Impact of international trade
on employment in Polish industrial sector

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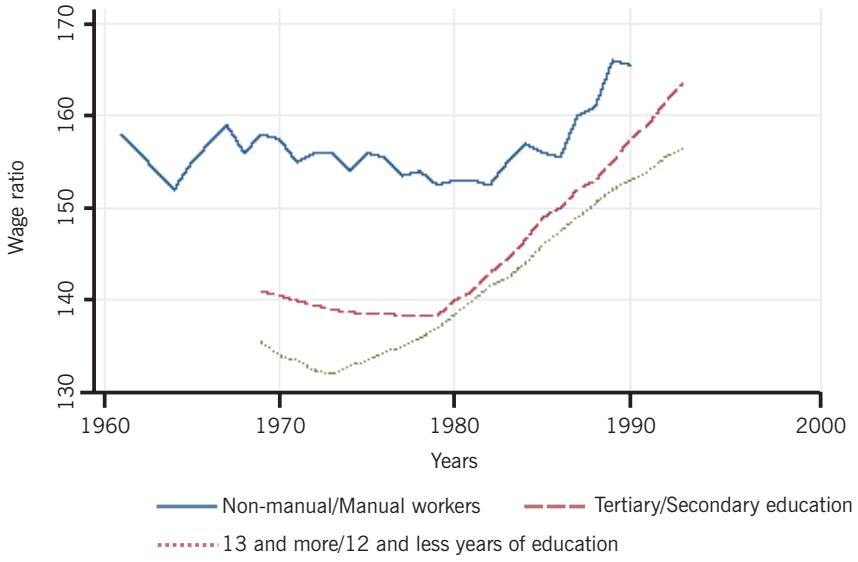
1. Introduction

During the last two decades, the problem of link between opening of economy (for international trade in particular) and functioning and performance of the labour market has been often discussed. It has become particularly "fashionable" in highly-developed countries when in the second part of the 1980s and the first part of the 1990s, a significant worsening of situation of low-skilled workers was observed. It was revealing itself with fall of relative wage (versus persons with higher qualifications) or with growth of relative unemployment rate. The first phenomenon was observed usually in countries with relatively flexible labour market (for instance: in USA, see: Graph 1), while the other—in countries of continental Europe, where labour markets are regarded to be relatively rigid.



Graph 1.
High-skilled/low-skilled workers'

The second half of the 1990s has brought the reversal of this unfavourable for low-skilled persons trend, both in European and non-European OECD countries. It is probably related to adjustment process to changing structure of the world economy (labour markets, particularly in countries of continental Europe, react with long lags), smaller dynamics of growth of trade with developing countries and active labour market policies and enormous financial resources spent on policies aimed at improving employability of low-skilled persons[1]. In the second part of 1990s and in first years of new century in fact we observed worsening of relative position of high-skilled persons.

Situation of Central and Eastern European countries, that are still in process of economic transition, is somehow different[2]. In their case, not only worsening of situation of low-skilled persons is observed until nowadays, but the scale of changes is enormous in comparison to the developed countries. For instance, both in Poland and in Czech Republic we observed a deep fall of employment rates and growth of unemployment rates, but it was particularly severe in the case of low-educated persons. During six years (1996–2002) the difference in employment rates of high- and low-educated labour force grew in Czech Republic by 12.7% and in Poland by 31.8% In the same time, the difference in unemployment rates doubled (rose by 91% in Poland and by 120% in Czech Republic).

Problems with comparable data make it difficult to assess if worsening of the position of low skilled workers in those countries regards relative wages as well. In Poland the only source of information on wages by education level is PLFS. However disadvantages of this data source as far as wages are concerned are well known (declared wages, bias towards avoiding answering wage questions). With lack of other sources, we may get some approximation on the scale of changes in this area with CSO's information on average gross wage by occupation. In 1996 the ratio of average wage among specialists to the average wage of workers at elementary occupations accounted for 1.87 for men and 1.71 for women. In 2002 the ratios accounted respectively for 2.47 and 2.17 (source: [CSO 1997, p.155] and [CSO 2004, p. 267]). Therefore, at least for Poland, relative worsening of the position of low-skilled persons on the labour market reveals itself both with changes in employment and unemployment rates and wages. So the reasons and results of this growing dispersion, although maybe less important for highly-developed countries, are still or even more and more important for countries undergoing economic transition as Poland.

Among potential explanations of observed changes, particularly in the case of highly-developed countries, skilled-biased technological progress,

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[1] Detailed analysis of efficiency of polices aimed at counteracting effects of opening of economies and destruction of jobs for low-skilled labour force is presented in [OECD 2005].

[2] Since in this part of the article I use mainly OECD database, by countries undergoing economic transition I mean Central European countries belonging to OECD, i.e. Poland, Czech Republic, Hungary and Slovakia.

migrations (inflow of low-skilled immigrants) and international trade are most often discussed. In the OECD countries, particular attention was given to growing (in 1970s and 1980s) exchange with newly industrialized economies of South-East Asia. All these potential reasons influencing labour demand, particularly for low-skilled labour force (technological progress, trade) or labour supply (trade, migrations) cause fall of equilibrium wages, and with some barriers for fall of wages—results in growth of unemployment of low-educated persons. As for countries undergoing transition, structural changes, both as for consumption and production, are additional factors that change labour demand versus high-qualified labour force. However in this, as we may call it, "internal" aspect of the problem, the role of trade may be significant as well. Changes in consumption and production structure may be driven by opening of the economy and forcing home producers to compete with foreign firms, usually having at their disposal new technologies that allow them to produce modern, high-quality products.

All in, it seems that it is still worth effort to theoretically and empirically investigate problem of impact of international trade on labour market. In this article I try to shed some light on this problem in Polish case. After presenting short theoretical background and main methodological approaches to the problem, I present stylized facts about changes in employment, wages and international trade in Polish secondary sector. Then more rigorous econometric analysis is presented. The article ends with estimates of quantitative effects of trade on employment and its skill-structure.

2. Theoretical background

The main theory used for explanation of links between trade and labour market is the neoclassical trade theory, most often refereed to as Heckscher-Ohlin-Samuelson theory. This theory, apart from explaining trade pattern (each country should specialize in production of goods, that make relatively intensive use of factors which are relatively abundant in that country) predicts also the impact of trade liberalization on the factors markets. According to its predictions, the price of imported good decreases in terms of exported good, and so does the production level. The other outcome is that trade rewards factors which are relatively intensively used to produce goods in the exported goods' sector. The real price of factor relatively intensively used in export sector will increase, and the real price of factor relatively intensively used in import competing sector will decrease (Stolper-Samuelson theorem, Stolper, Samuelson, 1941). Changing factor prices leads also to change in technique of production—share of more expensive factor decreases in both goods.

