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**Does Opening the Economy Affect Labor Productivity?
Estimating Full Labor Content of Trade for Poland**

Abstract

Opening the economy was one of the most important components of transition in Poland. This process started in 1990, although some steps towards it could be seen in the late 80s.

One of the basic concepts of international trade theory is that the economy benefits from its openness to international trade. The main question put in this paper is: Can we prove, on the basis on available statistics, that changes in Polish foreign trade during the transition period influenced the effectiveness of the economy, and if so, to what extent?

The study is based on two input-output tables showing the situation in 1990 (at the beginning of transition process) and in the year 2000 (when the process was over, or near to be over). Using the i-o data allowed for investigating the phenomena at more detailed level than it is done in most studies, which concern macroeconomic scale.

To estimate the differences in labor productivity between goods produced for domestic purposes and for export, the full content of labor was calculated. The calculations were based on Leontief inverse, which allowed for including costs of materials.

Introduction

One of the most important processes during the transition in Poland has been the changing foreign trade pattern and, generally, opening the economy,

which means not only an increase in the role of export and import, but also in the sense of the FDI inflow. Liberalization of foreign trade and opening the market, forced a significant rise in labor productivity.

Benefits from trade and generally, openness of the economy to international trade, has been widely discussed theoretically, and investigated using empirical evidence. Most studies concern macroeconomic level, and find positive influence of openness on GDP growth (see, for example, Harrison 1996 or Vamvakidis 2002).

The main question put in this paper is: Can we prove, on the basis on available statistics, that changes in foreign trade influenced the effectiveness of the economy, and if so, to what extent?

The study is based on two input-output tables showing the situation in 1990 (at the beginning of transition process) and in the year 2000 (when the process was over, or near to be over).

The conclusions are drawn upon studying relative labor productivity in branches, and average labor productivity calculated for export, import, and production for domestic purposes. Using i-o tables allow not only for analyzing overall openness in sense of growth in shares of foreign trade in the economy, but also for investigating the impact of changes in the structure of foreign trade. Using the Leontief inverse allow for estimation of full factor content of final production, including costs of materials.

The input-output multiplier (based on Leontief inverse) was used for estimating labor content of exported goods and services, and comparing it with the labor content of production for domestic purposes.

Openness of the economy

There are many definitions of "openness" (for short overview see, for example, Yanikkaya 2003), even if it is narrowed to "trade openness". However, trade openness measures can be divided into two major categories: measures of trade volumes (intensity of trade), and measures of trade restrictions. In the modern literature the term "openness" is used in much broader sense, including other aspects of international cooperation, first of all flow of production factors. This study concerns measures of trade intensity.

Before 1990 Polish economy was relatively closed, but far from autarky. Foreign trade was centrally organized and influenced by political circumstances. Distorted prices, fixed exchange rates, the so-called transfer ruble etc. suppressed the external trade and impacted its structure. Centrally planned

economy restricted foreign trade to a higher or lower degree throughout the period 1945-1989. Apart from inefficient foreign trade rules, a relatively low volume of exports was caused by inefficient system of production. Generally, Polish industrial products were not competitive. The most important exported good was coal. Scarce foreign currencies were allocated not according to market rules, but political decisions.

Soon after the fall of the centrally planned economy and COMECON, regulations in Polish foreign trade gradually changed towards the future joining the EU. Until 2002 the volume, as well as value calculated in USD, of commodity imports increased almost six times compared to 1990. According to National Accounts, the volume of imports of goods and services increased about 4,5 times. Similar tendencies were shown in export, but the rise was not so high. It reached 2,75 times for commodity export, and about 3 times for goods and services (in constant prices).

The changes in relative prices of export have been more dynamic, so that we can see a significant growth of the export/GDP ratio in the 90s only if the ratio is calculated in constant prices. Calculated in current prices, it seems rather stable.

Fig. 1 and Fig 2. show two most commonly used measures of trade intensity. Although the measures are different, and their scope is also not the same (Fig. 1 concerns only commodities, and Fig. 2 all products), they look quite similar. In the eighties we can observe low and rather stable levels of trade intensity, then with the beginning of nineties they start to rise. This process doesn't seem to be over.

