universität wien

# MAGISTERARBEIT

Titel der Magisterarbeit

## Backward and forward linkages and vertical specialisation measurement of the Polish economy with EU members, 1999-2009

Backward und Forward Linkages und vertikale Spezialisation
Messung der polnischen Wirtschaft mit EU-Mitgliedern, 1999-2009

Verfasserin

Lic. Malgorzata Mrowiec

angestrebter akademischer Grad

Magistra der Sozial- und Wirtschaftswissenschaften
(Mag.rer.soc.oec.)

Wien, 2014

| | |
|---|---|
| Studienkennzahl lt. Studienblatt: | A 066 913 |
| Studienrichtung lt. Studienblatt: | Magisterstudium Volkswirtschaftslehre |
| Betreuer | Neil Foster-McGregor, BA MSc PhD |

## Table of Contents

**I. Introduction** ..... 7

**II. General assumptions of Input Output tables and Backward and Forward Linkages** ..... 11

**III. Vertical specialisation** ..... 22

**IV. Empirical results from other working papers** ..... 24

**V. Database** ..... 29

**VI. The analysis for Poland** ..... 33

**VII. Conclusions** ..... 56

**VIII. Appendix** ..... 61

## List of Figures


- Figure 1: Gross Output in Poland for 1999-2009 in million of $
- Figure 2: Gross output for each sector in the Polish economy for 1999, 2004 and 2009
- Figure 3: Shares of the gross output for each industry with respect to total gross output for 1999, 2004 and 2009
- Figure 4: Exports and Imports for Poland with EU members and Non-EU members
- Figure 5: Net Exports for Poland with EU and Non-EU members
- Figure 6: Shares of Exports from Poland to EU and Non-EU members in percentage on average
- Figure 7: Shares of Imports to Poland from EU and Non-EU countries in percentage on average
- Figure 8: Example of a Vertical Specialisation chain relating three countries
- Figure 9: Visualization of the results of key sectors analysis in 1999 – normalized direct linkages
- Figure 10: Visualization of the results of key sectors analysis in 1999 – normalized total linkages
- Figure 11: Visualization of the results of key sectors analysis in 2004 – normalized direct linkages
- Figure 12: Visualization of the results of key sectors analysis in 2004 – normalized total linkages
- Figure 13: Visualization of the results of key sectors analysis in 2009 – normalized direct linkages
- Figure 14: Visualization of the results of key sectors analysis in 2009 – normalized total linkages
- Figure 15: Spatial linkages for interregional relation of Poland with EU members on average in 1999-2009
- Figure 16: Most important sectors for Poland dependent on external strength namely import for 1999, 2004, and 2009
- Figure 17: The most important sectors for Poland dependent on export from EU countries in 1999, 2004 and 2009
- Figure 18: Averaged internal and external spatial direct backward linkages for 1999-2009
- Figure 19: Averaged internal and external spatial direct forward linkages for 1999-2009
- Figure 20: Import Content of Export for Poland with EU members in percentage
- Figure 21: Import Content of Export with 10 most important EU countries in 1999, 2004 and 2009

## List of Tables


- Table 1: Average growth rate for EU members since 1999
- Table 2: Schematic outline of WIOT for three regions
- Table 3: Structure of traditional Input-Output Table for country A
- Table 4: Sectors in World Input-Output Table
- Table 5: Direct and total backward and forward linkages and normalized direct and normalized total backward and forward linkages for 1999
- Table 6: Direct and total backward and forward linkages and normalized direct and normalized total backward and forward linkages for 2004
- Table 7: Direct and total backward and forward linkages and normalized direct and normalized total backward and forward linkages for 2009
- Table 8 Ranked normalized direct backward linkages for 1999-2009
- Table 9: Ranked normalized direct forward linkages for 1999-2009
- Table 10: Ranked normalized total backward linkages for 1999-2009
- Table 11: Ranked normalized total forward linkages for 1999-2009
- Table 12: Key sectors from normalized direct backward and forward linkages for the Polish economy for 1999-2009
- Table 13: Key sectors from normalized total backward and forward linkages for the Polish economy for 1999-2009
- Table 14: Spatial direct backward linkages internal for Poland and external for EU countries in 1999, 2004 and 2009 in percentage
- Table 15: Spatial direct forward linkages internal for Poland and external for EU countries in 1999, 2004 and 2009 in percentage

## I. Introduction

Poland has been a member of the European Union since 4th May 2004. It is the eighth largest country in the EU in its surface area, which is 312685 square meters and seventh biggest country in terms of population with 38.5 million, comparing to other countries of EU. Since joining the European Union the economy of Poland has improved significantly. This has happened thanks to low barriers in open trade and profitable processes, which are supported by regulations that help open-market policies. But even then, Poland is described as a small open economy.

Thanks the transparent and favourable business climate further supported by political stability Poland was able to create a dynamic environment for entrepreneurs. When we compare Poland with the other member countries, Poland's economy has grown faster than the other member countries. Comparing the average growth rate of EU members, Poland is in fifth place, as is shown in table 1.

**Table 1: Average growth rate for EU members since 1999**

| Rank | Name of country | Average growth rate in percentage |
|---|---|---|
| **1** | Estonia | 4.2 |
| **2** | Latvia | 4.2 |
| **3** | Lithuania | 4.1 |
| **4** | Slovakia | 3.7 |
| **5** | Poland | 3.6 |
| **6** | Ireland | 3.4 |
| **7** | Bulgaria | 3.4 |
| **8** | Romania | 3.2 |
| **9** | Luxembourg | 3.1 |
| **10** | Czech Republic | 2.6 |
| **11** | Sweden | 2.5 |
| **12** | Slovenia | 2.1 |
| **13** | Finland | 1.9 |
| **14** | Hungary | 1.8 |
| **15** | Austria | 1.8 |
| **16** | Spain | 1.8 |
| **17** | United Kingdom | 1.7 |
| **18** | Belgium | 1.5 |
| **19** | Malta | 1.5 |
| **20** | Cyprus | 1.5 |
| **21** | Netherlands | 1.4 |
| **22** | Germany | 1.3 |
| **23** | France | 1.3 |
| **24** | Denmark | 1.0 |
| **25** | Greece | 0.7 |
| **26** | Portugal | 0.6 |
| **27** | Italy | 0.4 |

Source: own description.

Thanks to recent reforms, private industry nowadays accounts for two-thirds of Gross Domestic Product (GDP). This has made Poland one of the European Union's strongest economic players.

The structural changes in the Polish economy constitute an important element of economic policy, crucial for development and future character of the economy. National economy is the ingathering of the resources and businesses guided in the production sphere, division, circulation and consumption in a particular country. By contrast the determinants of competitiveness of the economy are high profits from enterprises, international character of production, high degree of product processing and the magnitude of investment expenditures forming the basis for its development. In the results the target of this work is to assess the structure and the level of expansion of the Polish economy using the different economic and financial measurements.

Nowadays the structural changes are very important processes, which contribute to the economic growth of a particular country for example by increasing the hypothetical production, social product and consumption, but it decides too about improvement general efficiency of the economy and about shaping of the national income level of the country and per capita. These processes lead to the quantity and quality changes of the elements of national economy and change between these elements, as well as between them and a whole economic structure. The quality structural changes appear by increasing management's efficiency, replacing previous technologies with more modern ones or introducing new products to the market. Whereas the quantity structural changes constitute a consequence of the economic progress within the economic structure, which lead to increase of the number of enterprises or to raising production.

The structural changes in Polish economy proceed and continue to run more faster than in matured economies of other EU members, whereas Poland is still faraway from developed countries. Poland has the one of the highest economic growth in EU. Before Poland the countries with higher growth rate on average are Estonia, Latvia, Lithuania and Slovakia.

In 2009 the growth rate for Poland was 1.6%, which was only one positive value comparing to other EU countries.

The purpose of this work is to examine the production structure of the Polish economy, using the World Input-Output Tables for years 1999 to 2009 and concentrating on the exchange economy with countries belonging to European Union. Measurement of backward and forward linkages helps to find the key sectors for the Polish economy. Spatial linkages will show if Poland is import or export (or both) dependent or a self-sufficient region. Measurement of vertical specialisation will answer the question how big is the share of imported goods from European Union members used to produce the goods, which are later exported to the EU countries?

The measurement of the structure of a particular economy using input-output tables is very interesting, because the input-output model gives a very clear transparency of interdependencies between different branches of a national economy or different regional economies. The input-output model lets to quickly calculate and flexibility in calculating the properties of the variations of demand. The input-output model is used to analyse the relations between industries that mutually are buying inputs and selling outputs. In a table of input-output it can be easily seen how the intermediate goods vary over the sectors in domestic country and between countries.

Nowadays, there are many possibilities to measure the economy of a particular country. For my analysis Poland was chosen because this is the big country and I wanted to check if the issue of structural changes in this country became important after joining to the European Union. Since 1990 Polish industries have been developing in different ways, which offer many new opportunities for its economy. This analysis will show the expanse of the Polish trade (import and export) with other EU members during 1999-2009, considering that Poland first joined the EU in 2004. It will prove that, like most of the global economy, the Polish economy suffered adverse effects following the financial crisis in 2009.

The backward and forward linkages will be used to calculate the key sectors for the Polish economy for the years between 1999-2009.

In each economy we can find inter-industry linkages among sectors. It is not the size of the sector that is important in this case but the production process, which has an impact on creating the system of "cross-sectoral" linkages and helps to obtain the key sectors of the Polish economy. Countries should invest in the key sectors to develop own economy due to interrelations with abroad production sectors[1]. To find the key sectors the normalized backward and forward linkages will be used and checked if the values of both linkages are greater than the corresponding average. Spatial linkages will show how much Polish economy is dependent, if at all, on import and export with European Union members.

The effect of the integration of international markets is inter alia the international fragmentation of production, that is the localization abroad of phases of production which earlier took place inside the country. The vertical specialisation is a measurement able to show the closer integration between countries, foreign investments or purchasing of the intermediate goods abroad, where these behaviours are concentrated on reducing costs and increasing productivity on external markets. Third measurement used for analysis of the Polish economy with European countries, is a vertical specialisation, proposed by Hummels et al. (2001), that shows the use of imported intermediate goods to produce goods that are afterwards exported. Using the World Input-Output Tables for 1999-2009 it will be shown that the vertical specialisation for Poland with European Union members was growing till 2004 and decreased after joining to European Union.