In the light of this theory, trade is a great explanation for labour market performance in developed countries. These countries are relatively abundant in high-skilled labour (as compared to developing countries) and they specialize in production of goods which make relatively intensive use of this

factor of production. On the other hand, these countries import goods, that make relatively intensive use of low-skilled labour (e.g.: textile and toy industries in East Asia). According to HOS theory predictions this kind of trade pattern should eventually lead to a worsening of low-skilled labour welfare situation in developed countries. It is worth noting here that HOS theory is static in its nature and relies on strong assumptions. Perfect competition, full employment conditions and perfect internal mobility of factors of production assumptions may be quite problematic. But the most controversies arise when we are talking about identical technologies used in both countries. This assumption needs not to be true especially in the case of explaining trade between countries that are different in level of development. Different technologies may completely reverse trade pattern predictions, and even more, this may reverse the impact of trade on factors' markets.

Furthermore it is worth noting that Heckscher-Ohlin-Samuelson theory, based on relative factors abundance, explains trade pattern between countries differing in the factor endowments (inter-industry trade). However, as for highly developed countries intra-industry trade plays a dominant role. Theory that explains intra-industry trade is mainly focused on the existence of imperfect competition and increasing returns to scale, and on demand side factors—specific consumption function (e.g. love for variety). This theory does not produce any meaningful implications for factors markets. The links between trade and changes in the labour market in case of developed countries receive strong theoretical support, it may seem, however, that practical significance of trade as a factor explaining worsening of the situation of low-skilled labour need not to be equally strong. On the other hand, theory of international trade distinguishes between horizontal and vertical trade diversification (see: Czarny [2002]). In both cases similar products are traded. But only in the first case products of similar quality are exchanged. In the other case, products often differ in quality and they are not targeted at the same groups of customers (different incomes and tastes), so there may not be direct competition between these goods on the market. Presumably, products of higher quality contain more capital (physical or human), so generally differ in production techniques, which is not the case in horizontal intra-industry trade. The impact of vertical intra-industry trade on the labour market is, however, qualitatively similar to this described by Stolper-Samuelson theorem.

Distinguishing between vertical and horizontal intra-industry trade is of limited use for developed countries, since major of their trade is located in products of similar quality. But this idea can be quite useful and may be a good extension of thinking about trade and labour market in countries like Poland, since growing importance of intra-industry trade comes mainly from vertical trade diversification (see: Michałek, Śledziewska [2000]).

3. Empirical research: different methodological approach

The link between trade and labour market performance has been one of the key issues both in trade analyses and labour market economics. However, no uniform methodological framework has been established. Among different approaches to the problem, three may be already called traditional [Cline 1997, Haskel 2001, Katz 1999].

The first approach uses factor content analysis. With cost function, the share of each production factor is estimated and changes in labour demand are assessed. Typical method used in this approach is to estimate the number of workers employed by the production of exported goods and number of workers needed to produce domestically the volume of imported goods. Difference between both estimates is interpreted as a net effect of trade for employment. This methodology requires information on technology in all sectors (input-output matrix). In practice it is often very difficult to find good estimates of technical coefficients. Katz and Murphy [1992] and Sachs and Shatz [1996] using this methodology have stated that the impact of trade with low-wage countries in the OECD countries is rather small, which may be in accordance with expectations if we take into account the fact that trade with low-wage countries equals to only 2% of GDP of OECD countries [OECD 1997, p. 112]. Methodology of factor content is sometimes criticized for not taking into account the fact that many of goods imported from low-wage countries are not produced in developed countries any more. Therefore the results of simple analysis underestimated the quantity of labour that is displaced in developed countries by the trade with low-wage countries. Wood [1994] in his famous work claims that estimates should take into account labour input of poor "South", not rich "North". He assumes as well that real or only expected pressure from exporting countries will force producers in developed countries to implement labour saving innovations. When Wood introduced those corrections, the impact of imports from the "South" appeared to be ten times higher than in previous research. Leamer [1996a] states that factor content is determined by consumers' preferences, technologies, production factors' supply and world market condition for each of final goods. Therefore if we use factor content method, we get reliable results only if we compare equilibria with the same consumers' preferences, technologies and factors' supply. Another problem is high sensitivity of results for small changes in methodology.

Second approach—used mainly by international trade economists [Leamer 1996, Feenstra and Hanson 1999]—bases on estimating price equations and total factor productivity equations (TFP) in market equilibrium (zero profit conditions). Most of methods are based on general equilibrium models (using explicit HOS theory). According to this approach labour market situation is a result of changes in factor prices and factor prices are determined by final goods' prices. Therefore if it is international trade to cause a growth of wage inequalities among different groups of labour force, it must have been a result of a fall of prices of goods in production of which low-skilled labour

force is intensively used. It appears that analysis of changes of prices of tradable goods doesn't allow us to draw any clear conclusions.

Third method consist in estimating parameters of regression, where changes in employment and/or wages are explained by changes in trade volumes and technology. In most cases such analysis consists of decomposition of changes in employment to changes caused by domestic demand, productivity changes, exports and imports. Research from the first half of the 1990s were usually trying to decompose employment changes to within-industry effect and between-industry effect. The first one is said to be representing rather asymmetric versus qualifications technological progress, and the other—international trade effect. Most empirical analyses showed that it is rather technological progress that is responsible for changes in labour demand, not international trade. Later research postulated taking into account indirect effect of trade for employment—impact through changes in technology (for instance: Abraham and Brock [2003]). The main critique of this stream of research is lack of solid theoretical background. According to HOS theory, prices of final goods are the main determinants of factor prices. Another problem is to find good proxies for technological progress.

All in, it seems that it is extremely difficult to assess the impact of trade on labour market. In spite of quite strong theoretical background, most of numerous attempts to confirm this link in empirical way has led to a conclusion that the role of trade in observed changes is small, if not insignificant. It is not international trade that lies behind a reduction of labour demand for low-qualified labour force in high-income countries. Most research show that technological progress and migration are the most important factors. However, we should bear in mind that it is extremely difficult to isolate influence of trade from other factors and technology in particular. Final goods' prices that are—at least from theoretical point of view—seen as main channel of interaction depends on many other factors. Another important question is the problem of economy's level of openness. We can not be surprised that most of research does not find trade to be an important factor influencing labour market situation since most of research refers to U.S. economy. As the share of exports in its GDP is little above 6%, and share of imports—a little over 11%, it is not a surprising result. We may expect different results in the case of small open economies, as Belgium, Ireland, Czech Republic (with shares of trade flows at the level of 70%–80%). Currently many authors underline that it is a mistake to treat trade and technology as two separate factors influencing labour market. They are to large extent related to each other. Currently in many research, both direct and indirect impact of trade on labour market are taken into account. As for USA migrations may play an important role as well, particularly migration of low-skilled workers.

