUROSTAT does only provide data on working hours by occupation (for the whole economy only). Assuming that the high-skilled are mainly found in the occupational groups 1 and 2 ('legislators, senior officials, managers and professionals'), in all countries, working hours per week of members

hours for the high-skilled and the lower-qualified were calculated for each industry. In the following section, empirical results of the analyses are presented for 2005. This is the last year for which input-output and/or supply and use tables are available for all of the countries considered.

4.3 Measuring the Factor Content of Trade

a) Factor content of total exports and imports

In a first step, factor content of countries' total exports and imports (sourced from supply and use tables) are determined on the basis of equations (12) and (13). Thereby, it is assumed that imports are manufactured with the same production technology as goods produced domestically. As can be seen from equations (12) and (13), the calculations reveal total working hours of high- and lower-qualified workforce for total exports (equation (12)) and imports (equation (13)). Of course, total working hours do depend on total export and import volumes and thus on country sizes. As a consequence, the results for the five selected Western European countries are difficult to compare. Therefore, in the following, not absolute factor inputs, but the shares of high-skilled and lower-qualified workers in total labor input for export and import production will be presented. Table 2 shows the results for factor content of country *m*'s total exports and imports in 2005:

Table 2: Factor Content of Countries' Total Exports and Imports in 2005
- *Share of factor services embodied in exports and imports in percent* -

Country m	*Factor Content of Country m's Exports*		*Factor Content of Country m's Imports*	
	High-Skilled	*Lower-Qualif.*	*High-Skilled*	*Lower-Qualif.*
Denmark	25,7	74,3	26,4	73,6
France	24,5	75,5	24,4	75,6
Germany	24,1	75,9	23,5	76,4
Netherlands	27,3	72,7	27,3	72,7
Sweden	23,9	76,1	23,5	76,5

Sources: EUROSTAT, own calculations

of these two groups are higher than working hours of members of the remaining occupational groups, who are probably lower qualified (ranging from 'technicians, clerks, and service workers' to 'plant and machine operators and assemblers' and 'elementary occupations'). The only exception is Hungary, where weekly working hours in occupations of the higher qualified are almost the same as in occupations of the lower qualified. In the remaining countries, weekly working hours in *superior* occupations exceed those in *inferior* qualifications between 6% (Czech Republic) and 13% (France).

As can be seen from table 2, factor services embodied in country *m*'s total exports and imports differ only slightly. Seemingly, imports of the highly developed countries regarded in this analysis do not contain considerably more lower-qualified factor services than exports. Only Germany's exports contain slightly more high-skilled factor services than imports sourced from the rest of the world. For Denmark, the opposite is the case. These results might seem quite surprising, since it is commonly expected that unemployment of the lower-qualified in high-wage countries results from specialization of these countries on (human-)capital-intensively manufactured goods in course of the international division of labor. Moreover, countries' international trade patterns analyzed in section 3 suggest that a large portion of total trade should result from specialization due to differences in factor endowments, which should entail adjustment effects. However, the results presented in table 2 are derived from equations (12) and (13), respectively, assuming that trading partner countries use the same production technologies and factor inputs as domestic producers. As already mentioned, this assumption is only justified if imports are perfect substitutes to home-produced goods. Under these assumptions, differences in factor services embodied in total exports and imports could only result from diverging patterns of exports and imports. This should be the case in inter-industry trade relations, where for instance highly developed countries do export goods from rather (human-)capital-intensive industries and, in return, import products from more labor-intensive industries. In the following, the critical assumption of identical production technologies shall be abandoned.

b) Factor content of trade between Western European countries

In this sub-section, factor content of countries' exports and imports shall be calculated on a bilateral basis, as depicted in equations (14) and (15). This allows considering country *m*'s trading partner country *n*'s production technologies for computing the factor content of imports. Thereby, international product differentiation is taken into account.