[1] Aydin H. "*An analysis of Input-Output Inter Industry linkages in the Turkish Economy*". Paper presented at the 16th International Input Output Conference, Istanbul, 2-6 July 2007

## II. General assumptions of Input Output tables and Backward and Forward Linkages

Professor Wassily Leontief developed input-output analysis in the late 1930s. He was awarded the Nobel Prize in 1973 in Economics for his development of this model[2]. This analysis helps to look carefully on interdependence of various industries by observing the commodities of each sector as demanded goods for final consumers and as a part in the manufacture of own goods and these produced by other industries. To be able to establish the final amounts of different commodities, which have to be manufactured for final consumption, a various assumption has to be made, inter alia that useful reserves will be mixed to create any quantity of a final good.

An input-output model is built from the different linear equations, where every of such equations show exact allocation of each good produced in a given sector in an economy[3].

The prevalent availability of high-speed digital computers made Leontief's input-output analysis a usually applied and beneficial tool for economic analysis on many geographic levels – local, regional, national, and even international.

Wassily Leontief used a matrix representation of a national (or regional) economy. His model illustrates interindustry and intraindustry relationships within an economy, showing how the output of one industry becomes an input to each other and to the same industry. In the input output matrix the columns characterize inputs to an industrial sector, while rows denote outputs from a given industry. From this format we can see how dependent each industry is from the other.

[2] Raa T. T., "*Input-output economics: theory and applications: featuring Asian economies"*. World Scientific, 2009

[3] Ronald E. Miller and Peter D. Blair, "*Input-Output Analysis: Foundations and Extensions".* Cambridge, 2009

**Methods of calculation of coefficients in input-output table**

By matrix notation we can describe the input-output model as this[4]:

$$X = Zi + f, \text{ or}$$

$$X = \begin{bmatrix} x_1 \\ . \\ . \\ . \\ x_n \end{bmatrix}, \; Z = \begin{bmatrix} z_{11} & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{n1} & \cdots & z_{nn} \end{bmatrix}, \; i = \begin{bmatrix} 1 \\ . \\ . \\ . \\ 1 \end{bmatrix}, \; f = \begin{bmatrix} f_1 \\ . \\ . \\ . \\ f_n \end{bmatrix}$$

Where,

$X$ – is the $n \times 1$ endogenous vector of gross output of $n$ sectors,

$Z$ – is the $n \times n$ transaction matrix of intermediate flows,

$i$ – is the $n \times 1$ summation vector consists of $n$ numbers of one's,

$f$ – is the $n \times 1$ exogenous vector of final demands.

Postmultiplication of a $Z$ matrix by $i$ creates a column vector whose elements are the row sums of a $Z$ matrix.

*$i'Z$ is a premultiplication of $Z$ by $i$ which gives a row vector whose elements are the column sums of the matrix.

In a stricter sense:

$x_i$ – is total or gross output (production) of sector $i$,

$z_{ij}$ – value of flows of domestic products produced by sector $i$ and used by industry $j$, at basic prices,

$f_i$ – is a total final demand for sector's $i$ product,

General equation of input-output table:

$x_i = z_{i1} + \ldots + z_{ij} + \ldots + z_{in} + f_i = \sum_{j=1}^{n} z_{ij} + f_i$

In more detail: $z_{ij}$ measures the inter-industry sales by sector $i$ (intermediate sales) to all sectors $j$ (including itself than $i = j$).

[4] U. Temurshoev, J. Oosterhaven., "*On input-output linkage measures*". International Input-Output Association, European Commission. 2010

$j$th column of $z$'s : $\begin{bmatrix} z_{1j} \\ . \\ . \\ z_{ij} \\ . \\ . \\ z_{nj} \end{bmatrix}$,

these elements are the sales to sector $j$ – $j$'s purchases of the products of the various producing sectors in the particular country.

The place and size of production of goods of sector $j$ are shown in the columns of an input-output matrix.

Since each equation $x_i$ includes own purchasing by sector of its own output as input to production, these inter-industry inputs include intra-industry transactions as well.

Example. If $z_{31}$ = \$2400 and $x_1$ = \$15000, sector 1 used \$2400 of goods from sector 3 in producing \$15000 output in sector 1.

To calculate Leontief Inverse, we need to construct a coefficient (or direct requirements) matrix – $A$. We get the coefficient matrix $A$ by dividing each cell of the intermediate matrix by its column total (output at basic prices), that is $A = Z(\hat{x})^{-1}$ , where $\hat{x}$ is diagonal matrix created from output vector $X$.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}, Z = \begin{bmatrix} z_{11} & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{n1} & \cdots & z_{nn} \end{bmatrix}, \hat{x} = \begin{bmatrix} \widehat{x_1} & & 0 \dots 0 \\ 0 & \widehat{x_2} & 0 \dots 0 \\ \vdots & \ddots & \vdots \\ 0 \dots 0 & & \widehat{x_n} \end{bmatrix}$$

The technical coefficient (input-output coefficient or direct input coefficient): $a_{ij} = z_{ij}/x_j$ informs about the amount of input consumed from sector $i$ per unit of output in sector $j$, (it describes the value of products used directly by sectors to produce one unit of gross product). The input-output coefficients provide valuable evidence on what the input structure is for a specific industry or product.

Example: $a_{31}$ = 0.15, products for 0.15 \$ from sector 3 are purchased by sector 1 in order to produce 1 \$ of output in sector 1.

The "Leontief inverse" or "total requirements" matrix is calculated from equation:

$L = (I-A)^{-1}$ and is used to find the main linkages in economy, where $I$ is a unit matrix with the same dimension such matrix $A$. A unit matrix $I$ is a specific matrix, where the diagonal elements are equal to 1 and all other elements are equal zero.

$$I = \begin{bmatrix} 1 & 0 & \dots & 0 \\ 0 & 1 & 0 & \dots 0 \\ \vdots & & \ddots & \vdots \\ 0 & \dots 0 & & 1 \end{bmatrix}, \qquad L = \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix}$$

From supply balance equation system we get reduced form of the Leontief model:

$$X = Lf \qquad or \qquad X = (I-A)^{-1}f$$

Leontief's coefficients $l_{ij}$ provide information about amount by which industry $i$ has to change its production level $x_i$ to satisfy an increase of 1 unit in final demand in sector $j$.

If $l_{12} = 0.33$, than if final demand in sector 2 increases by 1 unit, sector 1 has to change its production level by 0.33

**Backward and forward linkage analysis**

The measurement of the interindustry linkages has a long history inside the area of input output analysis. The purpose of this measurement is to find the inter-industrial linkages of a particular industry to other industries and to the sectorial structure of an economy. Using the linkages measurement I will try to find the key sectors in the Polish economy, which play the most important role for Poland.

Product flows measured by backward linkages may answer the question "Where do the products come from?", whereas when measured by forward linkages may answer the question "Where do the products go?".

The calculation of both linkages by various methods will allow us to find the leading sectors in the Polish economy.

The backward linkages show how much goods from a given industry have been bought by the same and other industries. So backward linkages give the numbers of goods purchased to the market.

The forward linkages show the amount of goods, which have been sold by a given industry to the same and other industries. That is the forward linkages give the amount of goods sold at the market.

Because of the transparency of linkages it is interesting to look at them, they show very clearly how much products of a given industry have been bought and sold to the market in general and to every industry alone.

Backward and forward linkages analysis is the one of the most useful methods for the analysis of interdependency among economic industries. Backward linkages occur when the industry uses inputs from other industries in its production process. When one sector supplies the inputs to other sectors then we have to deal with the forward linkages. Chenery and Watanabe (1958) made the first study of direct backward and forward linkages connected to international relationship of productive structures. Rasmussen (1956) was the first who proposed total backward and forward linkages, which are computed using Leontief inverse or total requirements matrix. These total linkages would be used to find the most important sectors in the Polish economy.

An increasing of output $x_j$ in sector $j$ that is equal to increasing of purchasing goods by a sector $j$ from other sectors, where products are used as inputs to production in sector $j$, is known as direction of causation in the demand-side model. This kind of interconnection of a specific industry with the "upstream" industries, from which it purchases inputs, is known as backward-linkage. In simpler words the backward linkages measure the size of supply to individual sectors.

The growth in amount of output in sector $j$ means that this sector has additional quantity of goods $j$ which can be used as inputs to other sectors for their own production – such that there will be bigger supply from industry $j$ for the industries using products $j$ in their manufacturing. This procedure is noted as the direction of causation in the supply-side

model. That type of interconnection of a given industry with “downstream” sectors where it supplies it's own output is named forward linkages. Using forward linkages we calculate the magnitude of sale of an individual sector to other sectors.

We distinguish two types of backward and forward linkages: direct and total. The first type refers to the traditional measurement based on input (or output) coefficients that are obtained by using Chenery-Watanabe Method giving direct requirement inputs. Second refers to Leontief inverse coefficients calculated using Rasmussen Method giving total requirement inputs.

Backward and forward linkages show how much each industry buys and sells to other industries, directly and indirectly caused by the unit increase in final demand and primary inputs.

Direct linkages show the sale or purchase by the final consumers, whereas the total linkages show the sale or purchase by other industries.

So the direct backward linkages tell us about the amount of goods bought by final consumers from a market, and total backward linkages show the amount of goods purchased by industries to its own uses, that is the bought goods are used in industries to produce other goods.

Direct forward linkages show the goods sold to final consumers, and total forward linkages show the amount of goods sold to other industries, which use these products to their own needs.

Direct and total backward linkages are given by the sum of the elements in the *j*th column of the direct input coefficients and total requirements matrix respectively.

$$BL(d)_j = \sum_{j=1}^{n} a_{ij}$$

or in matrix form: $b(d) = i'A$

$$BL(t)_j = \sum_{j=1}^{n} l_{ij}$$

or in matrix form: $b(t) = i'L$

Forward linkages direct and total are computed by a summation of the *i*th rows of the direct input coefficient and total requirements matrix respectively.

$$FL(d)_i = \sum_{i=1}^{n} a_{ij}$$

or in matrix form: f(d) = $Ai$

$$FL(t)_i = \sum_{i=1}^{n} l_{ij}$$

or in matrix form: f(t) = $Li$

Direct forward and backward linkages measure the effects caused by the inter-relationships between industries. The calculation of total forward and backward linkages show how a unit change of sector *i*'s initial input increase the distribution in other sectors.