Figure 2 shows also the evolution of price structure at the beginning of nineties. Prices of services grew faster than prices of commodities. Because services are less tradable than services, GDP deflator grew faster than trade deflators. Trade intensity calculated in nominal terms grew slower than calculated in real terms. At Fig. 1. both lines follow, more or less, the same path, which means that for commodities prices of imports, exports and output were kept close to each other.

Figure 1. Openness of the Polish economy 1985-2002.
Import/(Output-Export)*100%, commodities
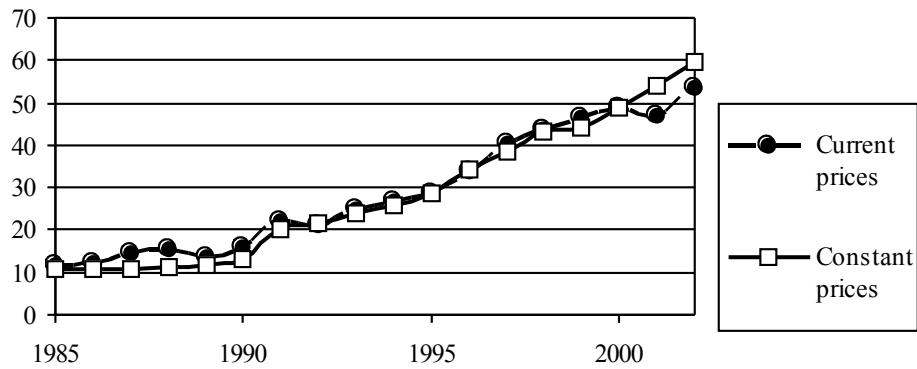
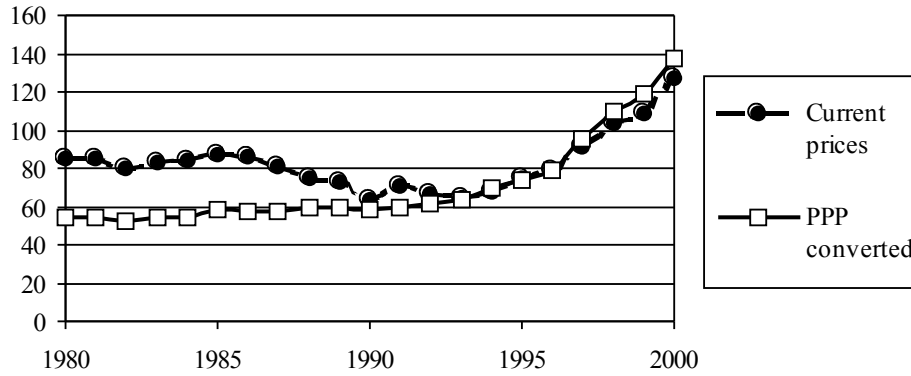Source: Polish Statistical Office.

Figure 2. Openness of the Polish economy 1980-2000. (Import+Export)/GDP*100%
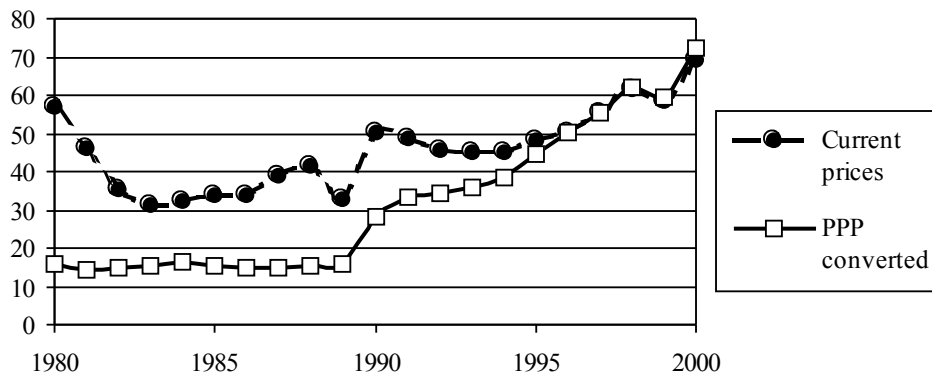
Source: Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center
           for International Comparisons at the University of Pennsylvania (CICUP), October 2002.