Calculating factor content in bilateral trade requires not only trading partners' input-output matrices and factor input vectors, but also bilateral trade vectors, i.e. bilateral trade by industries provided by EUROSTAT. However, bilateral trade data are only available for goods, but not for services. This shortcoming will be solved in two ways. In a first mode of calculation, it will be assumed that bilateral trade in services does not take place at all. This means that in the bilateral export and import vectors, trade flows are set to zero in the services sectors. In fact, services are of minor importance in international trade. For four of the countries considered, the share of services ranges from only 14% (in German exports) up to 24% (in Swedish exports). Only for Denmark, services trade is of higher relevance, since services share amounts to 34% in total exports and to 33% in total imports (according to balance of payments statistics for 2005, the year underlying the calculations). In a second mode of calculation, it is assumed that the composition of *bilateral* trade in goods and services is similar to the composition of countries' *total* goods and services exports and imports. For the latter, data are available from the supply and use tables, respectively. Hence, the relation of single services exports and imports to country *m*'s *total* manufacturing exports and imports, respectively, is calculated from supply and use tables. Afterwards these coefficients are used for estimating notional *bilateral* services trade volumes in the services sectors.

In a first step, factor content of trade between the five Western European countries is computed. The results for the first mode of calculation (without services trade) are depicted in table 3 (the results for the second mode of calculation, including notional services trade, are quite similar and can be found in table A-1 in the appendix).

Table 3: Factor Content of Western European Trade Relations in 2005

- Share of factor services embodied in exports and imports in percent -

Country m	*Trading Partner n*	*Factor Content of Country m's Exports*		*Factor Content of Country m's Imports*	
		High-Skilled	*Lower-Qualif.*	*High-Skilled*	*Lower-Qualif.*
Denmark	*France*	25,0	75,0	22,6	77,4
	Germany	23,4	76,6	22,7	77,3
	Netherlands	26,8	73,2	24,4	75,6
	Sweden	26,9	73,1	21,6	78,4
France	*Denmark*	22,7	77,3	25,8	74,2
	Germany	23,8	76,2	24,2	75,8
	Netherlands	22,0	78,0	24,8	75,2
	Sweden	24,6	75,4	21,6	78,4
Germany	*Denmark*	22,7	77,3	23,6	76,4
	France	24,2	75,8	23,8	76,2
	Netherlands	22,3	77,7	24,8	75,2
	Sweden	24,1	75,9	21,7	78,3
Netherlands	*Denmark*	25,2	74,8	26,4	73,6
	France	24,8	75,2	22,0	78,0
	Germany	24,6	75,4	22,4	77,6
	Sweden	25,4	74,6	22,0	78,0
Sweden	*Denmark*	21,4	78,6	27,2	72,8
	France	21,7	78,3	24,8	75,2
	Germany	22,1	77,9	24,2	75,8
	Netherlands	21,3	78,7	25,3	74,7

Sources: EUROSTAT, EU KLEMS, own calculations

Compared to the results for total exports and imports presented in table 2, differences in factor contents of bilateral exports and imports between highly developed Western European economies are only a little more distinct even if the product differentiation approach is applied (i.e. if factor content of imports is computed by using input-output tables and factor input matrices of trading partner countries *n* instead of country *m*'s). This result corresponds to the findings of Davis and Weinstein (2003), who analyzed factor content of trade between the US and other highly developed countries by using both, the US technology matrix for all countries as well as countries' national technology matrices. This is seemingly also the case for factor content of bilateral trade between Western European countries, which are quite similar with respect to factor endowments and stages of development.[8] However, for Denmark, exports to the four trading partner countries contain slightly more high-skilled factor services than imports from the corresponding countries. Surprisingly, the opposite is the case for Sweden.[9] For Germany and the Netherlands, the picture is inconclusive. But overall, factor content of bilateral exports and imports differ only slightly in trade between these Western European countries. Hence, adjustment effects resulting from Western European trade on the high-skilled as well as the lower-qualified labor should be rather low. In the next sub-section, the same calculations shall be performed for trade between the selected Western European countries on the one hand and Eastern European low-wage countries on the other.