Total backward linkages reflect the effects of growth in final consumption of industry *j* and measure the amount by which the production in all industries increases while the unit change in the demand for goods of sector *j*.

Direct forward linkages show the share of production of an industry used in production of all industries, whereas total forward linkages measure the magnitude of output increase in sector *i* if the final demand in each sector increases by 1 unit.

Louis Putterman[5] in his lectures describes the case of backward linkages as existing when growth in one industry has an impact on the development of other industries that produce goods for use in the industry of interest. For example the development of the food industry (restaurants, shops etc.) may support the growth of vegetable industry, which will encourage the greater profits for agriculturalists and will have an influence on the bigger demand for goods and services in the agricultural sector.

Direct and total backward linkages: construction sector inter alia has direct backward linkages to a windows producing sector and total backward

[5] http://www.econ.brown.edu/fac/louis_putterman/courses/ec151/Chapter_17.pdf

linkages to the glass producing sector, because glass is used to produce the windows.

Forward linkages occur when the growth of one sector impacts upon the evolution of other sectors that use the goods from this sector in their own production. For example, the final product cotton goes to the purchaser either through a seller or through manufacturers who open up their own shops to directly sell to consumer, in so doing minimizing the role of sellers in the network process.

## Key sectors

In this thesis, I will focus on total backward and forward linkages that allow identify the key sectors in the Polish economy. These key sectors have the greatest impact on the rest of economy. To find these key sectors I used linkages indices defined as NBL for the vector of normalized values of backward linkages and NFL for the vector of normalized values of forward linkages. The linkages are normalized such that their average is equal to one. The normalized total linkages are calculated with following formula:

$$NBL(t)_j = nBL(t)_j/\Sigma BL(t)_j$$

$$\text{or in matrix form} \qquad \overline{B}(t) = \frac{ni`L}{i`Li}$$

$$NFL(t)_i = nFL(t)_i/\Sigma FL(t)_i$$

$$\text{or in matrix form} \qquad \overline{F}(t) = \frac{nL`i}{i`Li}$$

where the overbar suggest the normalized value, and NBL(t) are known as "Index of the Power of Dispersion" and NFL(t) as "Index of Sensitivity of Dispersion"

After obtaining the results all sectors can be grouped into four categories.

- First group shows the key sectors. If the values of both linkages of sector *k* are above the corresponding average (that is the normalized values of both linkages NBL and NFL for the same sector are greater than one), then this sector *k* is called the key sector.

- Second group, if only the backward linkages of sector *k* are greater than corresponding average (only NBL>1 and NFL<1) than we have strong backward linkages in sector *k* and this sector is backward oriented.

- Similarly third group contain the forward linkages of the sector *k*, which are greater than corresponding average (NBL<1 and NFL>1) and then we have a strong forward linkages in sector *k* and it means that this sector is forward oriented.

- Forth group involves backward and forward linkages being below the corresponding average in sector *k* (NBL and NFL are smaller than 1) and than sector *k* is called weak oriented.

The total linkages are indices for identification the key sectors in the economy[6]. Thanks this analysis it is able to find the sectors that are acting as the sellers or purchasers of the goods used in the intermediate consumption and have the biggest impact on the economy. This is the very interesting method to look how the economy of a particular country vary over some period and it gives a very clear view on which industries are active in the economy of the country, without comparing the amount of flows of products.

[6] Aydin H. "*An analysis of Input-Output Inter Industry linkages in the Turkish Economy*". Paper presented at the 16th International Input Output Conference, Istanbul, 2-6 July 2007

**Spatial linkages – interindustry linkages over the borders**

For the assessment of the types and intensities of spatial interdependence or connectedness between Poland and EU member the spatial linkages will be used. These address the issue of strength of economic connections among regions in an economy, and for the dates for more periods it can be shown how these connections are changing over time, that is if the regional sufficiency or regional dependence become more important for a particular sector. Next step that can be done with spatial linkages is to aggregate them, to show if the region *r* is generally reliant on imports or exports (or both) or relatively self-sufficient?

For two regions we have following matrices, let assume that region *r* is a Poland and region *s* is the EU:

$$A = \begin{bmatrix} A^{rr} & A^{rs} \\ A^{sr} & A^{ss} \end{bmatrix}, \qquad L = \begin{bmatrix} L^{rr} & L^{rs} \\ L^{sr} & L^{ss} \end{bmatrix}$$

Spatial direct backward linkages of sector *j* in region *r* will have both an intraregional and interregional component:

$$\mathrm{SBL(d)}\,{}_{j}^{r} = \sum_{j=1}^{n} a_{ij}^{rr} + \sum_{j=1}^{n} a_{ij}^{sr}$$

Analogous with spatial direct forward linkages:

$$\mathrm{SFL(t)}\,{}_{i}^{r} = \sum_{i=1}^{n} a_{ij}^{rr} + \sum_{i=1}^{n} a_{ij}^{rs}$$

Spatial total backward linkages of sector j in region *r* will be:

$$\mathrm{SBL(t)}_{j}^{r} = \sum_{j=1}^{n} l_{ij}^{rr} + \sum_{j=1}^{n} l_{ij}^{sr}$$

And spatial total forward linkages of sector *i* in region *r* will have both an intraregional and interregional component:

$$\mathrm{SFL(t)}\,{}_{i}^{r} = \sum_{i=1}^{n} l_{ij}^{rr} + \sum_{i=1}^{n} l_{ij}^{rs}$$

To measure the relative strength of intra or interregional, that is internal or external direct backward dependence in percentage, the following formula can be used:

$$100 * [\frac{SBL(d)_j^{rr}}{SBL(d)_j^{r}}] \qquad \text{and} \qquad 100 * [\frac{SBL(d)_j^{sr}}{SBL(d)_j^{r}}]$$

Similar to measure the relative strength of internal or external direct forward dependence in percentage, will be used:

$$100 * [\frac{SFL(d)_i^{rr}}{SFL(d)_i^{r}}] \qquad \text{and} \qquad 100 * [\frac{SFL(d)_i^{rs}}{SFL(d)_i^{r}}]$$

The measure of spatial direct backward linkages to itself and to the other regions independent of sectors can be found by summing (or averaging) over all sectors:

$$SB(d)^{rr} = \frac{1}{n} i' A^{rr} i$$

and

$$SB(d)^{sr} = \frac{1}{n} i' A^{sr} i$$

and for the spatial direct forward linkages to itself and to the others regions, excluding comparison of sectors, is founded using the formulas:

$$SF(d)^{rr} = \frac{1}{n} i' A^{rr} i$$

and

$$SF(d)^{sr} = \frac{1}{n} i' A^{rs} i$$

## III. Vertical specialisation

Vertical specialisation[7] is the one of the many consequences of worldwide market integration, which is the localization out of the country of stages of production, which earlier took the place in domestic country. The international fragmentation of production is the worldwide spreading of elements of manufacturing procedures, with countries concentrating on specific steps of the production sequence.
The main item of vertical specialisation is that imported goods (inputs) are used in producing goods that are exported (output), so countries increasingly connect to produce goods.
Vertical specialization takes place when:

- A commodity is produced in two or more sequential stages,
- At least two countries deliver value added through the production of the goods,
- At least one country has to use intermediate imports in own phase of the distribution and some of manufactured goods have to be sold to abroad[8].

All intermediate goods trade is consistent with first and second condition. Third condition ensures that the goods in process cross various borders. Only the subset of imported goods that are used in production of new commodities, which are later on exported, is counted to vertical specialisation.
For the calculation of vertical specialization I used the import content of exports (*IC*) that is computed using input-output tables.

[7] Many different terms are used in the literature for this phenomenon: import content of export (Hummels et al., 2001), international fragmentation of production (Jones R.W. and Kierzkowski H., 2001), delocalisation (Leamer E., 1998), outsourcing (Feenstra R.C. and Hanson G.H., 1996), vertical production networks (Hanson G.H. et al., 2005), production sharing (Feenstra R.C., 1998).
[8] Hummels et al., *„The nature and growth of vertical specialisation in world trade"*. Journal of International Economics 54, pp. 75-96, 2001

Using the tables of input-output allows separating the output of each sector into two parts: representing inputs to other sectors and representing goods, which satisfy the final demand.

International fragmentation of production involves import and export side. On the import side, fragmentation is basically a subset of intermediate goods trade, whereas on the export side, fragmentation can contain intermediate or final goods.

Vertical specialisation as import content of exports occurs when a given country imports the intermediates from abroad and then it uses these imported intermediates in the production of goods, which are later exported.

Vertical specialisation appears when a given industry relocates production of computers to another country and imports these components from that country. The industry then completes the production of the computers and sells these abroad. Using import content of export it can be calculated how big share of imported goods is used by a given industry to produce the goods, which are next exported to other abroad partner.

## Measurement of vertical specialisation

Nowadays we can find many types of the measurement of vertical specialisation. In my work I will focus on the method proposed by *Hummels et al.* (2001). This method take into account the country that can participate in a vertical specialisation chain, when such a country uses imported good to produce an exported good. For country *c* and sector/industry *i*, the VS is defined as:

$$VS_{ci} = \left(\frac{\text{imported intermediates}}{\text{gross output}}\right) \times \text{exports}$$

$$= \left(\frac{\text{exports}}{\text{gross output}}\right) \times \text{imported intermediates}$$

Import content of export[9] $= IC = i'A^M(I-A^D)^{-1}e = i'A^ML^De$,

where

$i$ – is a unit vector of dimension $n$,

$A^M$ – is a $n$-dimensional square matrix containing the production coefficients for imported goods,

$e$ – is a $n$-vector of exports,

$A^D$ – is the matrix of the input coefficients for domestic intermediates goods,

$L^D$ – is the Leontief inverse for domestic country,

$n$ – indicates the number of sectors.

