

# Factor Content in Polish Trade with the European Union

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## Abstract

The paper studies factor content of Poland's trade with the EU since the beginning of economic transition that started in 1989. Fourteen factors of production are used, including seven categories of labor, capital, three categories of land, minerals, oil and coal. The empirical results show that Poland was a net exporter of some of the factors to UE only in the initial years of economic transition. These were skilled labor, labor of farmers and workers, capital, arable land, forest land and natural resources. Poland is found to be a net exporter of coal intensive products throughout the entire period. Correction for trade imbalance reveals that Poland is also a net exporter of unskilled labor. The final conclusion is that the opening of Polish economy in 1989 might have revealed the real comparative advantages in trade between Poland and European Union.

*JEL Classification: F11, F14, F16*

*Keywords: factor content in trade, Heckscher-Ohlin-Vanek, Poland, EU*

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## **Introduction**

This paper analysis the factor of production content in polish trade with the European Union in years 1989-2000. The calculation is based on Heckscher-Ohlin neoclassical theory of trade extended by Vanek that analysis three groups of variables: trade, factors of production resources and factor inputs. Fourteen factors of production are analyzed: two groups of high skill labor, three types of intermediate skill labor, two types of low skill labor, capital, arable land, pasture land, forest land, coal, minerals and oil.

The research refers to Vanek's concept of multiple commodities and multiple factors theory of international trade.

This article does not apply the H-O-V test itself as it does not concern factor abundance in comparison with factor content in trade. The aim is to measure various factors content of Polish trade with the European Union during the twelve years after political transformation from central planning to the free market rules. The following question are going to be answered:

- What is the structure of factor content in polish trade with the EU?
- Which factors are exported to the EU and which are imported from there?
- Has the pattern of factor trade been changing through the years 1989 – 2000?
- Has the political transformation had any impact on polish factor trade flows?

The article consists of the following sections: firstly the neoclassical theory of trade is presented, next section describes the empirical data, then various results are presented and finally conclusions derived.

## **Theoretical framework**

The Heckscher-Ohlin-Vanek model describes the world trade as driven from differences in countries' factor endowments. Following conditions are sustained: free competition in each market, constant returns to scale, the same technologies in every country and homothetic consumption patterns. The commodities are perfectly mobile within and outside the countries. The factors are fully employed and immobile outside the countries.

Countries export the commodities, that use intensively the factors relatively abundant in each country and tend to import the commodities which production uses scarce factors.

For each country  $i$ :

$$AT^i = V^i - s^i \bar{V}$$

Where  $A$  is  $K \times N$  matrix of input coefficients. The element  $a_{kl}$  measures the amount of factor  $k$  required for production of a unit of output in the industry  $n$ .

$T^i$  is a vector of trade,  $V^i$  is a vector of country  $i$  factor endowments,  $s^i$  measures the country  $i$  share of world production and  $\bar{V}$  represents vector of world factor endowments.

Our analysis considers only the left side of the above equation:

For each country  $i$ :

$$F_k = A_k T$$

Factor  $k$  content of trade is measured by vector  $k$  of matrix  $A$  multiplied by vector of trade.

Where:

$k$  – index of a production factor,  $k = 1..14$

$F_k$  – factor  $k$  content in trade

$A_k$  – vector of factor  $k$  input coefficients in matrix  $A$

$T$  – vector of trade. It represents exports, imports and net exports, depending on stream considered.

## **The empiric data**

The data is taken from two sources. Firstly, matrix  $A$  is the same as in the H-O-V test performed by Daniel Trefler (1993), and the trade data was taken from Eurostat (2001). The differences in data classification (trade data in 3-digit SITC, matrix  $A$  – in Input-Output industrial classification) were adjusted by the author.

There was a 12 years period considered, beginning from 1989 – the year of political change in Poland, up to year 2000.

## **Factor content in Polish trade with the EU**

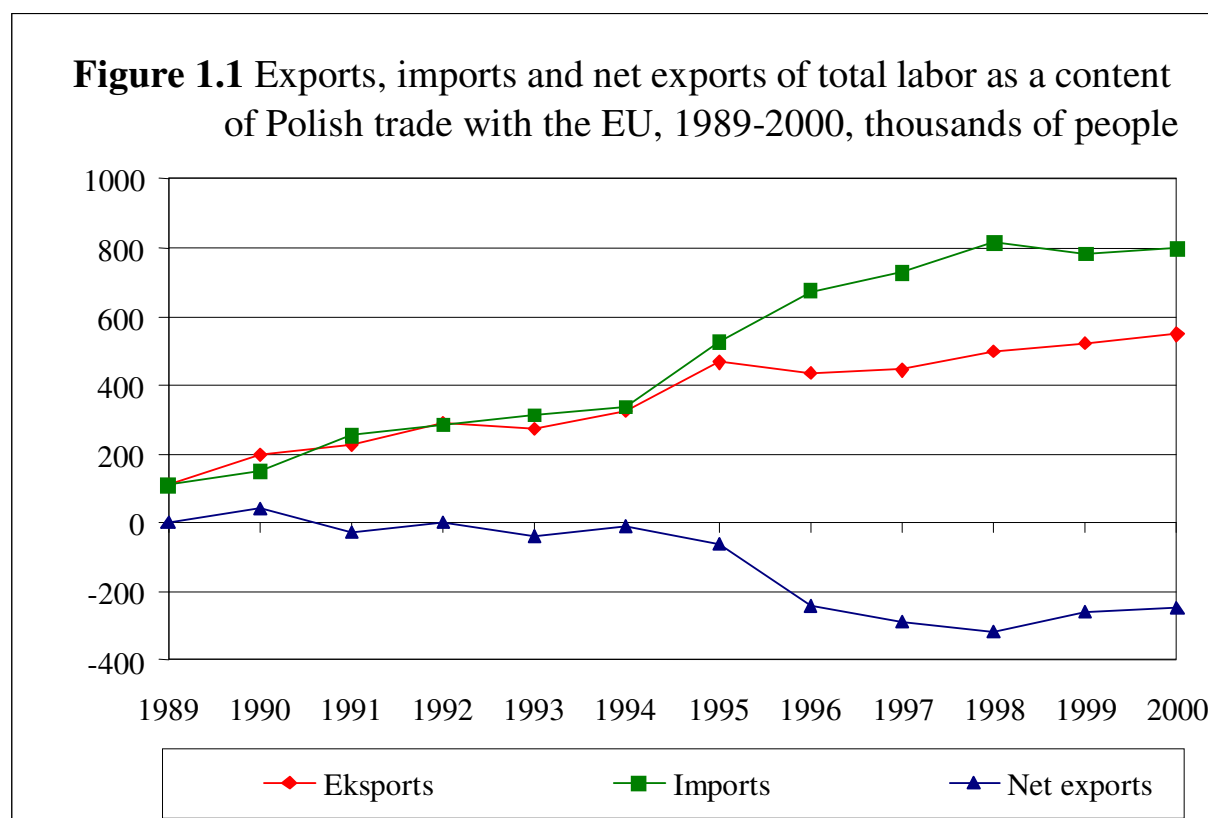
### **1. Labor**

Three flows, i.e. exports, imports and net exports of labor are collected and presented in Table 1.1 and Figure 1.1. To understand better the determinants of net exports we observe both flows of factor trade.