Opening the economy is a common tendency for all transforming
economies; we can observe these phenomena in other Central and East
European countries. Figures 3 and 4 show indices of trade intensity for
Hungary, Czech Republic and Slovakia. The indices are much higher than in the
case of Poland, following the general rule saying that smaller countries are more
involved in foreign trade than bigger ones.

Figure 3. Openness of the Hungarian economy 1980-2000. (Import+Export)/GDP*100%

Source: Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center
        for International Comparisons at the University of Pennsylvania (CICUP), October 2002.
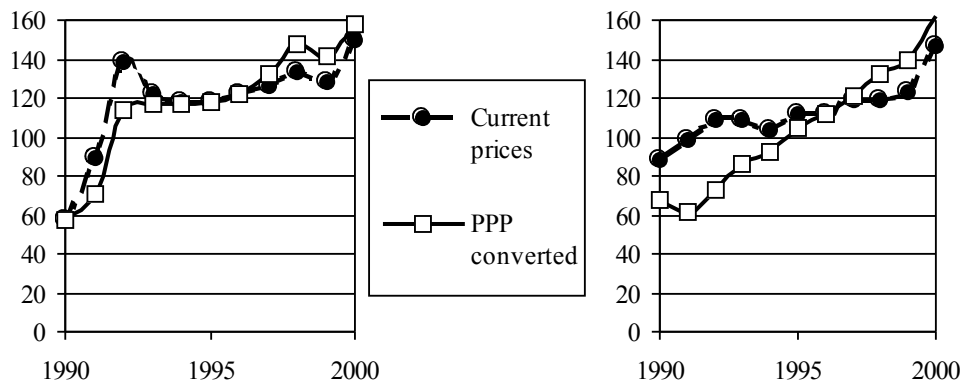
**Figure 4. Openness of the Czech (on the left) and Slovak (on the right) economies
1995-2000. (Import+Export)/GDP*100%**

Source: Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center
        for International Comparisons at the University of Pennsylvania (CICUP), October 2002.

There are three main reasons for the observed process of growing
intensity of trade:
1) changes in regulations towards free market,
2) preparations for accession to the EU,

3) global tendency to increase the trade turnover caused by more effective means of communications and transportation, growth in incomes etc., which in the case of transforming economies might be particularly strong.

Decomposition of the growth in openness according to the above list is not possible analyzing a single country's performance and, in fact, was never done. Theoretical and empirical studies for Poland are concentrated on the second group of factors, i.e. the effects of accession (see for example Wysokinska, Witkowska 2004).

Data source

Calculations of trade intensity and its impact on labor productivity require compatible data sets for trade, production and employment. At the macro level the problem of data doesn't exist, but analysis according to types of products is rather difficult, because the most common classifications used for trade statistics (SITC and PCN) don't fit to NACE, which is the base for labor and production statistics.

Input-output tables are a good solution for this problem. Such a table is a concise set of data and each economic category fits to another. Additionally, the framework of the table allows to control the calculations.

In the reality things are, of course, not so easy. I-o tables published by Polish Central Statistical Office differ from each other significantly, so any static analysis might be considered quite precise, but changes in time might be investigated only after time-consuming recalculations.

For the purpose of this study two i-o tables were used. The first one describes the economy in 1990 – the starting year of transition. This table (Bilans…1992) is based on the MPS (old Material Product System) and recalculated to the SNA with old classification of products and activities, in the product by industry layout, at the level of 43 categories, including 27 categories of commodities (and 16 kinds of services).

The second table (Bilans…2004) contains data on 2000 and its framework is quite close to Eurostat suggestions. It is a symmetric i-o table with products as the dimension of both rows and columns, distinguishing originally 54 categories, but due to the lack of data on employment, aggregated to 39 categories including 27 categories of commodities (and 12 kinds of services). The table is prepared in conformity with the SNA.