c) *Factor content of trade between Western and Eastern European countries*

For computing factor content of exports and imports in East-West trade, the Eastern European countries depicted in figure 1, for which input-output-tables and factor input matrices were available for 2005, were chosen: the Czech Republic, Hungary, Poland and Slovakia. Especially the Czech Republic, Hungary and Slovakia were important recipients of foreign direct investment from Western European countries in the course of the establishment of international production networks, which are considered to be harmful especially for the lower-qualified workforce in Western European high-wage countries. Table 4 shows the

[8] The deviations in the shares of factor services embodied in bilateral exports and imports are due to inconsistencies in trade statistics. Of course, the share of high-skilled factor services embodied in exports from country *m* to country *n* should equal the share of high-skilled factor services embodied in imports of country *n* from country *m*. This is not always the case since total export values declared from country *m* to country *n* in industries *i* are not identical to imports of country *n* from country *m* in industries *i* declared in trade statistics.

[9] In the case of Sweden, human-capital intensity of exports to the Western European trading partner countries is lower than total exports (table 2) due to the fact that cork, wood and products thereof (paper, paperboard, books), which are manufactured more labor-intensive, are considerably more important in Swedish exports to the European trading partner countries than to the rest of the world. Moreover, export surpluses in these product groups are much higher in intra- than in extra-European trade of Sweden.

computational results (the results including notional services trade can be found in table A-2 in the appendix).

Table 4: Factor Content of East-West Trade in 2005

- Share of factor services embodied in exports and imports in percent -

Country m	*Trading Partner n*	*Factor Content of Country m's Exports*		*Factor Content of Country m's Imports*	
		High-Skilled	*Lower-Qualif.*	*High-Skilled*	*Lower-Qualif.*
Denmark	*Czech Rep.*	25,0	75,0	9,2	90,8
	Hungary	24,5	75,5	15,0	85,0
	Poland	23,5	76,5	12,9	87,1
	Slovakia	25,6	74,4	8,7	91,3
France	*Czech Rep.*	24,8	75,2	9,4	90,6
	Hungary	24,9	75,1	14,5	85,5
	Poland	24,7	75,3	15,0	85,0
	Slovakia	24,8	75,2	9,9	90,1
Germany	*Czech Rep.*	23,8	76,2	9,3	90,7
	Hungary	24,1	75,9	14,6	85,4
	Poland	23,4	76,6	13,9	86,1
	Slovakia	24,6	75,4	10,0	90,0
Netherlands	*Czech Rep.*	26,2	73,8	9,3	90,7
	Hungary	26,7	73,3	14,7	85,3
	Poland	25,0	75,0	12,4	87,6
	Slovakia	25,5	74,5	10,5	89,5
Sweden	*Czech Rep.*	21,0	79,0	9,4	90,6
	Hungary	24,4	75,6	14,6	85,4
	Poland	20,4	79,6	15,6	84,4
	Slovakia	22,3	77,7	9,9	90,1

Sources: EUROSTAT, EU KLEMS, own calculations

Compared to the results for Western European trade relations, adjustment effects emanating from trade between Western and Eastern Europe seem to be quite considerable, since factor contents of Western European imports from CEECs do noticeably differ from factor content of exports from Western to Eastern Europe. This is especially the case for imports from the Czech Republic and Slovakia, which are clearly less human-capital intensively manufactured than the corresponding exports. In contrast, factor services embodied in imports from

Hungary and Poland, the most important Eastern European trading partner country for the Western European economies, are a little bit more human-capital intensive. Overall, (net) exports of high-skilled factor services to Eastern Europe are lowest for Sweden and Germany. Exports of Denmark, France and the Netherlands are obviously more human-capital intensively manufactured than Swedish and German exports, though only slightly. However, mainly due to geographical proximity, East-West trade is of higher importance especially for Germany than for the other Western European countries.

As the calculations show, allowing for product differentiation reveals that factor contents of exports and imports differ quite noticeably in trade between countries with different stages of development. Hence, assuming identical production technologies across countries could lead to a notable underestimation of possible labor market outcomes of international trade. This holds all the more, the higher differences in factor endowments between trading partner countries are.