**Table 1.1** Exports, imports and net exports of total labor as a content of Polish trade with the EU, volume and dynamics, 1989-2000, thousands of people

Year	Volume			Dynamics		
	Exports	Imports	Net exports	Exports	Imports	Net exports
1989	112	111	1	-	-	-
1990	195	152	43	74%	37%	5184%
1991	230	257	-27	18%	69%	-163%
1992	291	288	2	27%	12%	108%
1993	274	312	-38	-6%	8%	-1807%
1994	325	335	-11	19%	8%	72%
1995	465	525	-61	43%	57%	-473%
1996	436	677	-242	-6%	29%	-298%
1997	444	729	-286	2%	8%	-18%
1998	499	815	-316	12%	12%	-11%
1999	523	785	-262	5%	-4%	17%
2000	550	796	-246	5%	1%	6%

Source: Own calculations



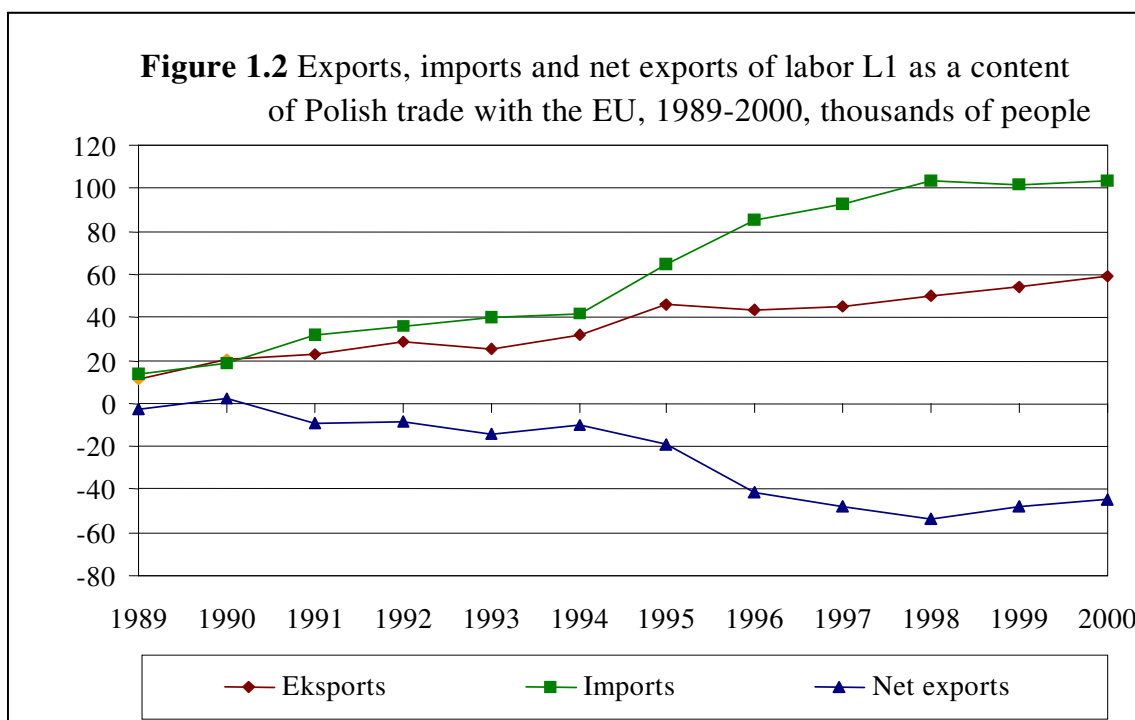
The lowest values of labor exports and imports amount of 110,000 of people are observed in 1989. The volume of Polish trade with the EU was increasing in the following years. At the end of the examined period labor content in trade amounted to 550,000 of people in exports and 800,000 in imports. The difference between exports and imports was growing continuously from the balanced level in 1989, through the surplus of 43,000 in the following

year and a deficit of a few dozen thousands in the years 1991-1995, growing to a big deficit of 200,000-300,000 of people in the second half of the nineties.<sup>2</sup>

The changes of exports volume calculated one year to the previous were positive in almost all considered years. The same situation is observed in import flows, but as we can see in the last column of the Table 1.1 (Dynamics of net exports), they were more significant.

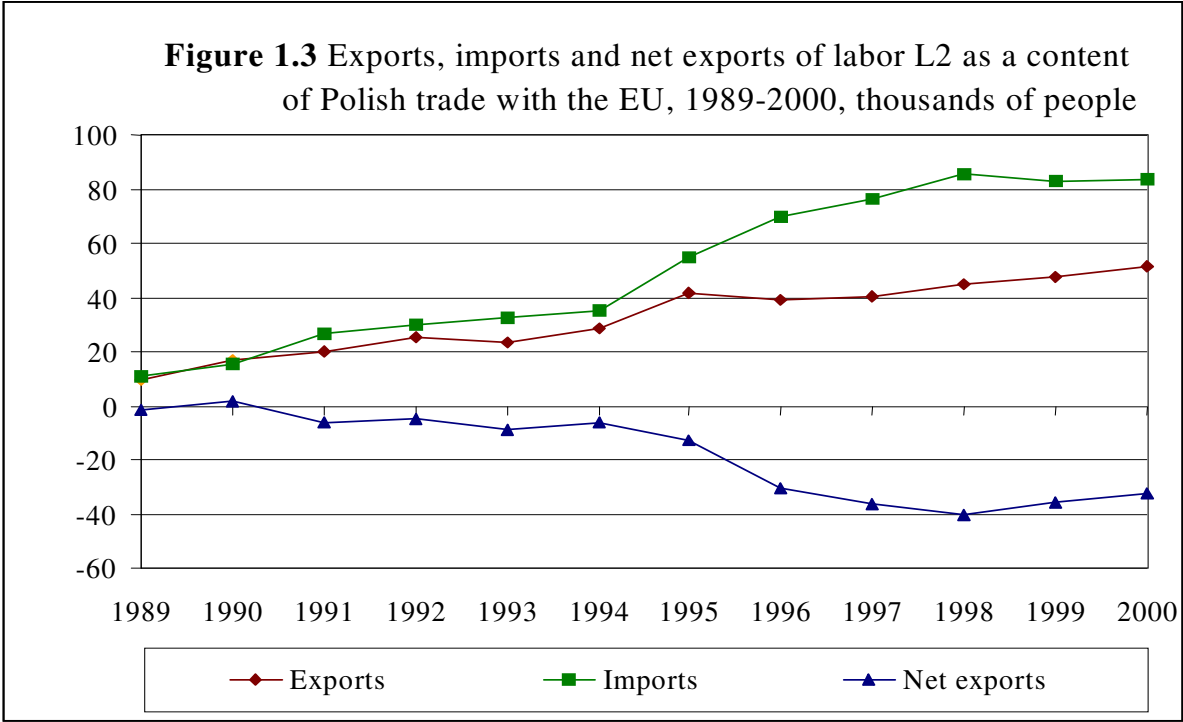
### Net exports of diversely skilled employees

The first considered group of high skill labor consists of professional, technical and related workers. As we can observe on the Figure 1.2, the net export was quite balanced in the first half of the nineties. However, since 1996 a significant deficit has occurred with slight improvement in years 1999-2000. Exports and imports of high skill labor was increasing in the most of examined years. The biggest growth of imports appeared in 1995, when it doubled in comparison to the previous year. Using the year 1989 as a basis, we can observe that starting from 1996 import volumes have been about 1,5 times higher than those exports each year.