Each element of $a_{ij}^M$ of the matrix $A^M$ describes the value of imported intermediate goods and services classified in the branch $i$ and is used to produce one unit of output in sector $j$.

While each element of $a_{ij}^D$ of the matrix $A^D$ measures the value of intermediate goods for the domestic country in sector $i$ and used to create one unit of output in industry $j$.

## IV. Empirical results from other working papers

The examination of the structural changes and sectoral interdependences of and in an economy is important for the understanding of its function and of its transformation over time. The key sectors may help policy makers in the creation of industrial tactic. So the finding of the propulsive sectors in the economy may help policy makers to target, in an industrial policy, the sectors that are the most likely to have essential outcomes on the economy.

The key sectors play an important role in the analyzed country and the outcomes could be used by policy makers for the development strategy for the economy in a given country. Investments in key sectors would initiate economic expansion due to the tight interrelations with other

[9] R. Cappariello, E. Breda and R. Zizza, *Vertical specialisation in Europe: evidence from the import content of exports.* Working Paper, Babk of Italy. 2008

production industries. So for the development strategy it is very important to determine which industries posses high backward and forward linkages. Then stimulating final demand or primary inputs namely in these sectors might positively affect the economic activity of the country.
The empirical papers below could be used by the policy makers in terms of which sectors of the economy to stimulate. That is in which sectors to create an additional final demand, where to decrease taxes in order to improve the results in the sphere of economic development of the countries.

Olczyk (2011) consider the structure of the Polish economy for the years 1995, 2000 and 2004. The author applied the methods proposed by Rasmussen, which help identify the key sectors in an economy. Using the OECD database and considering 27 sectors, Olczyk observed that the number of key sectors between 1995 and 2004 decreased from ten in 1995 to six in the 2000 and 2004. Concentrating on the final year in the dataset, Olczyk finds that the most important sectors in the Polish economy were the following: Food Products; Beverages and Tobacco; Transport; Production and Distribution Electricity; Agriculture, Hunting, Forestry and Fishing; Metal and Metal Products and the Construction sector. From this, Olczyk concludes that investment in these sectors is likely to be important for the development of the Polish economy.

Temurshoev (2004) investigates the production structure of the Kyrgyzstan economy using an Input-Output table for 1998 with thirty-four sectors. The author used the basic methods of Chenery-Watanabe (1958) and Rasmussen (1956), and the hypothetical extraction method of Dietzenbacher and van der Linden (1997) to determine the key sectors. After presenting the results and finding the key sectors according to each of the used methods, the author concludes that the overall key sectors of the Kyrgyzstan economy are those, which are considered key sectors by at least two of the methods used. The resulting list of key sectors is as follows: Agriculture, Hunting and Forestry; Fishing and Pisciculture; Foodstuffs and Tobacco Goods Production; Textile and Clothing Industry,

Leather Manufacture; Water Generation, Purtification and Distribution; Wholesale Trade and Finance. Temurshoev concludes that policymakers should take account of these sectors when setting the economic development strategy of Kyrgyzstan.

Tohmo, Littuen and Tanninen (2006) consider in their paper the sectoral concentration and regional specialization of Finland in the late 1990s. The results of their study indicate increasing specialization and in the case of some industries increased geographical concentration. One noticeable implication of their results is that the strongest sectors seemed to be those more dependent on imports than on the domestic economy, thus indicating that the "home-market effect" was less relevant in Finland. The authors conclude that "technological change and a shift in economic policy thinking towards research and development, with a focus on technology, and the gravitation towards international trade and collaboration played a more significant role than industrial linkages in modelling industrial attention patterns in Finland during the 1990s".

Aydin (2007) considered the most important sectors for the Turkish economy using the traditional methods of Chenery-Watanabe and Rasmussen and using input-output tables for 1998 with twenty-nine sectors. Aydin found 11 key sectors in the case of Turkey, namely: Agriculture, Hunting and Forestry; Manufacture of Food Products; Beverages and Tobacco; Manufacture of Wood and Wood Products; Manufacture of Pulp, Paper and Paper Products, Publishing and Printing; Manufacture of Chemicals, Chemical Products and Man-Made Fibers; Manufacture of Other Non-Metallic Mineral Products; Manufacture of Basic Metals and Fabricated Metal Product; Wholesale and Retail Trade, Repair of Motor Vehicles, Motorcycles and Personal and Household Goods; Transport, Storage and Communication; Real Estate, Renting and Business Activities. To further identify an appropriate development strategy it would be necessary to define which sectors have high backward and forward linkages and to know in which key sectors to invest.

Tzimos, Papadimitriou and Adamou (2007) using the input-output table from the National Statistical Service in Greece for the year 2000 identified the structure of production sectors and highlight the interindustry dependencies of the Greek economy. In this paper the authors used Hierarchical Cluster Analysis to find the most important sectors. They analyzed twenty nine sectors and found six important sectors in the Greek economy. The sectors with high inputs (backward linkages) and outputs (forward linkages) are the most important for the whole economy. These sectors were: Manufacture of Wood and Wood products; Manufacture of Pulp, Paper, Paper Products, Publishing and Printing; Manufacture of Food Products, Beverages and Tobacco; Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel; Manufacture of Chemicals, Chemical Products and Man-Made Fibres; Manufacture of Rubber and Plastic Products.

The measures of vertical specialisation show the status of the worldwide production chains in international trade but it does not permit classifying the "actors" that shape international value chains. And because it is calculated at the sectoral level, the notion of vertical integration does not allow one to distinguish between the share of vertical trade that occurs inside a global firm and the share that takes place through arm's length connections.

From Breda, Cappariello and Zizza (2008) it can be assumed, that between 1995 and 2000 the import content of exports increased in all European countries and that the production of transport equipment emerges at the most internationalized sector. The import content of exports grew between 1995 and 2005 in all countries considered. The strongest growth of the import content of exports in relative terms was in France and Germany. In 2000 in Italy and Germany the import content of exports was about 27-28%, while in Belgium and Netherlands the figures were 47% and 37% respectively. The Belgium and Netherlands are small economies, which helps explain why they use more imports to produce goods that are later on exported.

Loschky and Ritte (2006) wrote that "for the fourth time in a row, Germany exported more goods than any other country in the world. The increasing international integration in the production of goods leads to a growing share of foreign value added contained in German exports. The share of imports in German exports grew significantly in the second half on 1990s". Their share rose from 31.1% in 1995 to 40.1% in 2000 and again to 44.8% in 2006. In 1995 the share of imported goods was 12.4% of total exports. This share increased to 16.8% in the year 2000 and to 20.4% in 2006. From these calculations we see that international integration played a big role in Germany, partly due to the size of the country and due to the fact that Germany is a huge partner for other countries in international trade.

Hummels and Ishii (1999) showed that vertical specialization accounts for up to 30% of world exports, and has grown as much as 40% in the last twenty-five years. The authors used input-output tables from OECD for several years between 1968 and 1990. They assumed that "the reason why vertical specialization rose so much lies with the fact that trade barriers (tariffs and transportation costs), that are incurred continually as goods-in-process cross various borders, declined significantly over time". They argued that "even small decreases in tariffs and transport costs can lead to extensive vertical specialization, large trade growth and large gains from trade". In 1990 vertical specialization accounted for 20% of merchandise exports in OECD countries. Smaller countries and those outside the OECD database (e.g. Taiwan, Mexico, Korea, and Ireland) had a share of 40% of all exports, whereas countries such as Russia, Argentina, Brazil, India and South Africa exhibit low values of vertical specialisation, which lie below 15%.

## V. Database

The World Input-Output Database (WIOD) project was initiated in May 2009 and was created to analyse the effects of globalization on trade patterns, environmental pressures and socio-economic development across a wide set of countries. It covers 27 EU countries, 13 other major countries in the World and Rest of the World. The data are available for the 1995-2009 period. The project was financed by the European Commission in its 7th framework and received institutional support from OECD and WTO.

The input-output table represents a nation- or region-wide economic accounting that shows the way and where industries trade mutually and produce (flows of products and services). Each input-output table contains 35 industries and 59 products. In my work I will use the World Input-Output Database (WIOD) and work with World Input-Output Table (WIOT) for years between1999-2009. In World Input-Output Table the consumption of the goods is separated in the way taking into account, from where do these products come from. Each product is manufactured in the internal or external economy. For a country *A* flows of goods for intermediate and for final use comes from domestic production or are imported. What is interesting too, that in WIOT we can see exactly where the goods were produced. In table 2 we can see the case of three countries *A*, *B* and *C*. WIOD works with 40 countries and RoW (Rest of the World). This table shows for each country the exact origin of the imports, and at the same time shows the place where the exports are going to[10].

[10] http://www.wiod.org/publications/source_docs/WIOD_sources.pdf

**Table 2: Schematic outline of WIOT for three regions**

| | | Country A | Country B | Country C | Country A | Country B | Country C | |
|---|---|---|---|---|---|---|---|---|
| | | Intermediate industry | Intermediate industry | Intermediate industry | Final domestic | Final domestic | Final domestic | Total |
| Country A | Industry | Intermediate use of domestic output | Intermediate use by B of exports from A | Intermediate use by C of exports from A | Final use of domestic output | Final use by B of exports from A | Final use by C of exports from A | Output in A |
| Country B | Industry | Intermediate use by A of exports from B | Intermediate use of domestic output | Intermediate use by C of exports from B | Final use by A of exports from B | Final use of domestic output | Final use by C of exports from B | Output in B |
| Country C | Industry | Intermediate use by A of exports from C | Intermediate use by B of exports from C | Intermediate use of domestic output | Final use by A of exports from C | Final use by B of exports from C | Final use of domestic output | Output in C |
| | | Value Added | Value Added | Value Added | | | | |
| | | Output in A | Output in B | Output in C | | | | |

Source: http://www.wiod.org

The input-output table for a specific country *A* provides the complete picture of the flows of products and services in the economy for a given year clarifying the relationship between producers and consumers and the interdependencies of industries. This table is shown in table 3.