4. Polish industrial sector: stylized facts on employment, wages and trade

There is not much research on impact of trade on the Polish labour market. However, even in those few papers, different methodological approaches are used. Most empirical works are kind of reactions to often formulated opinions about job destruction in Poland due to foreign competition. Such opinions formulated usually by non-economists were pronounced in debates about Polish trade policy, the level of its liberalisation and integration with the European Union. Usually authors focus on the overall qualitative and quantitative effects of trade. Only few works take up the problem of trade in context of qualifications of labour force. An exception is a work that uses the model by Freeman and Katz [Liwiński, Socha, Sztanderska 2002] and analysis on relation between education level and foreign trade [Greszta, Michałek, Śledziewska 2001]. Some experts claim that Polish foreign trade deficit has resulted in destruction of 1–1.2 million jobs and only deficit in trade with the EU—of 600–700 thousand jobs [Kabaj 2000]). Another studies confirmed impact of trade on labour productivity [Faggio 2000]) and wage structure [Morawski and Socha 2000, Newell and Socha 2002]. An important problem we have to face while analyzing relation between trade and labour market are information limitations. Some of them are of universal character (for instance: problem of transition form product classifications used in trade statistics to activity classifications used in employment statistics). Other are more country-specific and regard typically Polish problems (for instance: often changes in methodology by CSO). One of the key issues is the question of skill structure of employment. It seems that the only possible way of approximation is to use data on the employment of blue-collar workers (employed at manual labour positions) and white-collar workers (employed at non-manual labour positions). This division is often used, but it is clear that it is not completely correct. It would be very interesting to use PLFS data, where labour supply is far better characterized (education level, job tenure etc.) but PLFS activity classification is very much aggregated (only 14 sections in manufacturing industry).

In this article, similarly to majority of other analyses of this kind, I try to assess the impact of trade in industrial goods on employment in industrial sector (numerous analyses limit themselves even only to manufacturing industry). It is a result of the fact that most of trade, at least in traditional form, is an exchange of industrial goods. In 2003 exports of goods showed by National Bank of Poland in balance of payments equaled to 237.3 billion PLZ, and imports 259.5 billion PLZ. Revenues from exports of services were equal to 43.5 billion PLZ, and expenditures for imported serviced 41.4 billion PLZ (respectively 18% and 16% of trade in goods). Then, the share of industrial goods in total trade accounted for 98.3% as for exports and 97.7% as for imports. So, although the share of services in the gross value added of the economy is systemically growing and in 2003 accounted for 72.5% (with 3% in agriculture and 24.5% in industry), the share of services in trade rest relatively

small [Source: CSO 2004]. Therefore concentration only on trade in industrial goods does not seem to omit large part of Polish foreign exchange.

On the other hand from the very beginning we have to bear in mind that analyses of the impact of trade on labour market limited only to industrial sector refer to quite small part of labour market. Clearly the structure of GDP is reflected in structure of employment. In Poland with still high share of agriculture (16.1% of employment in 2003, year average) and with growing share of services (61.0%), the importance of industrial sector for labour market situation is systematically falling (22.9% in 2003, against 24.2% in 1995 and 25.2% in 1992, without construction) [CSO 2004].

4.1. Employment and wages in industrial sector in last decade

In the year 2003, employment in industrial sector (mining and quarrying, manufacturing and electricity, gas and water supply) in Poland accounted on average for 2639.1 thousand persons, that constituted 30.5% of total paid employment in economy and 20.8% of all total employment (including self-employed persons). Between 1994 (the first year when CSO used new classification of economic activity) and 2003, the average employment fell by 21.5% (during the same period the economy lost 17.3% of employment and 4.5% of paid employment). At the same time, the structure of employment changed significantly: the share of persons employed as white-collar workers rose from 21.5% in 1994 to 24.4% (growth by 13.5%) in 2003. This improvement of qualification structure was a little stronger than on average in economy, where the share of blue-collar workers fell from 57% to 51.5%. Between 1994 a 2002, the share of people with tertiary or post-secondary education in employment rose from 12.81% to 20.19% (by 58%), and the share of people with education lower than basic vocational fell from 58% to 47.28% (by 18%). For industrial sections (sections C, D and E according to PKD classification) the respective share grew from 6.48% to 11.16% (by 72%) and the other fell from 63.05% to 55.91% (by 11%), own calculations based on PLFS 1994 and 2002, II quarter.

Between 1994 and 2003 real value of production measured with gross value added rose in industry by 58.6%, and measured with real production sold by 66.9%. If we add information on employment fall, we may notice a significant growth of labour productivity in industry.

Changes in employment level and structure are much differentiated among sections (see: Graph 3). In quite a few sections the share of blue-collar workers grew (manufacturing of food and beverages, manufacturing of textiles, manufacturing of wearing apparel and furring, manufacturing of leather and leather products, manufacturing of wood and wood products, manufacturing of electrical machinery and apparatus, manufacturing of motor vehicle and trailers, manufacturing of other transport equipment and manufacturing of furniture). Please note, that in many of those sections Poland is said to have comparative advantage or at least they are strongly export-oriented. The worsening of the relative position of low-skilled workers

was revealed with the fall of their relative wage as well. In the years 1994—2003, average real wage (deflated with CPI) in industrial sector rose by 46%. Blue-collar workers' wage rose by 28.7%, and white-collar workers by 77.2%. It resulted in drastic growth of the difference in wages depending on the type of job. As in 1994 the wage of white-collar worker was by 35% higher than the wage of blue-collar worker, in 2003—by 86.3%. However, growth of wages was not that dynamic in all sections. It was the most moderate in two groups of sections: manufacturing of wearing apparel and furriery, manufacturing of leather and leather products, mining of coal and manufacturing of textiles, where we observed fall of employment as well (these are shrinking sections where the labour demand is dynamically falling) and in manufacturing of wood and wood products, manufacturing of rubber and rubber products and manufacturing of furniture (where employment grew). It may mean that those last sections were booming with growth of the demand for final goods and with low-qualified labour supply curve elastic enough, employment grew only with moderate wage growth. On the other hand, two or even three times higher than the industry-wide growth of wages took place in tobacco manufacturing, manufacturing of computers, manufacturing of radio, television and communication equipment, chemicals production and manufacturing of machinery and equipment. In all those sections, with the exception of computer production, employment fell significantly. It may be a result of fast restructuring of those sections, where the growth of productivity is accompanied with employment reduction and growth of wages. Only manufacturing of computers faced such growth of final goods demand (growth of production sold by 797% in real terms), that allowed for growth of employment (by 20.5% on average and even by 144% of white-collar posts) with strong growth of wages, both for blue- and white-collar workers. On average, in the period 1994–2003, the surplus of blue-collar worker's wage over white-collar worker's wage grew by 37%. It fell only in manufacturing of coke and refined petroleum products, mining and manufacturing of metals. Significant growth over the industry-wide average was recorded in motor vehicle manufacturing, manufacturing of electrical machinery and apparatus, manufacturing of food and computer manufacturing.