<sup>2</sup> These results are significantly lower than those received by Kabaj (2000) for the year 1998. In that research the deficit of labor trade amounted to 600,000 –700,000 people. There were two methods applied: *factor method*, that calculates the quotient of net export divided by average unit productivity of a one Polish worker and *share method* that was a net exports share in total trade turnover multiplied by employment level in Polish economy. We may suppose that the method presented in this article is more precise due to detailed productivity data.

Second group of labor considered consists of clerical and related workers. Polish trade with the EU of this factor was similar to the first group of high skill labor (Figure 1.3). Only first half of the examined period was balanced in trade of this factor. The year of 1996 was the first year of significant deficit in net exports amounting for 40,000 of people.



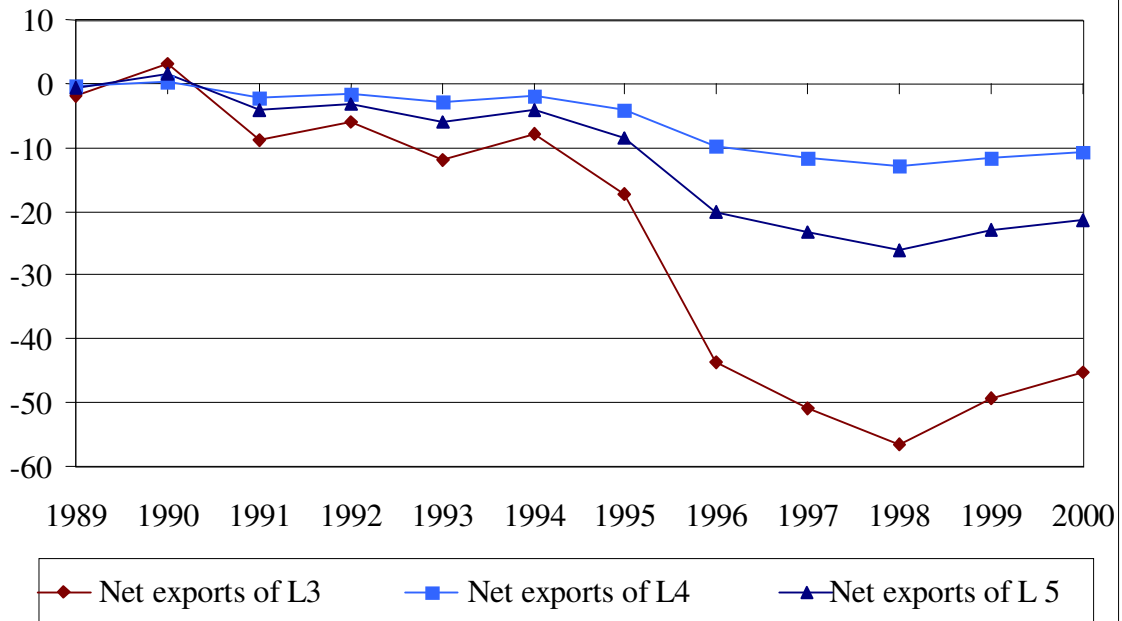
The similarity of both labor groups might be due to the structure of matrix A, where their unit productivity coefficients are highly correlated (0.87). The most characteristic of both human capital groups were the following years:

- 1990, when net exports reached a surplus,
- 1995, when significant slump in net exports occurred due to substantial increase of imports,
- 1998, when maximal deficit in both groups appeared.

Above results prove that human capital was imported from the EU to Poland throughout the whole period, with one exception in 1990. The deficit was increasing every year until 1998 when a small reversal in tendency occurred. This improvement might be continued as Polish export has been growing since year 2000.

Next three groups of workers belong to intermediate skill labor. It consists of vendors, clerks and other services workers. The factor content of trade was quite similar to previous two groups. Figure 1.4 shows net exports for these categories.

**Figure 1.4** Net exports of intermediate-skill labor L3, L4, L5 as a content of Polish trade with the EU, 1989-2000, thousands of people



Only in 1990 there was a surplus in these factors trade balance. The share of intermediate skill labor in European imports to Poland was increasing in the following years, what resulted in growing deficit of net exports.

Net exports of the first subgroup L3, i.e. clerical and related workers, was changeable in the first half of the nineties, and since 1994 started to fall in a deeper deficit (from 8 thousands workers to 57 thousands in 1998). This tendency reversed again in the last two examined years.

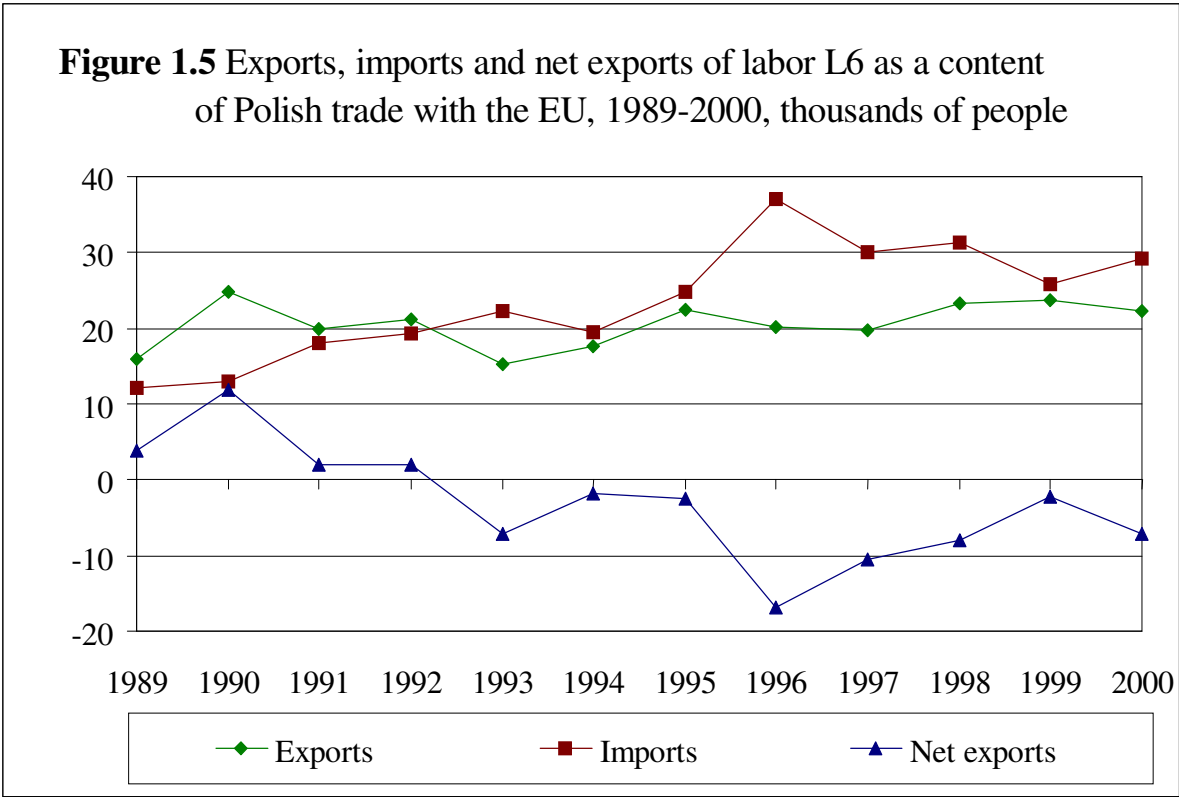
Subcategory L4 – sales workers – had the most stable negative balance of trade. In 1998 it reached the biggest deficit which amounted for 12,000 workers.