There are no price deflators available, so it is impossible to make any calculations in real terms.

Data on employment were taken from statistical yearbooks, published by Polish Central Statistical Office.

Measures

Most common measure of trade intensity at macroeconomic level is the ratio of trade turnover (import + export) to GDP. Formulating this measure for specific product, or group of products, is possible using two different denominators:

$$IT_i^X = \frac{E_i + M_i}{X_i} \cdot 100\% \tag{1}$$

or
$$IT_i^V = \frac{E_i + M_i}{V_i} \cdot 100\% \tag{2}$$

where:

E_i – export of products of i-th category,

M_i – import of products of i-th category,

X_i – output of products of i-th category,

V_i – value added of products of i-th category.

To compare indices (1) and (2) for both years, the data was aggregated to 30 types of products. Results can be found in Tab. 1.

The most spectacular growth can be found for crude oil, natural gas and mining products, as well as for textiles and textile products. Generally, commodity trade became more intensive, and for almost all categories of commodities the growth in indices exceed average (which is about 1.4 times in terms of output and 1.5 times in terms of value added). In case of services, only construction and trade encountered growth of trade intensity, narrowly exceeding the average.

Table 1. Intensity of trade (%) – types of products

Products	Based on output		Based on value added	
	1990	2000	1990	2000
Agriculture, hunting, forestry and fishing products	8,48	12,67	18,61	36,28
Crude oil, natural gas, metal ores and other mining products n.e.c.	41,19	361,16	109,15	664,07
Food, beverages and tobacco products	15,64	17,95	44,04	87,18
Textiles and textile products	28,16	177,58	65,84	482,65
Wearing apparel, furs	32,13	71,41	67,25	184,71
Leather and leather products	24,17	107,13	58,29	284,03
Wood and products of wood	21,46	44,90	54,51	158,13
Paper and paper products	25,39	96,80	72,06	431,49
Printed matter and recorded media	5,63	8,36	5,68	20,40
Coal, lignite, peat, coke, refined petroleum products	62,45	23,93	155,88	65,50
Chemicals and chemical products, rubber and plastic products	43,23	98,32	120,25	302,33
Other non-metallic mineral products	12,45	33,14	30,82	94,02
Basic metals	35,93	78,06	96,43	392,57
Fabricated metal products, except machinery and equipment	22,79	56,00	57,50	151,14
Machinery and equipment	75,70	132,21	153,52	380,03
Office machinery, computers, electrical machinery and apparatus n.e.c., rtv and communication equipment and apparatus	43,31	163,92	105,06	508,32
Medical, precision and optical instruments, watches and clocks	118,02	104,23	211,91	261,35
Motor vehicles and other transport equipment	40,67	113,16	90,44	479,77
Furniture, other manufactured goods and recycling	12,17	70,91	70,84	214,58
Electricity, gas, steam and hot water	2,38	1,67	7,35	4,84
Cold water and its distribution	0,00	0,00	0,00	0,00
Construction services	5,56	7,82	10,63	21,59
Trade and repair services	4,70	14,80	7,04	23,76
Hotel and restaurant services	5,73	5,48	13,27	11,40
Transport, storage and communication services	41,05	36,99	104,03	86,67
Financial intermediation services and other services	16,81	15,40	29,66	35,00
Real estate and business services	12,89	6,06	20,89	11,43
Public administration services	0,00	0,00	0,00	0,00
Education services	0,00	0,00	0,00	0,00
Health services	1,62	0,19	2,96	0,27
Average	21,52	31,02	45,28	69,41

Source: Author's calculations based on Bilans…(1992) and Bilans…(2004).

There is no evidence on trade of cold water and its distribution, public administration services and education services. Values of export and import of these categories of services might be negligible, but it is also possible, that the statistical system just could not record actual values, and zeros were put by definition. It is hard to believe that foreign students in Poland paid in 2000 altogether less than 1000 Polish zlotys[1], that was about $300, for their education; the same applies to Polish citizens studying abroad.