**Table 3: Structure of traditional Input-Output Table for country A**

| | | | Intermediate demands | Final demands | Total output |
|---|---|---|---|---|---|
| | | | Sectors | | |
| | | | 1, 2… n | 1, 2… n | |
| Intermediate inputs | Sectors | 1, 2… n | $z_{ij}$ | $f_i$ | $x_i$ |
| Value added | | | $v_j$ | | |
| Total inputs | | | $x_j$ | | |

Source: http://www.wiod.org

Looking from the column point of view, we can see each sector's inputs. From the row point of view, we can see each sector's output.

Final demand describes the size of sale by each sector to final markets for their production, such as personal consumption and sales to the federal government. The other (non-industrial) inputs to production, such as labor,

depreciation of capital, imports, we can find in Value Added. These inter-industry transactions are collected every year and are expressed in monetary terms.

The intermediate use or transaction matrix for each country in WIOD consists of 35 sectors. So we have 35 by 35 transaction matrix.

The exactly sectors for World Input Output Table are contained in the table 4

**Table 4: Sectors in World Input-Output Table**

| Number of sector | Full name of sector | Abbreviation |
|---|---|---|
| 1 | "Agriculture, Hunting, Forestry and Fishing" | AHF |
| 2 | "Mining and Quarrying" | MaQ |
| 3 | "Food, Beverages and Tobacco" | FBT |
| 4 | "Textiles and Textile Products" | TTP |
| 5 | "Leather, Leather and Footwear" | LLF |
| 6 | "Wood and Products of Wood and Cork" | WPW |
| 7 | "Pulp, Paper, Printing and Publishing" | PPP |
| 8 | "Coke, Refined Petroleum and Nuclear Fuel" | CPN |
| 9 | "Chemicals and Chemical Products" | CCP |
| 10 | "Rubber and Plastics" | RaP |
| 11 | "Other Non-Metallic Mineral" | NMM |
| 12 | "Basic Metals and Fabricated Metal" | MFM |
| 13 | "Machinery, n.e.c." | MaN |
| 14 | "Electrical and Optical Equipment" | EOE |
| 15 | "Transport Equipment" | TEq |
| 16 | "Manufacturing, n.e.c; Recycling" | MNR |
| 17 | "Electricity, Gas and Water Supply" | EGW |
| 18 | "Construction" | C |
| 19 | "Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel" | SRR |
| 20 | "Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles" | WTaCT |
| 21 | "Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods" | RTRoH |
| 22 | "Hotels and Restaurants" | HaR |
| 23 | "Inland Transport" | IT |
| 24 | "Water Transport" | WT |
| 25 | "Air Transport" | AT |
| 26 | "Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies" | AoTA |
| 27 | "Post and Telecommunications" | PaT |
| 28 | "Financial Intermediation" | FI |
| 29 | "Real Estate Activities" | REA |
| 30 | "Renting of M&Eq and Other Business Activities" | OBA |
| 31 | "Public Admin and Defence; Compulsory Social Security" | CSS |
| 32 | "Education" | Edu |
| 33 | "Health and Social Work" | HaSW |
| 34 | "Other Community, Social and Personal Services" | SaPS |
| 35 | "Private Households with Employed Persons" | PHwEP |
| Note: n.e.c. means not elsewhere classified | | |

Source: http://www.wiod.org

Final use matrix consists of five categories, which are:

- "Final consumption expenditures by households",
- "Final consumption expenditures by non-profit organizations serving households",
- "Final consumption expenditure by government",
- "Gross fixed capital formation",
- "Changes in inventories and valuables"[11].

An example of an inter-country table where we have two countries:

$$Z^{ij} = \begin{bmatrix} Z^{11} & Z^{12} \\ Z^{21} & Z^{22} \end{bmatrix}$$

The elements $z_{ij}^{12}$ of matrix $Z^{12}$ gives the flows from industry $i$ in country 1 to industry $j$ in country 2. The interpretation of matrices $Z^{21}$ is similar, whereas matrices $Z^{11}$ and $Z^{22}$ give the domestic flows (intra-country). The $f^{11}$ column vector with dimension $n \times 1$ gives the domestic final demand for products from industries in country 1. The $n \times 1$ column vector $f^{12}$ gives the exports to "consumers" (i.e. consumers, investors and government) in country 2. The $n \times 1$ column vector $f^{22}$ gives the domestic final demand for country 2 and $n \times 1$ column vector $f^{21}$ gives the exports to "consumers" in country 1.

The input coefficients are obtained like in one country Input-Output table by normalizing the industry columns in the inter-country Input Output table. For country one this yields $A^{11} = Z^{11}(\hat{x}^1)^{-1}$ for the domestically produced inputs, $A^{21} = Z^{21}(\hat{x}^1)^{-1}$ for the inputs imported from country 2.

More precisely the element $a_{ij}^{21}$ gives the inputs in dollars of product $i$ from country 2 used per dollar of output of product $j$ in country 1.

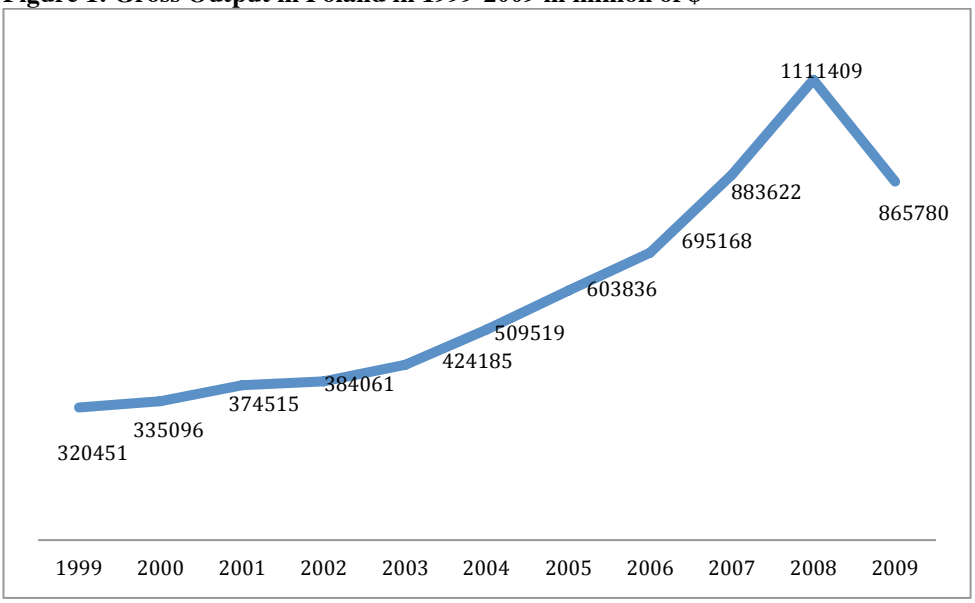
[11] http://www.wiod.org

## VI. The analysis for Poland

The last years were a period of faster and faster changes in international markets, which increased the internalization process and helped the growth of international industries. Since 1990 the Poland merged in the stream of internalization increasing the openness of the economy and shaping the markets mechanisms what was resulting in final as the joining by Poland to European Union. The membership in the European Union creates for Poland development opportunities and improvement of international competitiveness of the economy.

In the input-output analysis one of the important information is the gross output that is equal to intermediate inputs plus value added.

**Figure 1: Gross Output in Poland in 1999-2009 in million of $**



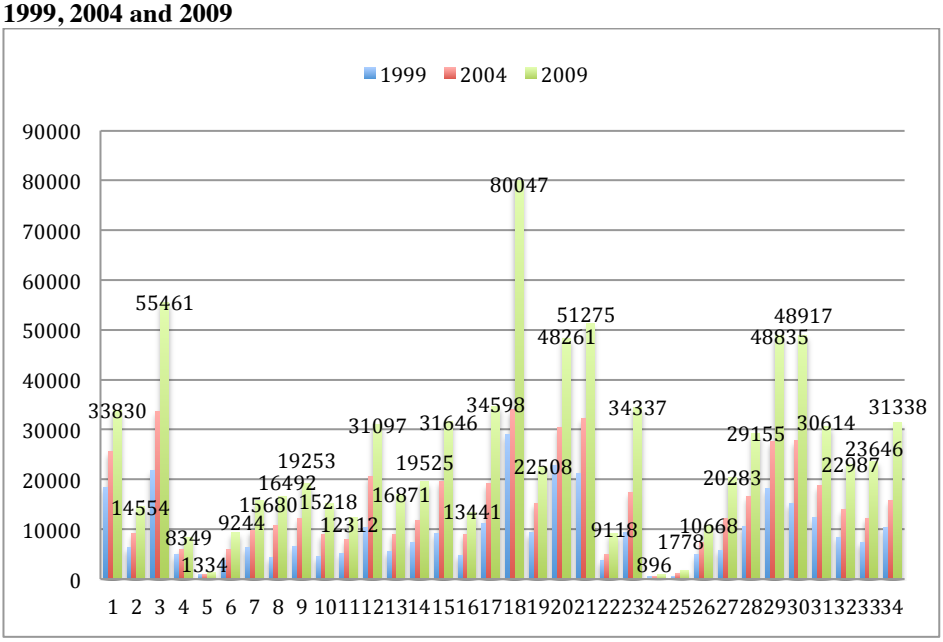

Source: own description.

From this figure it can easily be seen that gross output (in nominal terms) was growing at a rate of around 7% per annum between 1999 and 2004, whereas after joining the European Union, that is the period from 2004 to 2008, gross output in Poland was growing at about 21% per annum. After the world crisis, gross output in Poland decreased by 22% between 2008 and 2009. However, membership in the EU greatly improved the gross output for Poland.

Comparing the gross output for the Polish economy from a sectoral point of view, the gross output for each sector was growing during all years what is showed in figure 2, which presents the sectoral changes of the gross output for 1999, 2004 and 2009.

One of the most developed industries in the Polish economy was a Construction sector (18) of which the gross output increased twice form 2004 to 2009.