The last intermediate skill labor – group L5 - service workers, followed a similar pattern of trade as the subgroup L4. This might be explained by the fact that both groups consist of similar kind of occupation and their input coefficients are comparable.

To sum up, the intermediate skill categories of labor were imported from the European Union to Poland generally in the whole examined period. They followed the same pattern as previously described human capital, when the trade was balanced in the first half of the period, then fell into a deep deficit in years 1995-1998 and recovered in years 1999-2000.

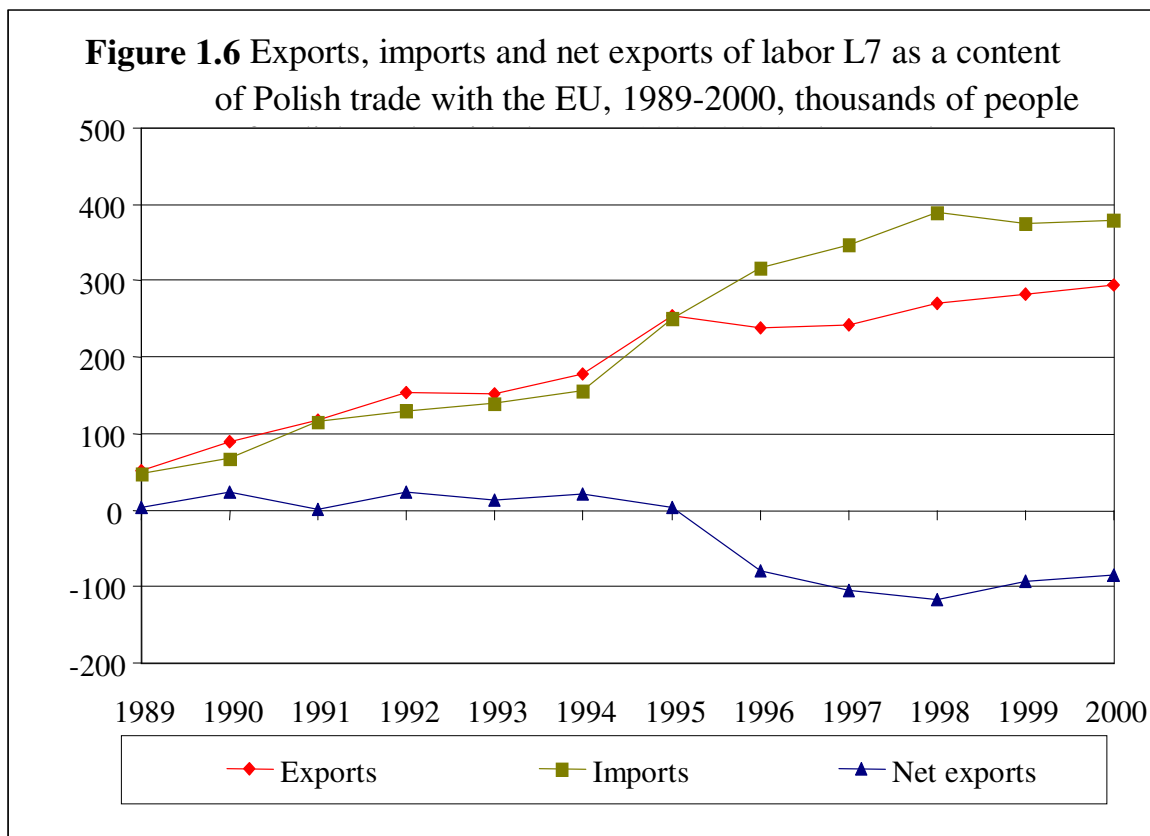
On the contrary, the next analyzed groups of low skill labor performed differently. The category of agriculture workers L6 is observed net exported in the first four years of the

nineties. The deficit which started in the second half of the period was not big, as it may be seen on the Figure 1.5.



In 1990 this labor group reached the maximum in balance of trade in amount of 12 thousands workers. There were two drops in net exports: in 1993 due to a fall in exports and in 1996 due to a significant growth of imports. Both slumps were followed by growth which led to balanced level of net exports. On the contrary to the previously considered labor factors of production, a decreasing tendency occurred in 1999.

The highest volumes in Poland’s labor trade with the EU appeared in the last low skill labor group L7 - production workers (Figure 1.6). Since 1991 this factor content in trade has been reaching 100 thousands of people. This group consists of many subgroups of workers and reveals the highest volumes of both trade flows – imports and exports. Total trade turnover amounted from 100 thousands in 1989 to 670 thousands in 2000. Until the year 1995 there were similar volumes of exports and imports, therefore the trade was balanced with a slight tendency for a surplus, amounting from 2 to 20 thousands workers. The trend reversed in 1996, when exports started to diminish, while imports was increasing continuously. The following two years showed that both flows grew in the same pace, but the deficit remained. Finally, in years 1999-2000 there was a slight improvement of the trade balance due to increase of exports and decrease of imports.



### Net exports of labor in the relative approach

Up to this moment all the results were presented in absolute values, US dollars, current prices. The results deriving from that approach were dependent on various conditions, such as exchange rate fluctuations or trade policy restrictions between Poland and the European Union. Now we present labor content in trade regardless these distortions. For every category of occupation we calculate net exports as follows:<sup>3</sup>

$$NX_i = (X_{Li} / \sum_i X_{Li} - M_{Li} / \sum_i M_{Li}) * 100\%$$

where:

$NX_{Li}$  – net exports of labor group  $i$ ,

$X_{Li}$  – exports of labor group  $i$ ,

$M_{Li}$  – imports of labor group  $i$ ,  $i = 1..7$ .

The index was calculated for each year and presented in Table 1.2. For example negative value of  $NX_i$  means that a share of  $L_i$  in Polish exports to the European Union is smaller than a share of the same labor group in imports, therefore using such relative approach Poland is a net importer of labor group  $L_i$ .