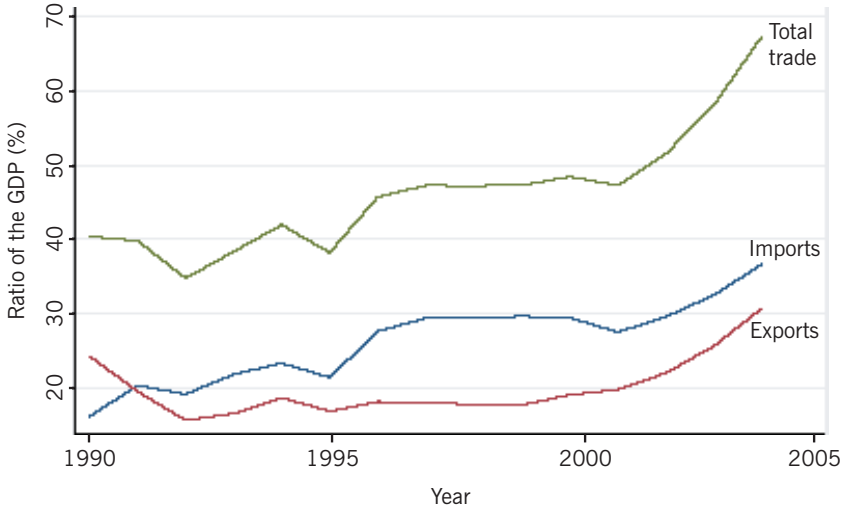
4.2. Changes in foreign trade in industrial products, 1995–2003

Literature indicates four key factors that could be responsible for changes in qualification structure of employment in industrial sector. These are: technological progress favouring high skills, changes in demand structure, migrations and international trade. In Poland, it seems that three of them are of key importance: very clear changes in demand structure (resulting from growth of the GDP per capita level, opening of the economy and changes in consumption patterns), technological shocks (to large extent related to inflow of foreign investments) and international trade. It seems that international migrations play the smallest role (there is some inflow of low-qualified

labour force form the East, but it doesn't seem to have significant impact on the overall situation on the Polish labour market). This analysis is limited only to role of one of those factors—international trade. In the period 1992—2003 openness of the Polish economy, measured with sum of exports and imported related to GDP, rose from 34.8% (minimum during the transition period) to 58.2% (see: Graph 2). In the recent years, import penetration (share of imports in consumption) grew particularly fast. Less important, but significant as well, was the growth of exports' share in GDP: in 2003 it was by 67% higher than in 1992 and accounted for 25%. Different sections were opening with different pace. In the first years, in almost all sections a growth of both import penetration and export share in GDP was recorded, although the pace of changes was different. In the last period, the changes were not that homogenous. In 2003 sections with highest (over 75%) level of export penetration were: manufacturing of motor vehicles and other transport equipment, manufacturing of radio, television and communication equipment and manufacturing of wearing apparel and furriery. The share of exports was scare at manufacturing of tobacco, in publishing, printing and reproduction of recorded media and in electricity, gas, steam and hot water supply. The last sections, however, are those where dynamics of growth were the highest. There were only two sections where export share in production fell: mining of coal (in 2003 only 16.2%) and manufacturing of metal products (29.8% in 2003).

Similarly, many of mentioned-above sections were faced with strong foreign competition. In 2003 highest import penetration was recorded in manufacturing of leather and leather products, manufacturing of wearing apparel and furring, manufacturing of motor vehicles and other transport equipment, manufacturing of radio, television and communication equipment and computers manufacturing. The scare share of imports in consumption is characteristic for manufacturing of food products, electricity, gas, steam and hot water supply, manufacturing of tobacco products and printing and publishing. In the last two sections import penetration significantly fell over last years (in the case of tobacco industry it was a fall by 50%). Significant growth of import penetration was recorded in production of wearing apparel, leather and leather products, wood and wood products, metals and in mining (where it grew from 1.5% to 53.6% [!]). Research made on the structure of the Polish foreign trade shows that Poland has revealed comparative advantage in production of goods containing a lot of low-qualified labour and physical capital (see: Michael, Śledziewska 2003). It is in accordance with predictions of neo-classical trade theory (it seems that these are factors in which Poland is relatively abundant). Still, most of our exchange has inter-industry character. The share of intra-industry trade is growing, particularly as for exchange with the EU, but much of this trade is vertically differentiated. Therefore the reasons for the exchange are similar to those underlying inter-industry trade. According to Stolper-Samuelson theorem, we should observe in Po-

land rather positive impact of trade on labour market situation of low-qualified persons: trade should pull up their wages and employment.

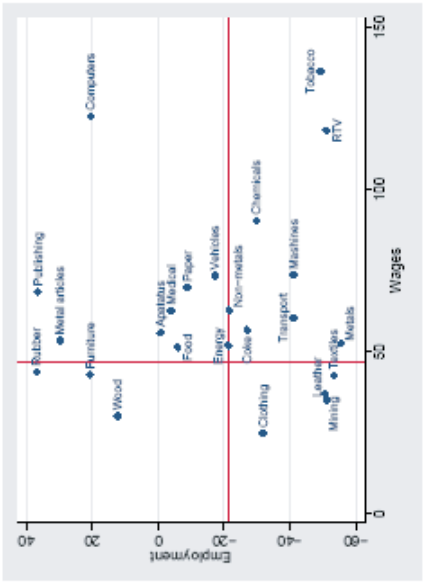


Graph 2.

Opening of Polish economy for international trade, 1990–2003
Source: own calculations based on [CSO 2004].

Analysis of changes in employment, wages and trade in sections of Polish secondary sector (during the period 1995–2003) allows us to divide those section among several typological groups. First group consist of sections that were booming: employment grew, real wages grew more than on average. These are publishing and printing, manufacturing of computers and office machinery, manufacturing of pulp and paper, manufacturing of medical, precision and optical instruments and manufacturing of metal products. It is characteristic that all those sections (with the exception of the last one) experienced high growth of exports (exceeding growth of imports) and significant growth of export penetration. The second type are these sections that reduced employment with fall of relative wage (versus industry-wide average). This group includes such sections as manufacturing of wearing apparel, manufacturing of leather and leather products, manufacturing of textiles and mining. In all these sections import penetration grew significantly, with dynamics of import penetration exceeding dynamics of exports penetration. Third class, grouping manufacturing of wood and wood products, manufacturing of rubber and rubber products and manufacturing of furniture, is characterized by growth of employment with limited growth of wages. These are sections that experienced significant growth of exports in real terms and growth of export penetration. What's more in all those sections share of exports in production is higher than the import penetration. Finally fourth group is made of sections where we observed strong fall of employment with