**Figure 2: Gross Output for each sector in the Polish economy for 1999, 2004 and 2009**




Source: own calculation

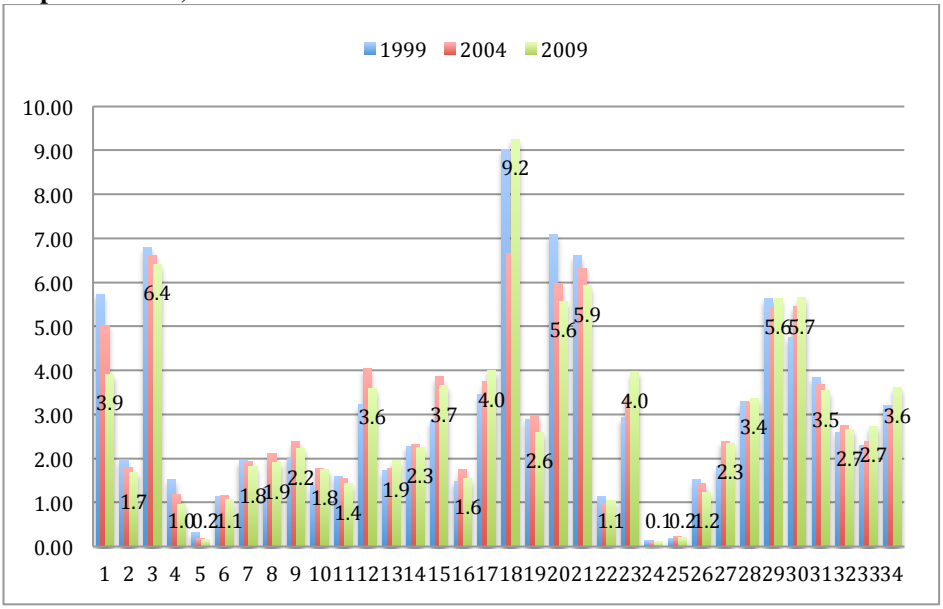
Comparing the shares of the gross output for each sector to the sum of gross output for analyzed period, that is shown in the figure 3, we can see that in sectors: Machinery (13), Electricity, Gas and Water Supply (17), Inland Transport (23), Renting of Machinery & Equipment and Other Business Activities (30), Health and Social Work (33) it was the increasingly share in terms of gross output.

The sectors: Agriculture, Hunting, Forestry and Fishing (1), Mining and Quarrying (2), Food, Beverages and Tobacco (3), Textiles and Textile Products (4), Leather, Leather and Footwear (5), Pulp, Paper, Printing and Publishing (7), Other Non-Metallic Mineral (11), Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles (20),

Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods (21), Water Transport (24), Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26) and Public Admin and Defence; Compulsory Social Security (31) follow decreasing share in gross output in 1999, 2004 and 2009.

For the sectors: Wood and Products of Wood and Cork (6), Coke, Refined Petroleum and Nuclear Fuel (8), Chemicals and Chemical Products (9), Rubber and Plastics (10), Basic Metals and Fabricated Metal (12), Electrical and Optical Equipment (14), Transport Equipment (15), Manufacturing, Recycling (16), Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel (19), Air Transport (25), Post and Telecommunications (27), Education (32) the share where bigger in 2004 than in 1999 but they felt again in 2009, whereas for Construction (18), Hotels and Restaurants (22), Financial Intermediation (28), Real Estate Activities (29), Other Community, Social and Personal Services (34) the share were higher in 1999 in respect to total gross output than in 2004 and again increased in 2009 what shows the figure 3, which gives the percentage share of each sector in gross output for 1999, 2004 and 2009.

**Figure 3: Shares of the gross output for each industry with respect to total gross output for 1999, 2004 and 2009**

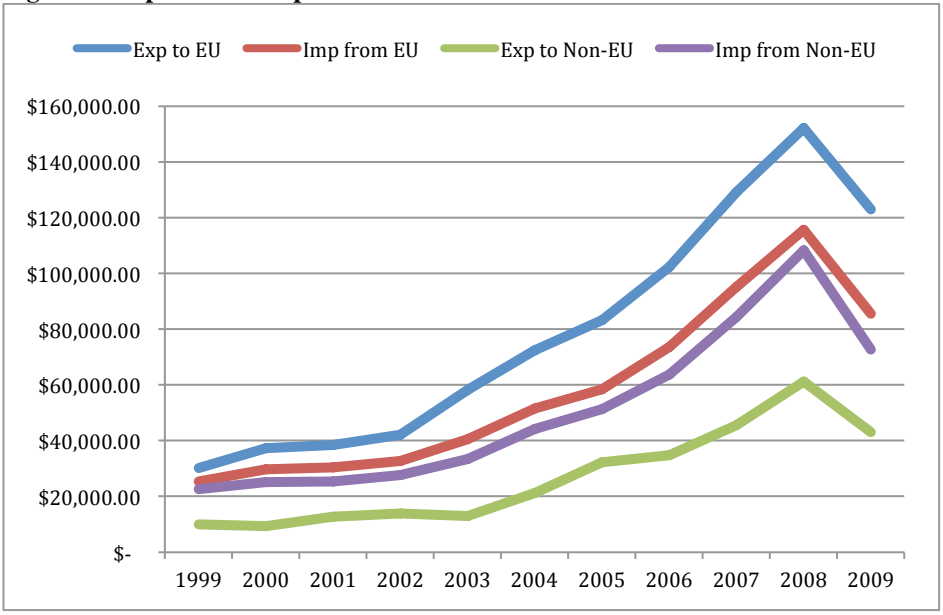



Source: own calculation

The membership of Poland in the European Union contributed to the improvement of the Polish economy and to the growth of the international trade with other European Union members. The European Union is the main destination market for Poland. Poland expanded its export to European Union countries from $30115 million in 1999 to $152095 million in 2008 and like most of the World got a decrease in export after world crisis in 2009 to $123043 million. The same was with imports for Poland from European Union the amount of $25279 million in 1999 rose to $115483 million in 2008 and decreased to $85482 million in 2009.

Just to short comparison it should be said that the exchange of the Polish economy plays the biggest role with European Union countries than with rest of the world by comparing exports to European Union members and Non-European Union countries. But the imports from EU members and from all other countries not belonging to EU differ not so much. Figure 4 shows the difference between exports and imports for Poland with countries belonging to EU and all other countries not belonging to EU.

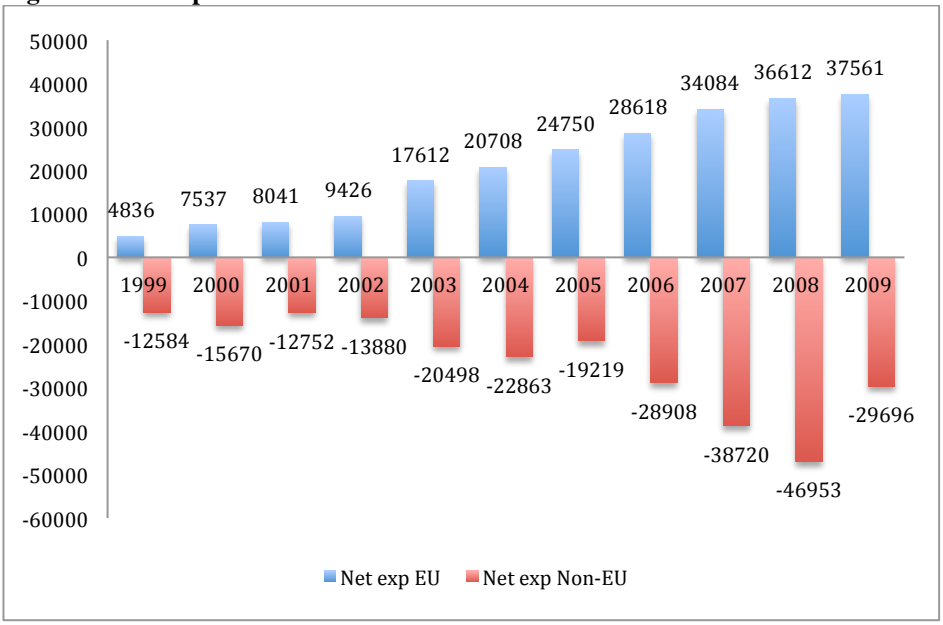
**Figure 4: Exports and Imports for Poland with EU members and Non-EU members**




Source: own calculation

From the Figure 5 we see that export was more important than import, net export was positive and Poland had a Trade Surplus within exchange with European Union countries. With other countries being Non-European Union member's net export for Poland was always negative for the analyzed period, Poland had the Trade Deficit with exchange outside the European Union in the years 1999-2009.

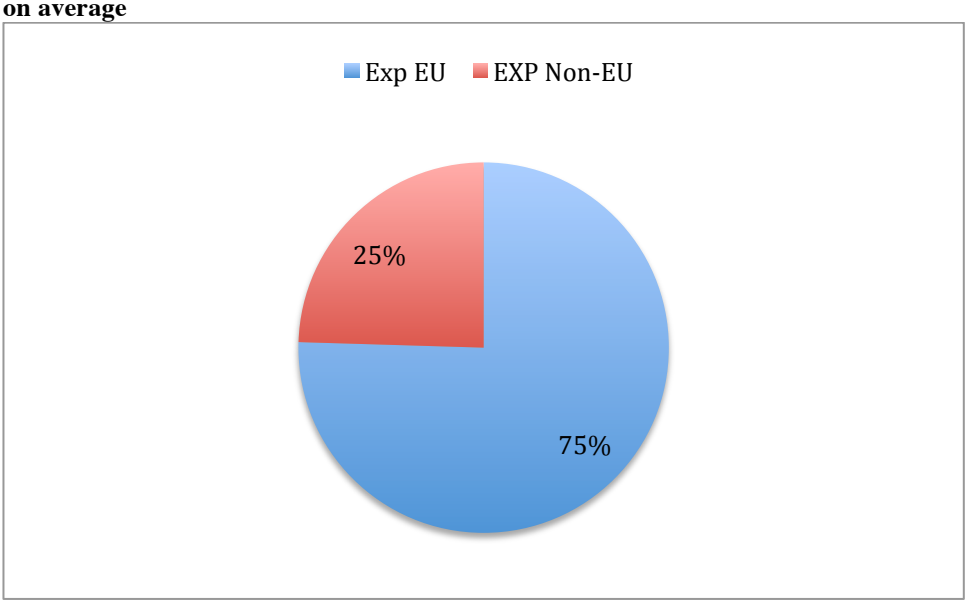
**Figure 5: Net Exports for Poland with EU and Non-EU members**