<sup>3</sup> On the basis of Neven (1994)

**Table 1.2** Net exports of various labor groups, relative approach, 1989-2000

Year	L1	L2	L3	L4	L5	L6	L7
1989	-2%	-1%	-2%	-0,4%	-1%	3%	3%
1990	-2%	-2%	-2%	-1%	-1%	4%	2%
1991	-3%	-2%	-2%	-1%	-1%	2%	6%
1992	-3%	-2%	-2%	-1%	-1%	1%	8%
1993	-3%	-2%	-2%	-1%	-1%	-2%	11%
1994	-3%	-2%	-2%	-1%	-1%	-0,4%	8%
1995	-3%	-1%	-2%	-0,5%	-1%	0,1%	7%
1996	-3%	-1%	-2%	-0,4%	-1%	-1%	8%
1997	-3%	-1%	-2%	-0,5%	-1%	0,3%	7%
1998	-3%	-1%	-2%	-0,5%	-1%	1%	7%
1999	-3%	-1%	-2%	-1%	-1%	1%	6%
2000	-2%	-1%	-1%	-0,5%	-1%	0,4%	6%

Source: Own calculations

There is an indication that net exports of high and intermediate skill labor was negative in each examined year and amounted for 0.5-3 % per annum. Only last two categories, agricultural and production workers, had a surplus in the trade balance. The highest values occurred in group L7; from 2-3 % at the beginning of the nineties, to 6-8 % in the following years. In 1993 group L7 reached maximum: 11 %.

For the agricultural workers the results were different, as first four years presented surplus in amount of 1-3 %. Then it reversed to -2% in 1993 and returned to the surplus, but in smaller values of 0.5 – 1 %, in the last four examined years.

The most stable labor category in relative approach was intermediate skill group L5, service workers, which performed deficit of -1 % each year.

For the other two intermediate skill labor groups the net exports amounted from -1 to -2 %.

The high skill workers (groups L1 and L2), presented also a deficit in trade (-1 % to -3 %). In the middle of the period the deficit in trade of group L2 decreased from -2 % to -1 %.

This approach follows us to the conclusion that Poland might have had a relative advantage in low skill labor trade and relative disadvantage in high and intermediate skill labor trade with the European Union.

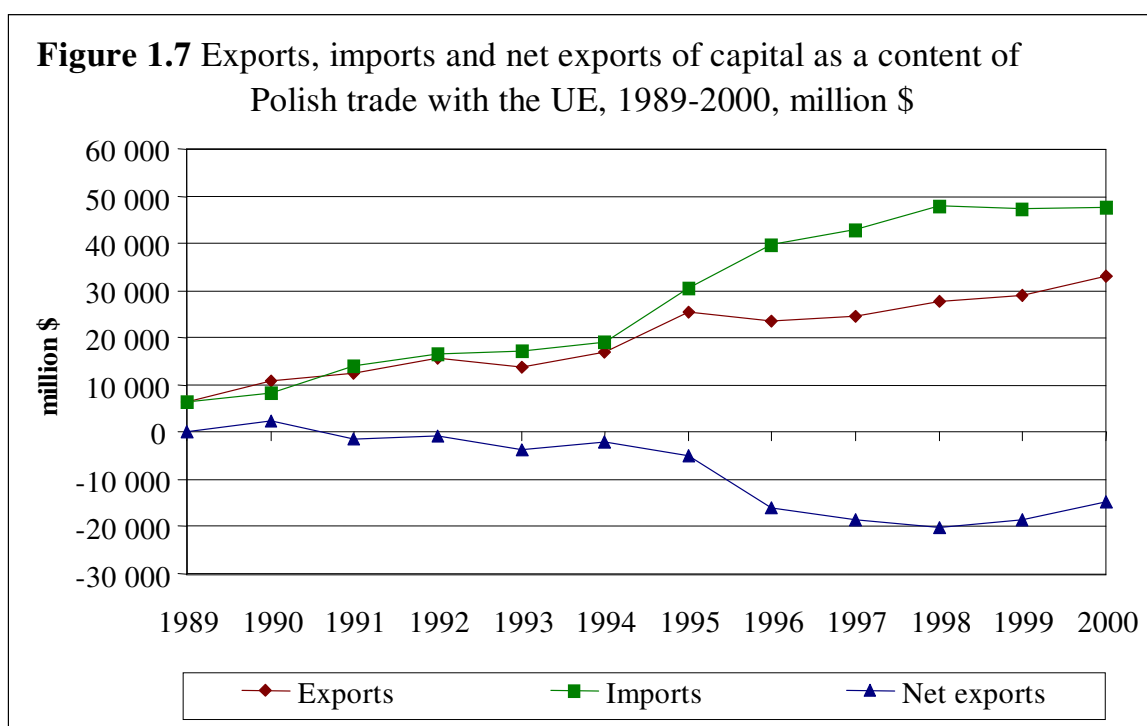
## 2. Net exports of capital

Polish total exports of capital in trade with the EU amounted for 6.5 – 33 billions USD (Table 1.3, Figure 1.7). It performed general growing trend since the beginning of 1989. There was a slight decrease in exports of capital in two years (1993 and 1996).

**Table 1.3** Exports, imports and net exports of capital as a content of Polish trade with the EU, 1989-2000, million USD

Year	Exports	Imports	Net exports
1989	6 462	6 396	66
1990	10 807	8 341	2 466
1991	12 525	14 141	-1 616
1992	15 730	16 442	-711
1993	13 695	17 363	-3 668
1994	16 876	18 997	-2 121
1995	25 484	30 597	-5 114
1996	23 507	39 580	-16 073
1997	24 412	42 920	-18 508
1998	27 712	48 038	-20 327
1999	28 934	47 444	-18 510
2000	32 943	47 724	-14 781

Source: Own calculations



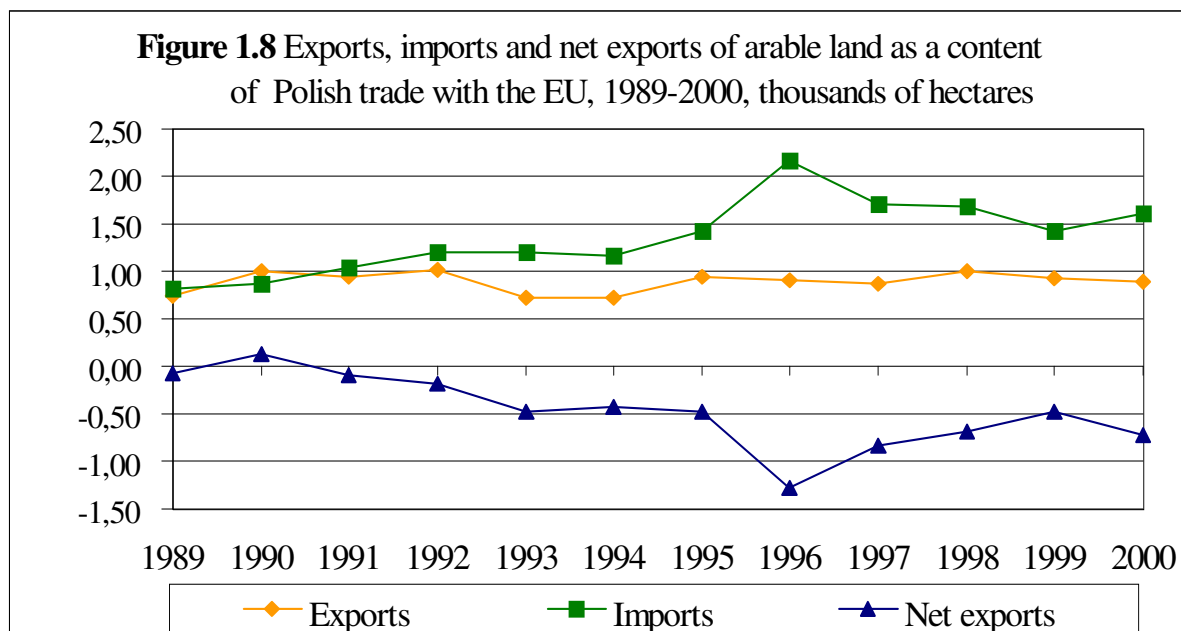
For the other flow of trade – imports – the values were higher, reaching maximal value 48 billions USD in 1998. Net exports of capital was generally negative, with exception of a small surplus in the first two years. The second half of the nineties showed that net exports fell into a big deficit of 16-20 billions USD. This might be explained by essential increase of capital imports since 1995 as well as a diminishing trend of capital use in polish economy, what