(a)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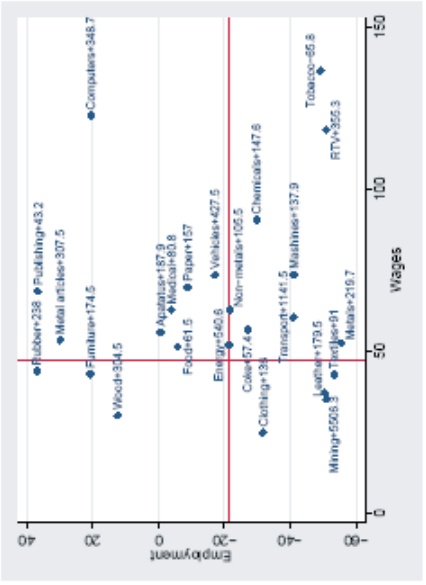
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Furniture+174.5
Wood+364.5
Apparatus+187.9
Medical+80.8
Fold+61.5
Paper+157
Energy+540.6
Vehicles+427.5
Coke+57.4
Non-metals+105.5
Chemicals+147.6
Clothing+138
Transport+1141.5
Machines+137.9
Leather+179.5
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Employment
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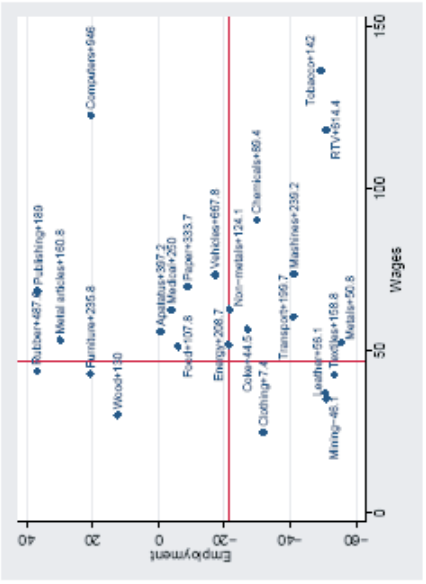
(c)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Chemicals+89.4
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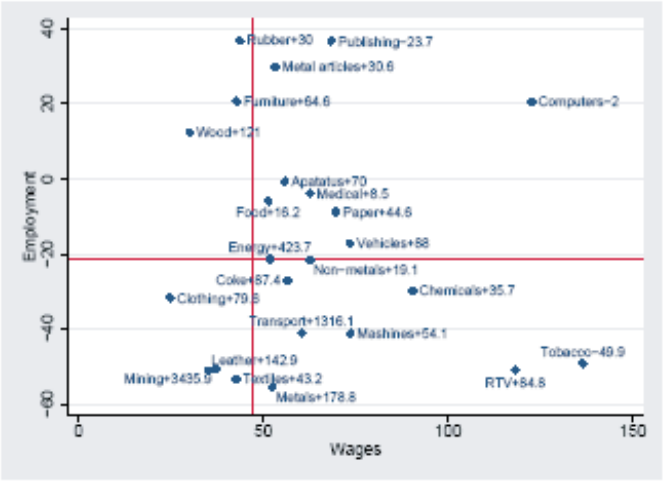

(d)

(e)

Graph 3.

Changes in employment and wages in Polish secondary sector (a) versus changes of imports (b) and exports (c) in real terms and changes of import penetration (d) and export share in production (e), 1995–2003

Horizontal line indicates industry-wide change of employment and vertical line—industry-wide change of wages. Average growth of exports in real terms accounted for 171%, and of imports—203%. Average growth of exports penetration equals to 75%, and import penetration—to 82%.

Source: author's calculations.

very dynamic growth of wages. Examples of such sections are: manufacturing of tobacco products, manufacturing of ratio, television and communication equipment, manufacturing of coke and refined petroleum products, manufacture of chemical products, manufacturing of food products and beverages and manufacturing of machinery and equipment. There is no clear pattern as for foreign trade for all those sections.

5. Impact of trade on employment in Polish industrial sector: some econometric evidence

After having presented theoretical background of the issue, key methodological approaches and changes in structure of employment and wage changes in Polish industry, now I will turn to presenting results of econometric analysis. It is based on the model of labour demand in the imperfect competition framework proposed by F. Abraham and E. Brock [Abraham, Brock 2003]. The most crucial point of his approach is possibility to take into account both: indirect and direct effects of trade (trade driven changes in productivity).

5.1. Theoretical model

The model assumes imperfect competition. We analyse single section representing the economy. In each of m countries, there are n identical firms operating in given sector. They use identical technology, therefore they are symmetric as far as production costs are concerned. It results in identical price for a given variety demanded by each of identical producers. The world consumption of goods manufactured by given sector equals to X and is modeled according to Dixit-Stiglitz approach [Dixit, Stiglitz 1977]. X_i is a production of given sector in i country. Since in each country n_i identical firms are operating, we may write down that: $X_\mathrm{i} = n_i x_i$, where x_i is the production of each firm operating in given sector in the country i. Let's assume that ó is the elasticity of substitution, where $\sigma > 0$. We may then write down:

$$X = \left(\sum_{i=1}^{m} X^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{(\sigma-1)}} = \left(\sum_{i=1}^{m} \left(n_i x_i \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{(\sigma-1)}} \tag{1}$$

where i states for different countries.

Maximalization of the utility function allows us to derive the following function of the demand for the product in the country i:

$$X_i = n_i x_i = \left(\frac{p_i}{P} \right)^{-\sigma} \frac{E}{P} \tag{2}$$

where p_i is the price demanded by all firms in country i, $P = \left(\sum_{i=1}^{m} p_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ is the

price index in given sector and $E = p_i X_i$ is the world expenditures for the good produced in the sector. Therefore the reversed demand function is given as follows:

$$p_i = \frac{E}{X}\left(\frac{X_i}{X}\right)^{\frac{-1}{\sigma}} = \frac{E}{X}\left(\frac{n_i x_i}{X}\right)^{\frac{-1}{\sigma}} \tag{3}$$

As for supply side of the model, we assume, that total production costs of a typical firm in a country i consist of fixed cost (F_i) and variable cost (C_i). Variable costs are determined by labour costs (w_i) and capital costs (r_i). To facilitate the analysis, let's assume that function of variable costs is a CRS function. Therefore, total costs (TC) can be written as follows:

$$TC = F_i + C_i = F_i + K_i A_i^{-1} \omega_i^{\gamma_i} r_i^{1-\gamma_i} \tag{4}$$

where $K_i = \gamma_i^{-\gamma_i}\left(1-\gamma_i\right)^{\gamma_i - 1}$

This expression allows us to introduce to the model both technological progress and increasing returns to scale. The profit of each firm is given by the following equation:

$$\pi_i = p_i x_i - TC$$

If we assume that firms are small enough not to influence the total level of production in the given sector, we may examine the equation (3) and find that firms perceive elasticity of demand to be constant at the level of σ. If we assume that marginal cost is equal to c_i, first order condition may be written down as follows:

$$p_i\left(1-\frac{1}{\sigma}\right) = c_i \tag{5}$$

where $c_i = K_i A_i^{-1} \omega_i^{\gamma_i} r_i^{1-\gamma_i}$

From the equations (3) and (5) we may derive the equilibrium condition for production quantity (demand quantity) of the given sector in country i:

$$X_i = \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} c_i^{-\sigma} E^{\sigma} X^{1-\sigma} \tag{6}$$