Source: own calculation

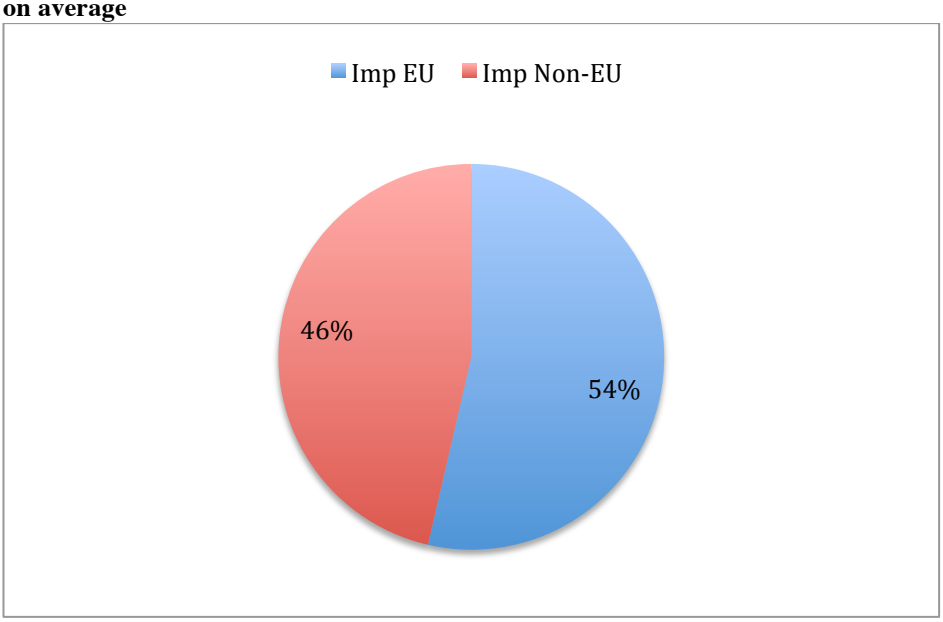
Figures 6 and 7 show the shares of exchange in the Polish Economy (exporting and importing goods) with EU and Non-EU countries during analyzed period on average. We can see that the share of exports for all other years stayed relatively unchanged that is on average 75% of exports went to European Union members. The share of imported goods by Poland from European Union and Non-European Union countries was virtually equivalent. On average 54% of imported goods was coming from EU in analyzed period.

**Figure 6: Shares of Exports from Poland to EU and Non-EU members in percentage on average**




Source: own calculation

**Figure 7: Shares of Imports to Poland from EU and Non-EU countries in percentage on average**




Source: own calculation

## Key sectors of the Polish economy

In this work it was used input-output tables for World economy including Poland and all European Union members for years 1999-2009. In the original World Input-Output table each country is divided into 35 sectors, in my work I removed the thirty-fifth sector that is

"Private Households with Employed Persons", because the values in this sector from demand side were all equal to zero and from supply side the values were so small, that they were without any impact on my analysis.

The first part of my analysis focus on finding the key sectors in Poland, which play the most important role in the Polish economy. The normalized forward and backward linkages are needed for identifying the most important sectors. I will analyze each year and define the sectors, which are the most active in trading in the Polish economy.

Finding the key sectors help the policy makers to make a decision in development strategy of Polish economy. After obtaining the most important sectors for the Polish economy, stimulating final demand and primary inputs namely of these sectors would positively influence the economic activity of Poland.

Tables 5, 6 and 7 show the values of direct and total backward and forward linkages and normalized direct backward and forward linkages and normalized direct and total backward linkages known as "Index of the Power of Dispersion" and normalized direct and total forward linkages known as "Index of the Sensitivity of Dispersion" for thirty-four sectors for 1999, 2004 and 2009 in the Polish economy.

Figures 9 to 14 present the visualization of the key sectors, founded by "Index of the Power of Dispersion" and "Index of the Sensitivity of Dispersion". According to the magnitude of the normalized total linkage indicators, each sector can be classified into four categories.

- The most important is the first category for the key sectors indicated by letter **K** (normalized backward and forward indices are both greater than one). These sectors are located in the North-East quadrant of the Figures 9-14

- Second is for sector with strong backward linkages denoted by **B** (normalized backward indices are greater than one and normalized forward indices are smaller than one). These sectors can be found in the South-East quadrant of the Figures 9-14

- Third category is for sector with strong forward linkages marked by the letter **F** (normalized forward indices are bigger than one and normalized backward indices are smaller than one). These sectors are located in the North-West quadrant in the Figures 9-14

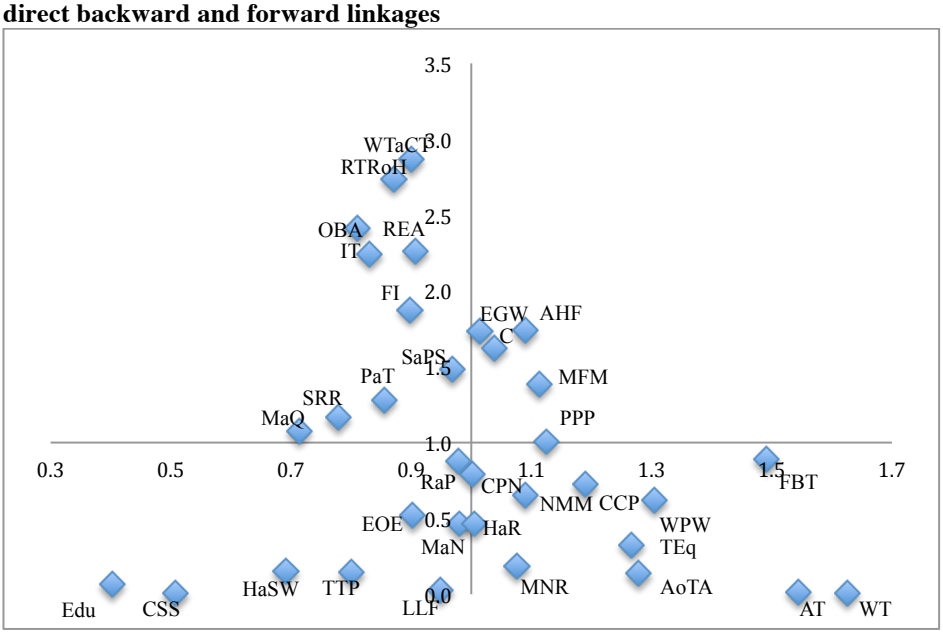
- The last one is expressed by the letter **L** – for sector with weak linkages (both normalized backward and forward indices are smaller than one). These sectors are shown in the South-West quadrant in the Figures 9-14

**Table 5: Direct and total backward and forward linkages and normalized direct and normalized total backward and forward linkages for the Polish economy for 1999**

| 1999 | Abbreviation | FL(d) | BL(t) | FL(t) | NBL(d) | NFL(d) | NBL(t) | NFL(t) | Result |
|---|---|---|---|---|---|---|---|---|---|
| 1 | AHF | 0.754 | 1.851 | 2.361 | 1.090 | 1.740 | 1.063 | 1.355 | K |
| 2 | MaQ | 0.468 | 1.525 | 1.873 | 0.714 | 1.079 | 0.876 | 1.075 | F |
| 3 | FBT | 0.387 | 2.201 | 1.692 | 1.491 | 0.894 | 1.263 | 0.971 | B |
| 4 | TTP | 0.063 | 1.579 | 1.086 | 0.801 | 0.145 | 0.906 | 0.623 | W |
| 5 | LLF | 0.012 | 1.714 | 1.016 | 0.949 | 0.029 | 0.984 | 0.583 | W |
| 6 | WPW | 0.270 | 2.020 | 1.393 | 1.305 | 0.624 | 1.160 | 0.799 | B |
| 7 | PPP | 0.435 | 1.866 | 1.783 | 1.124 | 1.004 | 1.071 | 1.024 | K |
| 8 | CPN | 0.344 | 1.718 | 1.600 | 1.001 | 0.793 | 0.986 | 0.919 | W |
| 9 | CCP | 0.313 | 1.871 | 1.505 | 1.190 | 0.723 | 1.074 | 0.864 | B |
| 10 | RaP | 0.382 | 1.730 | 1.603 | 0.979 | 0.881 | 0.993 | 0.920 | W |
| 11 | NMM | 0.284 | 1.806 | 1.510 | 1.090 | 0.656 | 1.037 | 0.867 | B |
| 12 | MFM | 0.600 | 1.829 | 1.990 | 1.113 | 1.385 | 1.050 | 1.143 | K |
| 13 | MaN | 0.202 | 1.729 | 1.325 | 0.980 | 0.467 | 0.993 | 0.761 | W |
| 14 | EOE | 0.225 | 1.661 | 1.368 | 0.902 | 0.520 | 0.953 | 0.785 | W |
| 15 | TEq | 0.142 | 1.943 | 1.215 | 1.266 | 0.328 | 1.116 | 0.697 | B |
| 16 | MNR | 0.081 | 1.820 | 1.131 | 1.076 | 0.186 | 1.045 | 0.649 | B |
| 17 | EGW | 0.753 | 1.724 | 2.385 | 1.014 | 1.738 | 0.990 | 1.369 | F |
| 18 | C | 0.703 | 1.780 | 2.276 | 1.038 | 1.623 | 1.022 | 1.307 | K |
| 19 | SRR | 0.505 | 1.576 | 1.854 | 0.779 | 1.164 | 0.905 | 1.064 | F |
| 20 | WTaCT | 1.243 | 1.658 | 3.200 | 0.900 | 2.876 | 0.952 | 1.837 | F |
| 21 | RTRoH | 1.186 | 1.652 | 2.959 | 0.871 | 2.736 | 0.948 | 1.699 | F |
| 22 | HaR | 0.201 | 1.746 | 1.301 | 1.006 | 0.464 | 1.002 | 0.747 | B |
| 23 | IT | 0.973 | 1.604 | 2.383 | 0.831 | 2.245 | 0.921 | 1.368 | F |
| 24 | WT | 0.004 | 2.172 | 1.007 | 1.626 | 0.009 | 1.247 | 0.578 | B |
| 25 | AT | 0.005 | 2.113 | 1.009 | 1.544 | 0.013 | 1.212 | 0.579 | B |
| 26 | AoTA | 0.060 | 1.920 | 1.090 | 1.279 | 0.138 | 1.102 | 0.626 | B |
| 27 | PaT | 0.555 | 1.619 | 1.921 | 0.855 | 1.280 | 0.929 | 1.103 | F |
| 28 | FI | 0.814 | 1.642 | 2.443 | 0.898 | 1.877 | 0.943 | 1.402 | F |
| 29 | REA | 0.981 | 1.659 | 2.887 | 0.907 | 2.263 | 0.952 | 1.657 | F |
| 30 | OBA | 1.048 | 1.592 | 2.944 | 0.810 | 2.418 | 0.914 | 1.690 | F |
| 31 | CSS | 0.003 | 1.375 | 1.006 | 0.508 | 0.008 | 0.789 | 0.577 | W |
| 32 | Edu | 0.029 | 1.294 | 1.047 | 0.402 | 0.067 | 0.743 | 0.601 | W |
| 33 | HaSW | 0.067 | 1.521 | 1.092 | 0.692 | 0.155 | 0.873 | 0.627 | W |
| 34 | SaPS | 0.643 | 1.711 | 1.968 | 0.968 | 1.484 | 0.982 | 1.130 | F |