4.4 Testing the HOV-Model

Finally, the performance of the HOV-Model shall be examined. The standard model, depicted in equation (9) above, implies that the measured factor content of trade of a country should equal differences in factor endowments between country *m* and the rest of the world. Since estimating world factor endowments is quite difficult, the modified version of the HOV-Model developed by Staiger et al. (1987) and Hakura (1999) will be used (see also Nishioka (2006)), which is applicable to the country pairs considered in the foregoing analyses. Therefore, equation (9) has to be adapted to a two-country world. Considering two countries *m* and *n*, the ratio of equations (7), depicting countries' final demand, takes the following form:

$$D^m = \left(\frac{s^m}{s^n}\right) D^n \qquad (16)$$

Whereas $\mathbf{D^m}$ and $\mathbf{D^n}$ represent final demand of countries *m* and *n*, respectively, s^m and s^n stand for country *m*'s and *n*'s shares in world final demand. On the basis of equations (9) and (16), the bilateral HOV-Model is given by:

$$F^m - \left(\frac{s^m}{s^n}\right) F^n = V^m - \left(\frac{s^m}{s^n}\right) V^n \qquad (17)$$

Whereas $\mathbf{F^m}$ and $\mathbf{F^n}$ stand for the relative measured factor content of (net) trade of countries *m* and *n* (which is the difference between factor content of exports and imports), $\mathbf{V^m}$ and $\mathbf{V^n}$ depict the relative predicted factor content of trade resulting from differences in factor endowments (with high-skilled and lower-qualified) between trading partner countries *m* and *n*. Thus, endowment differences of countries *m* and *n* should be reflected in different factor contents of (net) trade. For the present country sample, including 40 country pairs, high-skill-intensity of trade (i.e. net-trade in high-skilled factor services) and differences in countries' relative endowments with high-qualified labor are tested against each other. Traditionally, the HOV-Model is examined by applying sign tests, slope tests and variance ratio tests (see e.g. Maskus 1985, Bowen et al. 1987, Davis and Weinstein 2003).

In the present case, the sign test indicates the probability that high-skill abundance of a country results in net exports of high-skilled factor services. Strictly speaking, the validity of the HOV-Model would require a sign coincidence of 100 percent. In the slope test, measured factor content of trade is regressed on predicted factor content of trade (without intercept). If the HOV-theorem would hold, regression coefficient should be unity. The same holds for the variance ratio test: If the variance ratio of measured factor content of trade over predicted factor content of trade is around unity, the HOV-hypotheses would be confirmed. The results of these tests for the present country sample are depicted in table 5.

Table 5: Results of HOV-Model tests

Test		*Result*
1. Sign Test[a]		0.95
2. Slope Test[b]	Coefficient	0.710***
	T-Statistic	36.66
	R-Squared	0.84
3. Variance Ratio Test[c]		0.58

No. of observations: 40

[a]: (number of sign fits)/(number of observations)
[b]: Regression of measured factor content of trade on predicted factor content of trade (without intercept)
[c]: (variance in measured factor content of trade)/(variance of predicted factor content of trade)

According to the sign test, the HOV-model seems to perform quite well for intra-European trade flows, since for 95% percent of the country pairs considered, measured factor content of trade corresponds to predicted factor content of trade. Although the results of the slope and the variance ratio test are less convincing, they are still comparatively robust compared to other studies. Hence, if different technology matrices are used for computing factor content of exports and imports of trading partner countries, the results are largely in line with the theoretical predictions of the Hecksher-Ohlin-Vanek model of trade.