In order to derive a conditional labour demand in each firm, we use Shepard's lemma to the equation (4), what gives the following function of the labour demand:

$$l_i = K_i A_i^{-1} \gamma_i \omega_i^{\gamma_i - 1} r_i^{1-\gamma_i} x_i \tag{7}$$

Since all firms in the sector are identical, total employment in the whole sector equals to $L_i = n_i l_i$:

$$L_i = K_i A_i^{-1} \gamma_i \omega_i^{\gamma_i - 1} r_i^{1-\gamma_i} X_i \tag{8}$$

If we substitute the equation (6) to equation (8) and substitute a proper expression for c_i, the equation for labour demand in a given sector may be given as follows (after taking log):

$$\ln(L_i) = G_i + \sigma \ln(E) - (\sigma - 1)\ln(X) - (\gamma(\sigma - 1) + 1)\ln(\omega_i) - (1 - \gamma_i)(\sigma - 1)\ln(r_i) + \\ + (\sigma - 1)\ln(A_i) \tag{9}$$

where $G_i = (1 - \sigma)\ln(K_i) + \ln(\gamma_i) - \sigma \ln(\sigma) + \sigma \ln(\sigma - 1)$

In the equation (9) variable E may be interpreted as an effect of growth of all the world expenditures for given good on employment in the sector. According to the theoretical model, if $\sigma > 1$, increase in E should lead to growth of employment. Variable E is therefore measured by the level of home production and the level of exports. In the model, growing competition for the foreign producers is hidden in the growing production of the country j. Using equations (1) and (9), influence of growing foreign production on employment in a given sector of the country i may be expressed as follows:

$$\frac{d\ln(L_i)}{d\ln(X_j)} = \frac{d\ln(L_i)}{d\ln(X)} \frac{d\ln(X)}{d\ln(X_j)} = -(\sigma - 1)\left(\frac{P_j X_j}{E}\right) < 0 \tag{10}$$

As we may see, this impact is negative. What's more, the higher the share of foreign producers in the home market, (measured with $P_j X_j = E$), the stronger the negative impact on employment in the given sector.

In theoretical model variable A_i measures technology. In empirical part it is measured with labour productivity (value added per employed, *VA*). If we assume that productivity (*PROD*) is an approximation of the variable A_i from theoretical model, and therefore form the equation (9) we get:

$$(\sigma - 1)\ln(A_i) = \lambda \ln(PROD_i) + \varepsilon_i \tag{11}$$

Finally basing on the equations (9) and (11) we may write down employment equation in a given sector[3]:

$$\ln(EMPL_{it}) = \alpha_0 + \alpha_1 \ln(HOME_{it}) + \beta_1 \ln(EXP_{it}) + \xi_1 \ln(IMP_{it}) + \\ + \eta_1 \ln(WAGE_{it}) + \lambda_1 \ln(PROD_{it}) + u_{1it} \tag{12}$$

Another aspect that is taken into account in the model is the influence of trade on labour productivity. Therefore another equation is estimated, in which factors determining the level of productivity are analysed:

[3] The model does not include price of capital, which may be approximated with interest rate. However, it would be identical for all sectors and would vary only in time. Since adding dummies for each year has not influenced regression results, the capital price has been removed form the model.

$$\ln(PROD_{it}) = \beta_2 \ln(EXP_{it}) + \xi_2 \ln(IMP_{it}) + \delta_2 \ln(RD_{it}) + \phi_1 (CAP_{it}) + u_{2it} \quad (13)$$

The aim of estimating the equation (13) is to get parameters standing by trade variables. They may be positive or negative, depending on the way firms react to the increase of foreign trade. Fixed assets have been taken into account as well, since usually introduction of new labour-saving technologies is accompanied with increase of physical capital stock. Similarly spending on R&D measures technological progress that we observe in given sector. Adding both effects allows us to assess total influence of exports and imports for employment:

$$\begin{aligned} \ln(EMPL_{it}) = \alpha_0 + \alpha(HOME_{it}) + \beta \ln(EXP_{it}) + \xi \ln(IMP_{it}) + \\ + \eta \ln(WAGE_{it}) + \delta \ln(RD_{it}) + \phi \ln(CAP_{it}) + u_{it} \end{aligned} \quad (14)$$

where:

$\alpha = \alpha_1$
$\beta = \beta_1 + \lambda\beta_2$
$\xi = \xi_1 + \lambda_1\xi_2$
$\eta = \eta_1$
$\delta = \lambda_1\delta_2$
$\phi = \lambda_1\phi_1$

Therefore eventually we estimate equations (12) and (13). Estimation of parameters of these two equations allows us to find parameters of the equation (14) and to assess total (direct and indirect) influence of trade on employment.

5.2. Data and econometric method

Above equations have been estimated with data on Polish secondary sector (mining, manufacturing industry and energy, gas, and water supply) for the years 1995–2003 (NACE classification at the two-digit level of aggregation: 24 sections, 9 years). Data on trade comes from WTO PCTAS database (PCTAS 1995–1999 and PCTAS 1997–2001) and from yearbooks of Foreign Trade Statistics (years 2002–2003, CSO). Other data came form successive editions of Statistical Yearbook of Industry by CSO (editions 1996—2004). As for value added and sold production it was necessary to use chain growth indices (at fixed prices). Data on employment regards average level of employment at given year and refers to full-time hired employees and part-time in terms of full-time hired employees. As for data on employment of blue-collar workers and white-collar workers, it refers only to entities employing 9 persons or more (in previous periods—to even bigger firms), which results in a fact that data on total employment and blue/white collar workers is not fully coherent. Data on wages was deflated with prices of sold production (production wages). As for data on capital input, gross value of fixed assets was chosen as a measure. It was deflated with sold production indices. Similarly expenditures on innovation activity and new technologies were deflated. Expendi-

tures include expenditures on R&D activity, acquisition of disembodied technology and know-how (patent, non-patent innovations, licenses, disclosures of know-how etc.), acquisition of fixed assets required for innovations introduction, other preparation for implementation of innovation (necessary training, marketing etc.). Before starting estimation procedure, logs of all variables were taken. Estimation was made with Stata packet, with methodology of general least squares for panel data. Hausaman test showed that we may use random effect model and since test for heteroscedasticity of the panels showed that it is necessary to include correction for heterogeneity of variance, a FGLS method of estimation was used. First, the equation (12) was estimated, then (13) and (12) again, but as variable PROD were used fitted values form estimation of the equation (13). Therefore the employment equation included only changes in productivity caused by trade, changes in capital stock and expenditures for innovation. The procedure was repeated for blue- and white-collar workers.