affected negatively Polish exports of goods that intensively use this factor of production.<sup>4</sup> In general capital was the imported factor of production in the whole period after political transformation in Poland and its deficit increased in the second part of it. This may follow to the conclusion that Poland have not had comparative advantage in capital resources against the European Union and still belongs to the group of countries dependant on foreign capital inflows.

### 3. Net exports of land

There are three kinds of land described in this analysis. The first interesting feature of these factors of production is that the trade flows are rather small when measured as a content of the commodity trade. This might result from small shares in production of final goods observed in the technology matrix. Only forest land presents higher flows of trade as well as bigger values of input coefficients.

Considering arable land there was a quite balanced trade in the beginning of the nineties with a surplus in the year 1990 (Figure 1.8). The second half of the period, with exception of



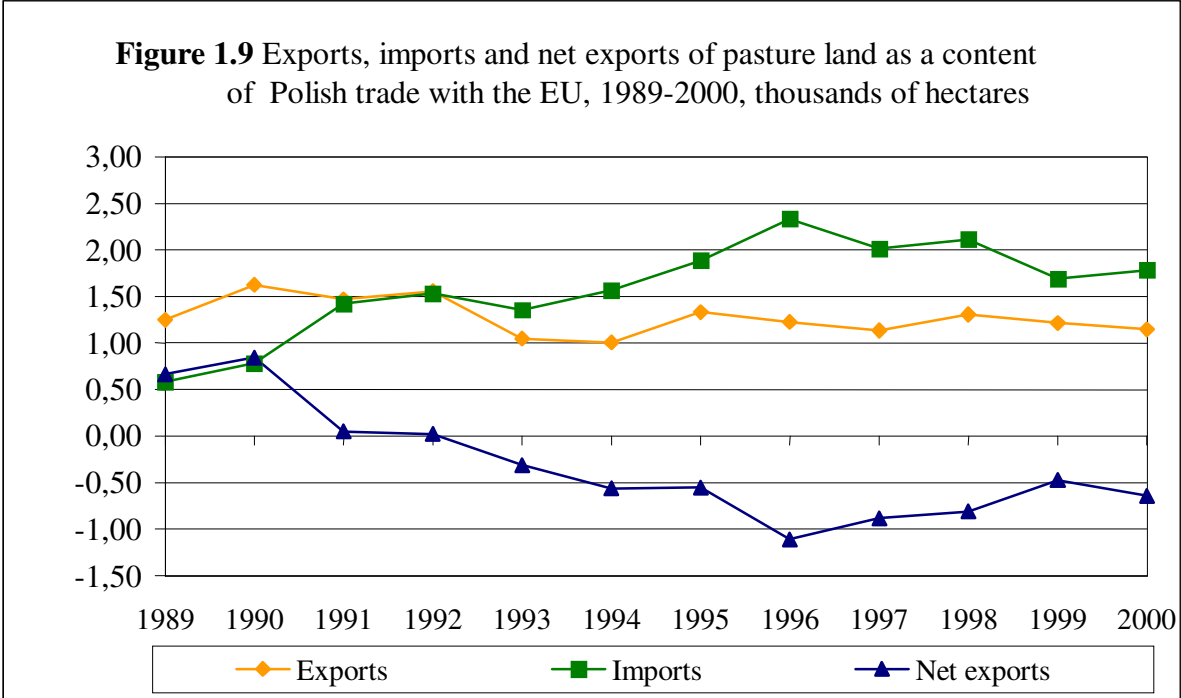
significant slump in 1996, presented rather stable deficit.

As we can observe, values of net exports resulted only from changes of imports, while exports remained invariable throughout the whole period.

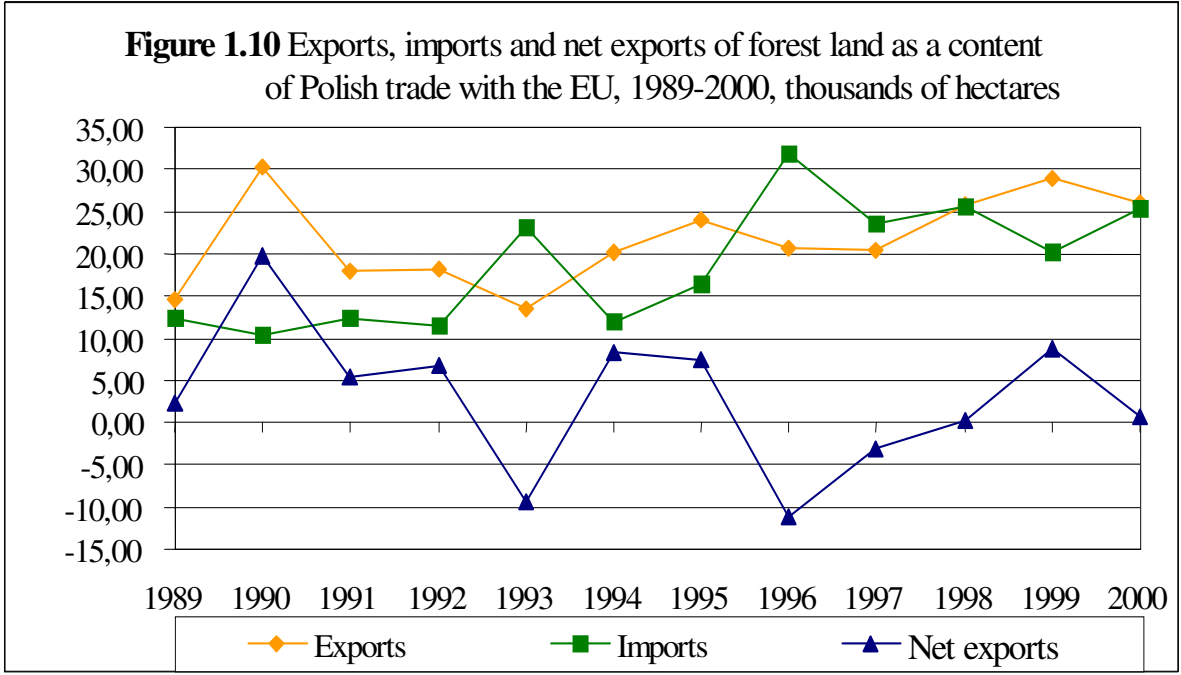
Similarly, exports of pasture land had a stable trend, while there were changes of average growing tendency of imports, what resulted in distortions of trade balance (Figure 1.9).