5. Conclusions

In the course of globalization, high-wage countries experienced rising unemployment, especially of the lower-qualified. Theoretically, this development is, at least partly, ascribed to the integration of the Central and Eastern European as well as the Newly Industrializing Asian Economies into the international division of labor. In this context, (human-)capital-abundant industrialized countries are expected to specialize on capital- and skill-intensively manufactured goods. Moreover, globalization promoted the establishment of international production networks, where producers in high-wage countries increasingly sourced intermediate inputs from low-wage countries. Both developments are supposed to be favorable for the high-skilled but harmful for the lower-qualified workforce in the highly developed countries. The present paper tested these hypotheses by using input-output techniques. For five selected Western European economies the results of the analyses show that factor content of exports and imports differ only slightly under the assumption that all trading partner countries share the same production technology as the five EU Member States considered in this study. However, abandoning this critical assumption and allowing for product differentiation yields considerably different results. This is achieved by computing factor content of trade bilaterally using national technology and factor input matrices for the exporting and importing country, respectively. Whereas for trade flows in between Western European countries, factor contents of exports and imports do hardly differ, the opposite is the case for bilateral trade between Western and Eastern European countries. Hence, exports from Western to Eastern Europe contain considerably more high-skilled factor services than imports of Western European countries from their Eastern European trading partners. Consequently, allowing for product differentiation, East-West trade can be identified as a vital cause of labor market pressures in Western European high-wage countries.

APPENDIX

Table A-1: Factor Content of Western European Trade Relations in 2005 (including notional services trade)

- Share of factor services embodied in exports and imports in percent -

Country m	*Trading Partner n*	*Factor Content of Country m's Exports*		*Factor Content of Country m's Imports*	
		High-Skilled	*Lower-Qualif.*	*High-Skilled*	*Lower-Qualif.*
Denmark	*France*	25,4	74,6	23,8	76,2
	Germany	24,4	75,6	21,9	78,1
	Netherlands	26,5	73,5	24,6	75,4
	Sweden	26,5	73,5	22,8	77,2
France	*Denmark*	23,5	76,5	26,9	73,1
	Germany	24,4	75,6	24,2	75,8
	Netherlands	22,9	77,1	25,7	74,3
	Sweden	25,1	74,9	22,3	77,7
Germany	*Denmark*	22,2	77,8	24,9	75,1
	France	23,5	76,5	24,7	75,3
	Netherlands	21,9	78,1	25,8	74,2
	Sweden	23,4	76,6	22,3	77,7
Netherlands	*Denmark*	25,4	74,6	28,1	71,9
	France	25,1	74,9	24,0	76,0
	Germany	25,0	75,0	22,6	77,4
	Sweden	25,6	74,4	23,1	76,9
Sweden	*Denmark*	22,5	77,5	29,3	70,7
	France	22,7	77,3	26,5	73,5
	Germany	23,0	77,0	24,4	75,6
	Netherlands	22,8	77,2	26,8	73,2

Sources: EUROSTAT, EU KLEMS, own calculations

Table A-2: Factor Content of East-West Trade in 2005 (including notional services trade)

- Share of factor services embodied in exports and imports in percent -

Country m	*Trading Partner n*	*Factor Content of Country m's Exports*		*Factor Content of Country m's Imports*	
		High-Skilled	*Lower-Qualif.*	*High-Skilled*	*Lower-Qualif.*
Denmark	*Czech Rep.*	25,4	74,6	10,5	89,5
	Hungary	25,1	74,9	15,8	84,2
	Poland	24,4	75,6	14,7	85,3
	Slovakia	25,8	74,2	10,1	89,9
France	*Czech Rep.*	25,2	74,8	10,2	89,8
	Hungary	25,4	74,6	15,1	84,9
	Poland	25,2	74,8	15,8	84,2
	Slovakia	25,3	74,7	10,7	89,3
Germany	*Czech Rep.*	23,2	76,8	10,1	89,9
	Hungary	23,4	76,6	15,3	84,7
	Poland	22,8	77,2	14,9	85,1
	Slovakia	23,9	76,1	11,0	89,0
Netherlands	*Czech Rep.*	26,2	73,8	10,8	89,2
	Hungary	26,6	73,4	16,1	83,9
	Poland	25,3	74,7	14,3	85,7
	Slovakia	25,7	84,3	12,1	87,9
Sweden	*Czech Rep.*	22,1	77,9	11,0	89,0
	Hungary	24,7	75,3	16,0	84,0
	Poland	21,7	78,3	17,1	82,9
	Slovakia	23,1	76,9	11,7	88,3

Sources: EUROSTAT, EU KLEMS, own calculations

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