Labor productivity

Labor productivity is measured as nominal value of output or nominal value added, alternatively, divided by a number of full time workers. In both cases, the numbers are not comparable in time because of inflation. To estimate the relative changes in labor productivity, deviations from average labor productivity were calculated.

Results are shown in Tab. 2. In 1990 the interval covering deviations was extremely wide. The highest labor productivity in 1990 was recorded for coal, lignite etc., which was then more than 7 times higher than the average in the case of output and almost 6 times in the case of value added. The less productive categories were agricultural products and cold water and its distribution. The highest value was greater over 30 times than the lowest.

In 2000 the spread of deviations accounted for 26 times. Agricultural products were still the less productive category of products. Coal, lignite etc. experienced the most dramatic fall of labor productivity. It is worth noticing, that this category of products was the only one among non-service categories that reduced its trade intensity. The highest rise in labor productivity was recorded for crude oil, natural gas and mining products, category which experienced also the highest growth in trade intensity index.

To find any correlation between trade intensity and labor productivity values of linear correlation coefficients were calculated. Their values were respectively: 0.39 for the measures based on output, and 0.34 in the case of value added.

The above results can not undoubtedly prove that growth in labor productivity was caused by opening the economy, but these two processes seem to be, to some extent, correlated.

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[1] All values published in the i-o table were given in thousands of zlotys.

Table 2. Labor productivity - types of products, percentage deviations from average

Products	Based on output		Based on value added	
	1990	2000	1990	2000
Agriculture, hunting, forestry and fishing products	-72,70	-83,52	-73,82	-87,13
Crude oil, natural gas, metal ores and other mining products n.e.c.	-41,00	101,99	-53,16	145,82
Food, beverages and tobacco products	195,92	58,06	121,16	-27,18
Textiles and textile products	-15,04	-2,56	-23,56	-19,78
Wearing apparel, furs	-2,20	-40,23	-1,69	-48,29
Leather and leather products	-1,38	-25,60	-13,99	-37,20
Wood and products of wood	21,67	17,61	0,78	-25,27
Paper and paper products	51,18	160,15	12,07	30,60
Printed matter and recorded media	62,38	113,29	238,57	95,68
Coal, lignite, peat, coke, refined petroleum products	725,44	143,65	595,70	99,17
Chemicals and chemical products, rubber and plastic products	152,03	132,39	90,63	69,11
Other non-metallic mineral products	18,66	49,06	0,85	17,55
Basic metals	357,22	124,94	258,38	0,09
Fabricated metal products, except machinery and equipment	82,40	27,79	52,10	5,96
Machinery and equipment	24,51	24,32	29,17	-3,22
Office machinery, computers, electrical machinery and apparatus n.e.c., rtv and communication equipment and apparatus	50,51	99,30	30,52	43,82
Medical, precision and optical instruments, watches and clocks	16,38	34,15	36,37	19,72
Motor vehicles and other transport equipment	53,90	150,29	45,62	32,10
Furniture, other manufactured goods and recycling	62,38	6,67	-41,31	-21,12
Electricity, gas, steam and hot water	294,64	164,51	168,45	104,73
Cold water and its distribution	-73,21	-5,32	-44,18	10,98
Construction services	6,90	60,53	17,71	30,12
Trade and repair services	2,99	19,46	44,75	66,51
Hotel and restaurant services	-9,12	-3,01	-17,43	4,33
Transport, storage and communication services	-10,89	30,09	-26,02	24,25
Financial intermediation services and other services	90,54	35,90	124,77	33,77
Real estate and business services	90,11	83,19	122,33	117,25
Public administration services	148,16	26,66	281,00	111,43
Education services	-61,42	-55,80	-38,92	-19,70
Health services	-46,91	-55,71	-38,80	-29,88

Source: Author's calculations based on Bilans…(1992), Bilans… (2004), and statistical yearbooks published by Polish Central Statistical Office.