<sup>4</sup> Economy and trade... (2001), pp. 41-42

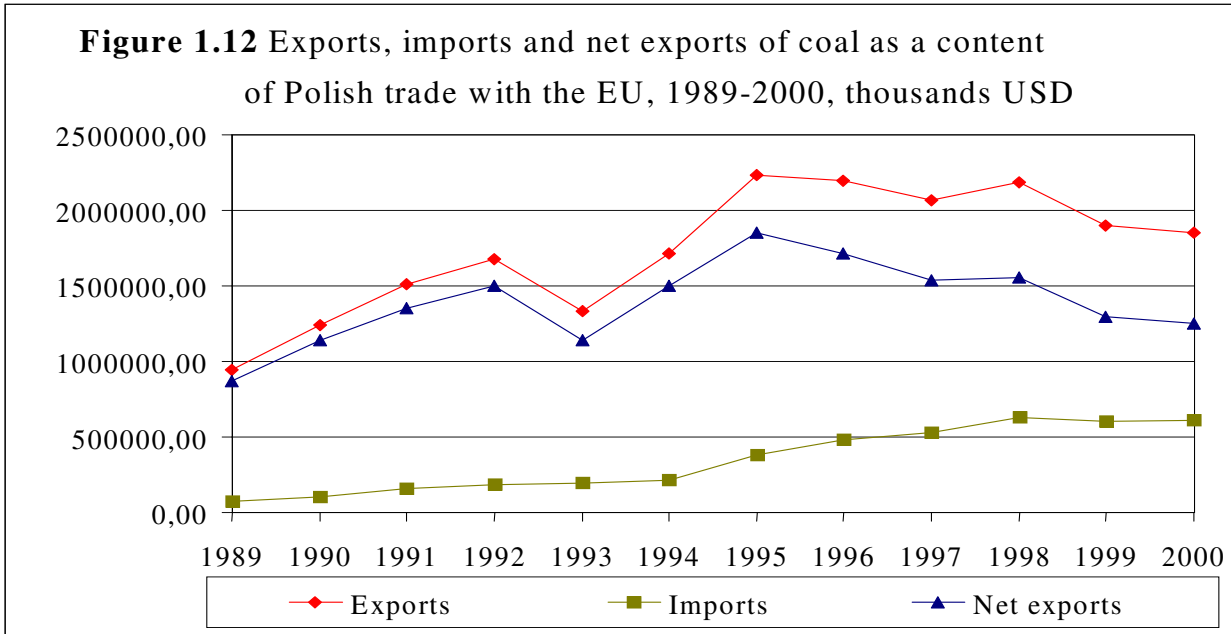
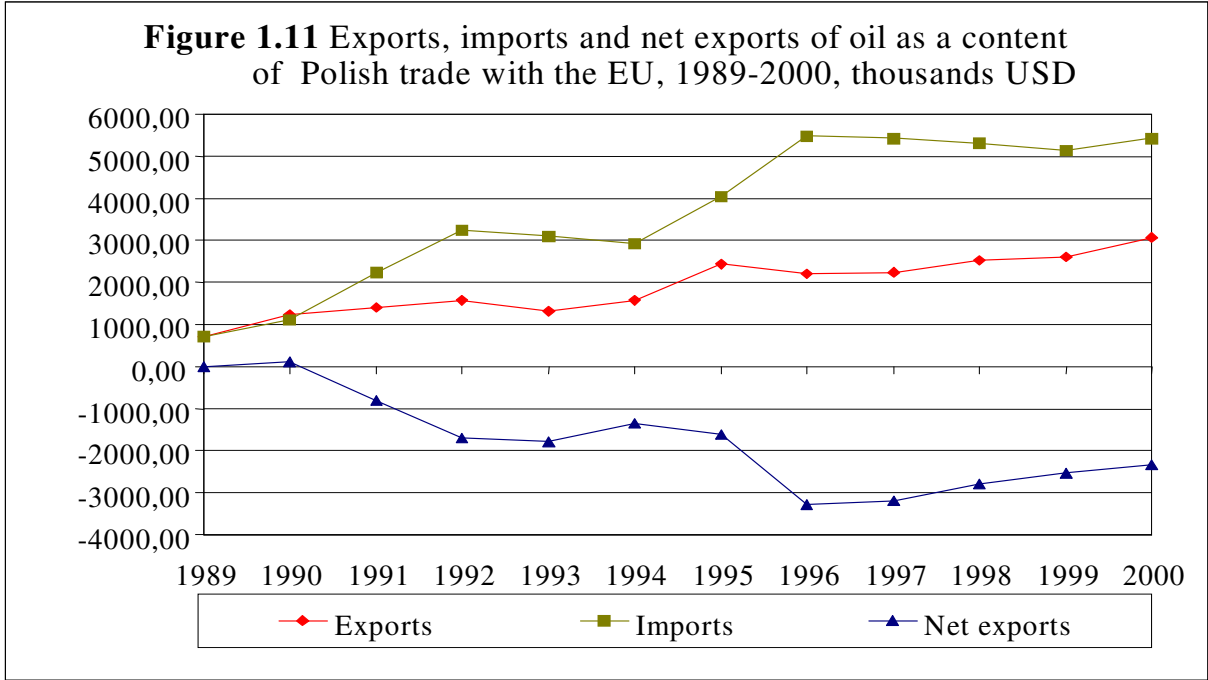
Firstly, a surplus occurred in years 1989-1990. It was followed by a balanced trade in the years 1991-92 and deficit since 1993. Stable trend of exports and some distortions of decreasing tendency in imports were observed in the second half of the period.



In case of the last land factor, forest land, there were significant fluctuations of trade observed. The surplus of net exports occurred in years 1988-92, 1994-95 and 1999. The fall of exports was observed in years 1993 and 1996, when tree felling diminished significantly and imports of forest goods picked up. Generally, this factor of production might be perceived as achieving a comparative advantage in trade relations with the European Union. Figure 1.10