5.3. Estimation results

Table 1 presents the results of estimation of the equation (12) for total employment—in two versions: with value of imports in fixed prices (a) and with degree of import penetration (b) as an approximation of variable IMP. Further estimations showed that as for employment equations with fitted values of productivity equation (13), variable IMP influenced employment in a statistically significant way only if it is approximated with import penetration, not total value of imports. Since that in all further estimations (c–f) the share of imports in consumption was used as a measure of IMP. As a next step parameters of productivity regression (c) were estimated and then—three employment equations (12)—for total employment, for blue-collar employment and for white-collar employment—all with fitted values of regression (c). Then total—direct and indirect—effect of trade on employment was calculated. Most of variables appeared to be statistically significant at 1% level of significance. Estimators had expected signs. Employment is positively related to final goods demand (domestic sales and exports, with much higher elasticity versus domestic sales). It is in accordance with expectations basing on information of the level of openness of Polish economy and importance of particular elements of aggregated demand for GDP and its derivatives. However, it may be interesting to compare the value of estimators of employment elasticity versus domestic demand in case of blue and white-collar workers. Knowing the structure of comparative advantage of Polish economy, we may expect that elasticity of employment versus domestic sales is higher for white-collar workers that for blue-collar. The results confirm this prediction.

On the other hand, the relation versus wages, productivity and imports (measured both in absolute value and in relative terms) was negative. Trade flows have small, but statistically significant impact on labour productivity. We may find some support for hypothesis that foreign competition "acti-

vates" domestic industry and leads to higher productivity: increase of import penetration by 10% increased labour productivity by 0.85%. However, we may be somehow surprised with exports' effect: it is negatively related to labour productivity. It may be a result of Polish comparative advantages' structure. As for exports, we specialize in production of labour-intensive goods. With relatively low labour costs, it may give incentives to increase employment and develop labour-intensive techniques. As we may have expected, productivity is positively related to capital investments (increase of fixed assets by 10% leads to productivity growth by 2.5%) and to innovation expenditures (growth of expenditures by 10% increases labour productivity by 1.2%.).

After inserting to the equation (12) fitted values from equation (13) parameters of the regressions were estimated once again ((d)–(f)). The signs of estimators have not changed and all variables were significant at the level of 1%, with the exception for import penetration in the regression (f) (significance at the level of 35%).

Table 3 present calculation of total (direct and indirect)—impact of trade for employment. Both direct and indirect impact of exports on employment is positive. It means that exports stimulates labour demand both—by directly stimulating demand for final goods and has indirect impact—by lowering labour productivity and therefore increasing labour demand. The first effect dominates. Total elasticity of employment versus exports equals to 0.43. The impact of exports on blue-collar workers was stronger (0.52). For low-skilled workers, the direct effect is more important (77% of total effect versus 71% for total employment). For white-collar workers situation is somehow different (0,22), with 67% share of direct effect.

Elasticity of employment versus import penetration is negative and—as for absolute value—smaller than in case of exports (–0.19) and is significant parameter only for blue-collar workers. As 43% of total import impact may be attributed to its direct effect, in the case of blue-collar workers it is much higher (92%). It is worth noting that elasticity of employment versus trade flows is higher than in Western Europe. Abraham and Brock [2003] estimated elasticity versus exports at the level from 0.06 in France to 0.19 in Sweden. Relatively strong effects of export demand were recorded in Belgium (0.16) and UK (0.17). Polish result (0.31) is much higher than those results. It may be related to higher labour intensivity of Polish exports, comparing to Western European countries. In Poland, however, the effect of import penetration is much smaller, particularly in comparison to Scandinavian countries where it reaches even 0.40–0.45.

The impact of trade on productivity is different than in Western European countries as well. In Western countries exports is linked with productivity growth, with elasticity between 0.10 (Spain) and 0.33 (Belgium). In Poland, exports is linked with lower productivity. It probably doesn't mean that exports causes fall of productivity in manufacturing of goods competing goods, but is rather related to growth of production share of low-productivity goods (ex-

port sucking). While in Western European countries it seems that import competition doesn't influence firms' behaviour or even decrease productivity, in Poland rather the opposite is the truth: the higher import penetration and degree of competition pressure from abroad, the higher productivity in Polish industry.

Table 1.

Estimation results

	(a)	(b)	(c)	(d)	(e)	(f)
Parameters	**FGLS**	**FGLS**	**FGLS**	**FGLS**	**FGLS**	**FGLS**
Number of observations	214	214	214	214	214	214
Number of groups	24	24	24	24	24	24
Number of periods	9	9	9	9	9	7
Wald statistics χ^2	2915.13	2814.08	132.30	1628.37	925.33	1416.38
Probability > χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	–34.48	–36.96	–128.17	–39.76	–83.29	–42.59
Estimated variable	ln(*EMPL*)	ln(*EMPL*)	ln(*PROD*)	ln(*EMPL*)	ln(*EMPL* – *ROB*)	ln(*EMPL* – *NIEROB*)
Log of production sold on domestic market in real terms	0.567** (0.016)	0.440** (0.022)		0.544** (0.030)	0.457** (0.037)	0.612** (0.025)
Log of labour productivity (value added per one employee)	–0.438** (0.048)	–0.448** (0.050)				
Log of hypothetical productivity calculated as fitted values of equation (c)				–1.272** (0.081)	–1.224** (0.095)	–0.765** (0.067)
Log of value of exports in real terms	0.375** (0.018)	0.391** (0.019)	–0.097** (0.030)	0.308** (0.025)	0.398** (0.034)	0.147** (0.022)
Log of imports in real terms	–0.136** (0.021)					
Log of import penetration degree		–0.188** (0.025)	0.085** (0.030)	–0.082** (0.028)	–1.122** (0.036)	0.019** (0.020)
Log of average wage in real terms	–0.436** (0.074)	–0.499** (0.074)		–0.320** (0.016)		

	(a)	(b)	(c)	(d)	(e)	(f)
Parameters	FGLS	FGLS	FGLS	FGLS	FGLS	FGLS
Log of average wage of blue-collar worker, in real terms					–0.309** (0.065)	
Log of average wage of white-collar worker, in real terms						–0.188** (0.051)
Log of value of capital per employee, in real terms			0.246** (0.051)			
Log of value of innovation expenditures per employee, in real terms			0.122* (0.031)			
Constant	–3.408** (0.426)	–2.622** (0.448)	3.370** (0.432)	–1.877** (0.455)	–2.350** (0.512)	–4.763** (0.453)

Source: Author's calculations.

Table 2.

Direct and indirect effect of trade for employment in Polish industry, 1995–2003

	Direct impact of trade for employment	Impact of trade for employment through productivity	Total impact of trade
Impact of exports on total employment	0.308	–1.272 (–0.097) = 0.123	0.431
Impact of imports on total employment	–0.082	–1.272 (0.085) = (–0.108)	–0.190
Impact of exports on employment of blue-collar workers	0.398	–1.224 (–0.097) = 0.118	0.516
Impact of imports on employment of blue-collar workers	–1.122	–1.224 (0.085) = (–0.104)	–1.226
Impact of exports on employment of white-collar workers	0.147	–0.765 (–0.097) = 0.074	0.221
Impact of imports on employment of white-collar workers	–0.019	–0.765 (0.055) = (–0.065)	–0.084

Source: Author's calculations.