Average labor productivity

Another way of investigating the impact of trade on labor productivity is calculating average labor productivity for import, export and domestic production, using the following formulas:

$$\frac{\sum_{i}\left(X_i - E_i\right)}{\sum_{i} n_i\left(X_i - E_i\right)} \tag{3}$$

$$\frac{\sum_{i} E_i}{\sum_{i} n_i E_i} \tag{4}$$

$$\frac{\sum_{i} X_i}{\sum_{i} n_i X_i} \tag{5}$$

$$\frac{\sum_{i} M_i}{\sum_{i} n_i M_i} \tag{6}$$

Because labor productivity might be considered in terms of output or value added, above formulas were calculated twice, first defining: $n_i = \dfrac{N_i}{X_i}$, and then redefining: $n_i = \dfrac{N_i}{V_i}$, where N_i is the number of full time employees producing goods and services of *i*-th category.

The above averages present labor productivities of production for domestic purposes (3), and for export (4), labor productivity of domestic production (5) hypothetical labor productivity of import, if the imported goods were produced in Poland (6).

Results are shown in Tab. 3. As it was mentioned before, the numbers cannot be compared in time. PLZ and PLN symbols denote the old and new Polish currency.

Table 3. Average labor productivity

Average labor productivity of:	No. of formula	In terms of output		In terms of value added	
		1990, mln PLZ/employee	2000, th. PLN/employee	1990, mln PLZ/employee	2000, th. PLN/employee
Production for domestic purposes	(3)	74,57	90,25	36,14	41,34
Production for export	(4)	92,46	120,90	37,98	45,04
Domestic production	(5)	76,44	93,48	36,33	41,77
Import (hypothetical value)	(6)	116,42	131,77	50,92	43,88

Source: As in Tab. 2.

Higher labor productivity was achieved for export production, than for production for domestic purposes. The difference is quite small in the case of value added, but significant when calculated in terms of output. The relations between numbers in rows of Tab. 3 in 2000 are similar to the relations of 1990.

There is not much difference between labor productivity of domestic production and production for domestic purposes.

The conclusion from comparing last two rows of Tab. 3 is that Polish import is more "productive" than domestic production. It means, that products imported to Poland are more technologically advanced in the sense of higher labor productivity, than goods and services produced in Poland. What is worth noticing, the significant gap in 1990 in terms of value added was reduced in 2000.

I-o table for 2000 contained information on trade with the EU, so it was possible to compare average labor productivity of trade with EU and other countries (see Tab. 4). The EU seems more technologically advanced than other partners, as Poland exports there less "productive" goods and services and imports more "productive" - than to the other countries.

Table 4. Average labor productivity in 2000: Trade with the EU

	th PLN of output / employee	th PLN value added / employee
Export to the EU	118,9	44,95
Other export	125,8	46,56
Import from the EU	138,15	44,91
Other import	122,86	42,36

Source: Author's calculations based on Bilans… (2004), and statistical yearbooks published by Polish Central Statistical Office.

Leontief inverse and full labor content of final demand

All calculations presented above took into account only the workforce employed directly at the last stage of production. To calculate full labor content of trade, which means including also employment at the intermediate stages of production, input-output methodology must be used.

According to the notation presented previously, the total number of full time workers may be written as:

$$N = n_1 X_1 + n_2 X_2 + ... + n_n X_n \tag{7}$$

In, more convenient, matrix notation this can take the form:

$$N = \mathbf{n}' \mathbf{X} \tag{8}$$

where: $\mathbf{n}$ is the vector of n_i, calculated on the basis of output, and $\mathbf{X}$ is the vector of outputs. According to one of the basic input-output relations, vector of output may replaced by:

$$N = \mathbf{n}'(\mathbf{I} - \mathbf{A})^{-1} \mathbf{Y} \tag{9}$$

where: $\mathbf{Y}$ is the vector of final demand, and $\mathbf{A}$ is the matrix of input-output coefficients. $(\mathbf{I} - \mathbf{A})^{-1}$ is a matrix, called Leontief inverse, which elements in an i-th column represent the average cost of each product used to produce a unit value of i-th category of products.