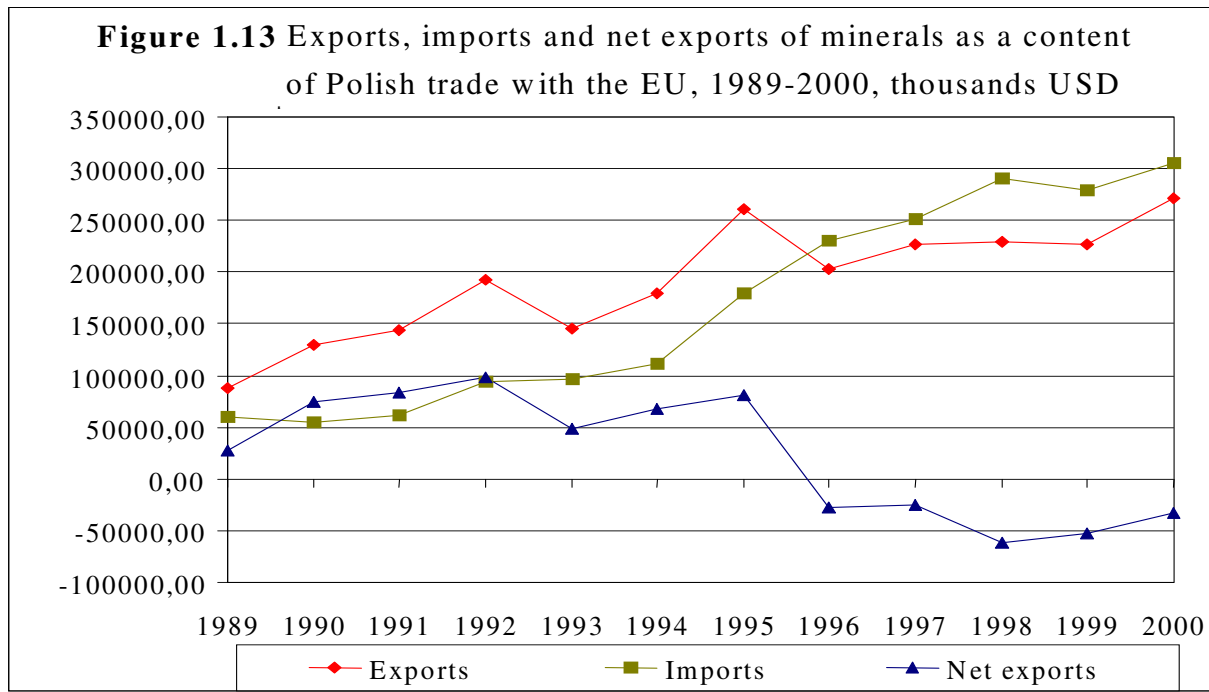


The analysis contains other natural factors of productions: oil, coal and minerals. The net exports of oil had a deficit in trade amounting for 1.5 – 3 billion USD (Figure 1.11). This is consistent with small oil resources in Poland. Contrary to oil, net exports of coal revealed a growing surplus in exchange with the EU (Figure 1.12). Coal is a primary fuel in Poland, therefore such result might have been expected.



For the category of minerals, initially there was a positive level of trade balance reaching 100 millions USD but since 1996 a small and stable deficit occurred (Figure 1.13). It might be

explained by the drop of polish exports which responded to international copper market where the increasing supply has been observed, resulting in a fall of copper prices. The second reason was a slump in building industry in Germany, the country which imported 2/3 of Polish commodities made of iron and steel.<sup>5</sup>



## Summary

The aim of the research presented in this article was to analyze polish trade with its most important trade partner – the European Union – regarding various types of factors of production. Using the input coefficients matrix of seven types of labor of various occupation, six categories of natural resources and capital, allowed us to focus on direction and amount of their indirect flows in ten years after polish political transformation of 1989.

Firstly, in case of labor we were observing relatively balanced net export in the first half of the nineties. Since 1996 an essential growth of import has occurred, what caused a big deficit of about 250-300 thousands workers. The flows of the high skill labor were similar: since 1996 there was the essential deficit of about 40-50 thousands of people, and in case of the intermediate skill labor force it amounted for about 10-30 thousands. As an exception in the intermediate skill labor were clerks, in case of which the deficit was more unstable, reaching the highest value 60 thousands of people in 1998.

<sup>5</sup> Mroczek (1997), p. 111

In case of the low skill labor there were greater values of the trade flows, as well as more often the surplus occurred during the examined period. The agriculture workers were the category which had a positive balance of trade in first four analyzed years. Only two break downs were observed: in 1993 due to the fall in exports and in 1996 due to the significant growth in imports. The highest values of indirect flows of labor occurred in the category of production workers. They amounted for 290 thousands of people in exports and 380 thousands of people in imports. The surplus in trade balance of this labor group was observed up to 1995, however a significant deficit occurred in 1996, reaching 100 thousands of people. Using the relative approach above results were confirmed for the categories of the high and intermediate skill labor. Net imports of those groups amounted for a few percent. In case of agriculture and production workers Poland had positive balance of trade mostly in the whole analyzed period. The highest values occurred in the category of production workers: 6-8 %. In addition such high positive balance of trade in the second half of the nineties along with the growth of absolute imports suggests the increasing contribution of polish workers in indirect exports of labor force to the EU. Therefore these results show that the comparative advantage in trade of commodities using intensively the resources of the low skill labor has deepened throughout the ten years after political transformation.

Secondly, the trade of capital had a stable deficit in the nineties. It reached a small surplus only in two initial years 1990-91 and then starting from 1996 fell into the deficit of above 15 billion USD. There was a significant surplus of capital imports to Poland in the second half of the considered period. In 1999 the deficit started to diminish slightly. Nevertheless during the whole examined period there was a tendency of capital imports from the European Union to Poland.

In case of arable and pasture land, which take a small part in production of final goods, a balanced trade in years 1989-92 was observed, which turned into a small deficit since 1993. Net exports of the last land category – forest land – showed the highest volatility in the examined years. The surplus of trade of this factor remained in the whole period, excluding the years of 1993 and 1996-97 when significant deficit took place. This might be explained by the drop of exports, when the amount of produced wood diminished significantly, along with a growth of imports of forestry products.

In case of the natural resources only coal appeared to have the positive balance of trade with the EU. On the contrary the trade of oil had almost permanent stable deficit. Finally the trade of minerals revealed the surplus in trade up to 1996 but this direction reversed in the following years.

The research may follow us to the conclusion that Poland of the nineties was the net importer of almost all skill categories of labor. Only the low skill labor of agriculture and production workers had a positive balance of trade. Capital was the imported factor of production during the whole period. We observed also that this tendency was deepening in the second half of the nineties.

This may follow to a general suggestion that the political change of 1989 in Poland has not redirected the structure of exports of products that use intensively modern factors of production like human capital and physical capital.

The analysis of land factors showed that they are of rather small significance in trade, excluding the forestry land that was the factor which revealed the positive balance of trade, possibly due to the high foreign demand for polish wooden commodities.

Among the energy sources coal was the one factor with a stable surplus in the trade balance. As Poland does not have any other energy resources the category oil is the factor revealing the stable deficit in Polish trade with the EU. The exports of minerals has lost its meaning in the second half of the nineties.

This simple analysis of Polish factor content in trade with the European Union might follow to the conclusion that the neoclassical theory of trade in H-O-V meaning might be satisfying when it is applied to the economies with different factor resources. Essential share of the least skilled labor in the exports may lead to the conclusion that Poland has a comparative advantage in this kind of labor. Poland is also the country abundant in natural resources like forestry land and coal. Both categories show high meaning in polish exports to the EU. The rest of factors of production, especially human capital and physical capital are imported by Poland from the European Union. Therefore we can conclude that European Union has relative comparative advantage in these modern kinds of factors of production.

To sum up, the process of expanding the production in the countries like Poland, based on abundant factors of production, which are therefore cheaper, may lead to acquiring the important position in trade with economies like these from the western Europe. On the other hand the accumulation of the factors responsible for the technology growth should not be excluded. It seems that process of creation of polish human capital resources might be faster and more possible than this regarding physical capital.

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