5.4. Quantitative employment effects of trade

The presented-above estimates of elasticity of employment versus exports and import penetration allows us to calculate hypothetical change in total employment, in employment of blue-collar workers and white-collar workers caused by changes in trade flows in the period 1995–2003. For each section, relative change in exports in real terms, relative change in imports in real

terms and relative change in import penetration were calculated. Then the average level of total employment, and of blue- and white-collar workers is calculated as well. In the next step, with elasticity estimator (from Table 2), the relative change in employment caused by trade variable is estimated. The procedure has been repeated for regressions (a), (b), (d), (e) and (f). All sections, with the exception for mining of coal and lignite experienced the growth of exports in real terms. With positive elasticity of employment versus exports, we get a result of employment increase due to exports expansion. In the whole industry we get estimates from 1930 thousand (regression (a): only direct effect of trade, imports in absolute value) to 2220 thousand (indirect effect of trade as well). The highest absolute growth was observed in the production of motor vehicles and trailers, manufacture of machinery and equipment, manufacturing of rubber and plastic products and manufacture of food products and beverages. On the other hand, exports doesn't seem to stimulate employment in manufacturing of wearing apparel (in spite of high openness) and in manufacture of coke and refined petroleum. At the same time, most of sections experienced growth of import penetration, which entailed fall of employment.

Although the sensitivity of employment versus import penetration is much smaller than in case of exports, high dynamics of inflow of goods to Poland resulted in high quantitative effects. Estimated fall of employment caused by growing imports varies from 2.1 mln (estimate with indirect effect of import penetration) to 2.5 mln (absolute value of imports, not import penetration). However, there are sections where impact of trade is insignificant. These are: manufacturing of food products and beverages, publishing, printing and reproduction of recorded media, manufacture of coke, refined petroleum. On the other hand, the highest (relative) fall of employment (except of mining, see further for comment) took place in manufacturing of wood and wood products, manufacture of radio, television and communication equipment and in the manufacturing of motor vehicles. If we therefore measure imports with import penetration, in the years 1995–2003, total effect of economy opening for international trade may be estimated to be somehow between –600 thousand (only direct impact) do +100 thousands of jobs (indirect impact as well). These are rather small changes not being significant for total changes of employment in industry. Positive effect of exports and negative effect of imports to much degree neutralise one another: higher—as for absolute value—elasticity of employment versus exports is compensated with more dynamic change of import penetration. However, we should notice that as for job destruction, mining industry played dominating role (about 70% of total job loss). Estimates based on regressions (a), (b) and (d) indicate the total loss of about 1.5 million jobs only in this section (!). The effect was particularly visible in estimates of impact of trade on employment of blue-collar workers, where over 35-times growth of import penetration in mining (from 1.5% to 54%) caused the result of 8 million jobs lost in mining and about 11 million in

the whole industry. Therefore we might consider removing mining industry from the sample. It may be justified with specifics of this sector, on-going restructuring process, relatively high level of trade coverage and close link between economics and politics. The change of import penetration was exceptionally high as well and was significantly higher than in the case of other sections.

Table 3.

Quantitative effects of trade for industrial employment, without mining

	Change caused by exports	Change caused by imports	Net effect
(a)	1970.3	–829.0	1141.3
(b)	2054.4	–624.3	1430.1
(c)	2264.6	–630.9	1633.7
(d)	1847.8	–2880.1	–1032.3
(e)	267.2	–67.1	200.1

Source: Author's calculations.

Not taking mining of coal and lignite into account gives us a completely different picture of trade influence on employment (see: Table 3). In the period 1994–2003, international trade has caused an increase of employment in manufacturing and electricity, gas, steam and hot water supply. Then, if not for trade influence, the drop of employment that we observed in the 1990s would have been even deeper (loss of 2 million job instead of 750 thousand). In the same time, in spite of favourable for low-skilled persons results of estimation of employment elasticity versus trade, if we take into account changes that took place in export value and import penetration, we find that trade causes fall of employment of blue-collar workers. To some extent (about 20%) it is compensated with employment of high-skilled persons.

6. Summary

Studying links between trade and labour market seems especially important in the context of growing trade openness of Poland and ongoing process of integration within the EU. The analysis presented in this paper provides an empirical proof of significant impact of trade on the labour market in Poland. Exports tend to increase employment, while imports decrease it, which is quite intuitive. But contrary to many existing opinions, this impact is rather moderate and per saldo—positive. Despite continuous trade deficit, the increase in employment induced by exports exceeds its loss induced by imports. This is consistent with comparative advantage structure for Polish economy.

Furthermore, overall employment effect is stronger for blue-collar workers. We can therefore argue that increasing international trade is not the fac-

tor, which stands behind reduction of industrial employment. Probably other factors are at work, and international trade impact on the labour market is rather positive (reducing scale of employment decrease), if any. It seems, however, that international trade may be responsible for widening wage and unemployment rates differentials for high-skilled and low-skilled labour. The elasticity of low-skilled employment with respect to import penetration and dynamics of opening to international competition are very high, which makes net employment effect for low-skilled negative by increasing exports and imports. Quantitative effects of trade impact on high-skilled are significantly smaller. Nevertheless, if we take into account that employment of high-skilled decreased by 300 th. between 1994–2003, then the increase of employment by 200 th. induced by international trade is quite substantial. Presented analysis does not fully answer the question of trade impact on the labour market.

Some possible extensions of this research could involve studying employment effects for groups of industries: export-oriented, import-competing, and non-trading. Other possible direction could be studying the differences of impact of trading partners—the EU countries, East Asian countries, an so on. Further analysis should also include more industry characteristics—level of privatization, foreign ownership share, but also more labour force characteristics—age, gender, job experience or occupation.

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Abstract In this article I am trying to address the question of impact of international trade on employment and its skill structure in the Polish secondary sector. After presenting stylized facts concerning changes in employment and wages in the years 1994–2003, I estimate elasticity of employment versus international trade flows. Both direct and indirect effects (impact of trade through changes in labour productivity) are taken into account. The elasticity appears to be positive in the case of exports and negative as far as imports is concerned, but is much higher—as for absolute value—in the case of outflow of goods from Poland. What's more, the sensitivity of employment for international trade appears to be much higher in the case of blue-collar workers than in the case of white-collar workers. Using estimated parameters and relative changes in trade in the analyzed period, the quantitative effects of trade are estimated: in spite of high dynamics of import penetration, higher elasticity of employment versus exports results in positive general effect of trade for employment (about 1.6 million workers as for secondary sector except for mining). It seems therefore that there are different factors that lie behind fall of employment in manufacturing (changes in demand structure, industry structure, technological shocks) and the main effect of trade was a changes of both skill and branch structure of employment.