Final demand can then be split into several categories:

$$N^k = \mathbf{n}'(\mathbf{I} - \mathbf{A})^{-1} \mathbf{Y}^k \tag{10}$$

For the purpose of this study, only two categories were distinguished; k=1 denotes domestic final demand and k=2 denotes export.

N^1 is the number of employees, which can be associated with production for the purposes of domestic final demand, and N^2, number of employees needed for production of exported goods and services. These numbers include workforce needed also for producing intermediate products, so N^2 may be treated as an estimate of full labor content of export.

The idea of Leontief inverse is extensively described in classical literature (Miller and Blair 1986). The most modern approach to the idea can be found in ten Raa (2006).

On Fig. 5 two bars on the left represent employment calculated in terms of output, without using Leontief inverse. In 1990 from the total of 16.28 mln workers 14.57 mln were employed for the purpose of domestic production (black bar) and 1.71 mln for the purpose of export (black and white bar). After including the employment necessary for intermediate production, it is 12.87 mln and 3.41 mln respectively (these numbers were calculated using (10), and are represented by two bars on the right). Dotted bar in the middle shows hypothetical number of employees needed to replace import with domestic production.

Figure 5. Employment due to domestic production and foreign trade
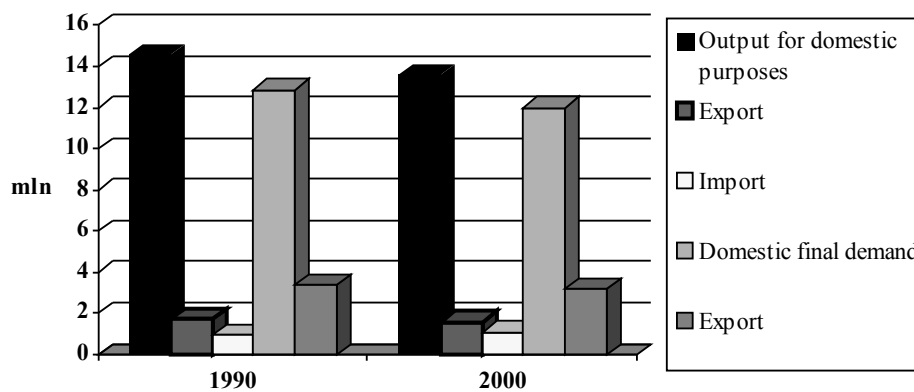
Source: As in Tab. 2.

In 2000 employment was lower than in 1990. The proportions in bars haven't changed much, except rise in "import" employment.

Numbers calculated with (10) were then used as denominators, to calculate labor productivity. Results in Tab. 5 show, that including full content

of labor, production for export was about 20% more productive than production for domestic final demand. In other words, production for domestic final demand is more labor intensive than exports. This relation was similar both in 1990 and 2000, so it seems to be stable over the analyzed period. Additionally, Tab. 5. shows that labor productivity calculated for export to the EU is slightly higher than for export to other countries.

Table 5. Labor productivity including full content of labor

	1990 mln PLZ/employee	2000 th. PLN/employee
Domestic final demand	39,04	50,59
Export	46,33	60,85
Export to EU		61,80
Other exports		58,73

Source: As in Tab. 2.

Conclusions

The study confirmed positive influence of foreign trade on labor productivity in the period of transition in Poland. Goods and services produced for export are generally more productive (and less labor intensive) than goods and services produced on domestic purposes. This relation is clearly visible when estimating the full content of labor, including labor used at the intermediate stages of production, and seems to be stable in time.

Competition on international markets force reductions of labor costs per unit of output, and this positive phenomenon is transferred to the local market. In this way, opening the economy might be one of driving forces for the labor productivity growth in the last decade of the XXth century.

The dynamic effects expressed in real terms are probably much bigger, than nominal but they are reduced by changes in relative prices. These price adjustments were the reason, that macroeconomic relations, like relations of average labor productivities, haven't changed much, in spite that Polish economy witnessed dramatic changes in the structures of production, foreign trade, prices etc.

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