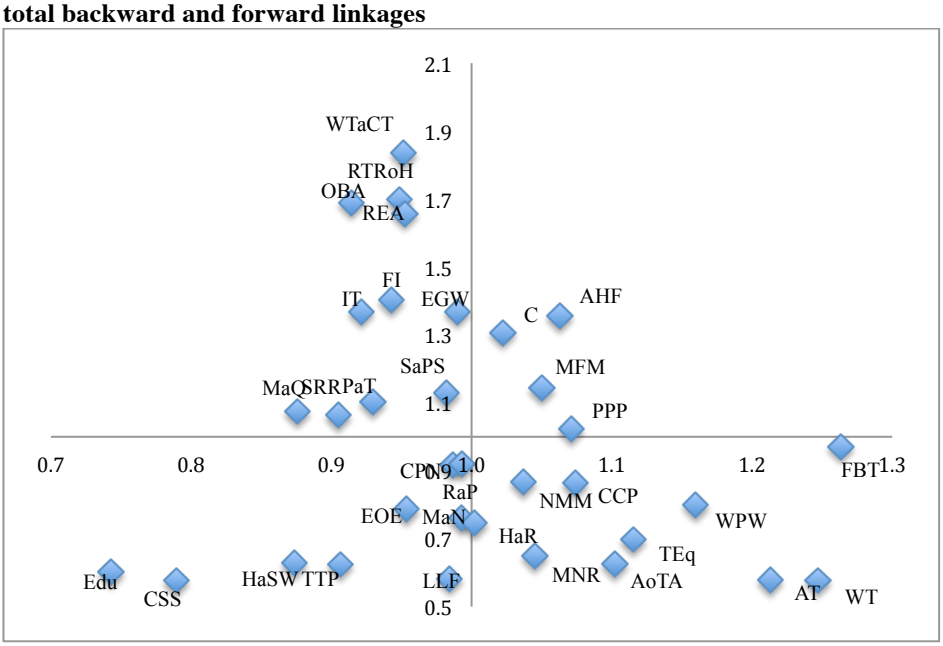
Source: own calculation

**Figure 9: Visualization of the results of key sectors analysis in 1999 – normalized direct backward and forward linkages**




Source: own calculation

**Figure 10: Visualization of the results of key sectors analysis in 1999 – normalized total backward and forward linkages**



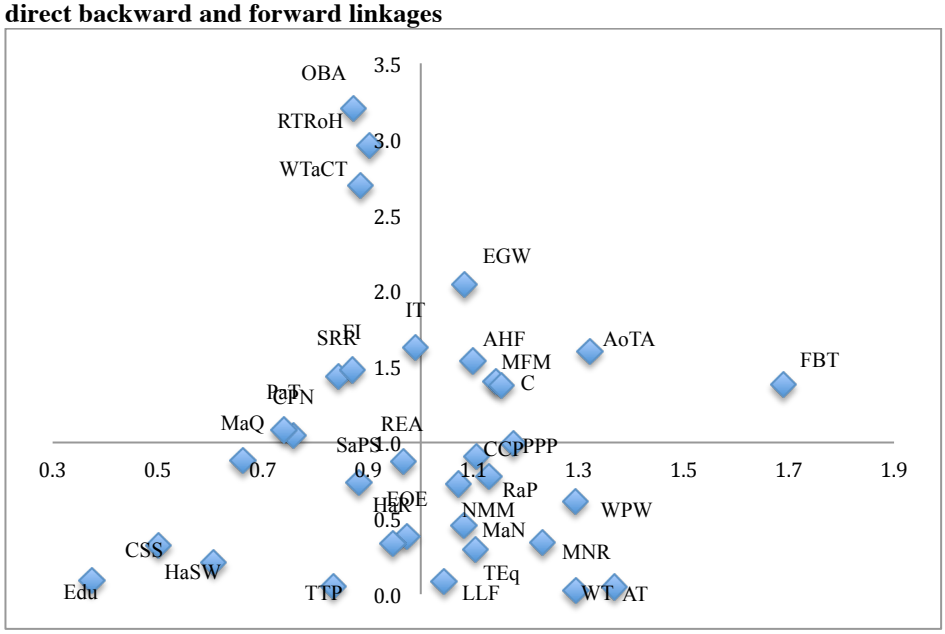

Source: own calculation

**Table 5: Direct and total backward and forward linkages and normalized direct and normalized total backward and forward linkages for the Polish economy for 2004**

| 2004 | Abbreviation | FL(d) | BL(t) | FL(t) | NBL(d) | NFL(d) | NBL(t) | NFL(t) | Result |
|---|---|---|---|---|---|---|---|---|---|
| 1 | AHF | 0.621 | 1.780 | 2.153 | 1.099 | 1.538 | 1.061 | 1.283 | K |
| 2 | MaQ | 0.354 | 1.443 | 1.689 | 0.622 | 0.878 | 0.860 | 1.006 | W,F |
| 3 | FBT | 0.558 | 2.229 | 1.965 | 1.689 | 1.383 | 1.328 | 1.171 | K |
| 4 | TTP | 0.022 | 1.554 | 1.034 | 0.834 | 0.054 | 0.926 | 0.616 | W |
| 5 | LLF | 0.034 | 1.716 | 1.036 | 1.044 | 0.083 | 1.023 | 0.617 | B |
| 6 | WPW | 0.248 | 1.904 | 1.351 | 1.294 | 0.615 | 1.134 | 0.805 | B |
| 7 | PPP | 0.401 | 1.797 | 1.701 | 1.176 | 0.992 | 1.071 | 1.013 | B,K |
| 8 | CPN | 0.423 | 1.485 | 1.738 | 0.758 | 1.047 | 0.855 | 1.013 | F |
| 9 | CCP | 0.367 | 1.740 | 1.569 | 1.106 | 0.909 | 1.037 | 0.935 | B |
| 10 | RaP | 0.314 | 1.764 | 1.504 | 1.129 | 0.779 | 1.051 | 0.896 | B |
| 11 | NMM | 0.294 | 1.719 | 1.485 | 1.072 | 0.728 | 1.024 | 0.855 | B |
| 12 | MFM | 0.566 | 1.770 | 1.908 | 1.143 | 1.403 | 1.055 | 1.137 | K |
| 13 | MaN | 0.184 | 1.729 | 1.294 | 1.082 | 0.455 | 1.030 | 0.771 | B |
| 14 | EOE | 0.153 | 1.650 | 1.241 | 0.974 | 0.379 | 0.983 | 0.740 | W |
| 15 | TEq | 0.120 | 1.743 | 1.181 | 1.103 | 0.296 | 1.039 | 0.703 | B |
| 16 | MNR | 0.138 | 1.849 | 1.205 | 1.231 | 0.341 | 1.102 | 0.718 | B |
| 17 | EGW | 0.823 | 1.695 | 2.358 | 1.083 | 2.039 | 1.010 | 1.405 | K |
| 18 | C | 0.555 | 1.796 | 2.038 | 1.154 | 1.376 | 1.070 | 1.214 | K |
| 19 | SRR | 0.580 | 1.545 | 1.970 | 0.844 | 1.437 | 0.921 | 1.173 | F |
| 20 | WTaCT | 1.088 | 1.603 | 2.750 | 0.886 | 2.695 | 0.955 | 1.639 | F |
| 21 | RTRoH | 1.194 | 1.623 | 2.928 | 0.903 | 2.958 | 0.967 | 1.745 | F |
| 22 | HaR | 0.136 | 1.710 | 1.214 | 0.947 | 0.337 | 1.019 | 0.724 | W,B |
| 23 | IT | 0.656 | 1.638 | 2.149 | 0.990 | 1.625 | 0.967 | 1.280 | F |
| 24 | WT | 0.009 | 1.902 | 1.012 | 1.295 | 0.021 | 1.133 | 0.603 | B |
| 25 | AT | 0.019 | 1.952 | 1.026 | 1.368 | 0.046 | 1.163 | 0.611 | B |
| 26 | AoTA | 0.646 | 1.909 | 1.892 | 1.322 | 1.599 | 1.138 | 1.127 | K |
| 27 | PaT | 0.436 | 1.475 | 1.778 | 0.740 | 1.081 | 0.879 | 1.060 | F |
| 28 | FI | 0.597 | 1.558 | 1.985 | 0.870 | 1.479 | 0.928 | 1.183 | F |
| 29 | REA | 0.353 | 1.654 | 1.655 | 0.966 | 0.873 | 0.986 | 0.986 | W |
| 30 | OBA | 1.292 | 1.572 | 3.314 | 0.873 | 3.201 | 0.936 | 1.974 | F |
| 31 | CSS | 0.130 | 1.334 | 1.236 | 0.501 | 0.321 | 0.795 | 0.736 | W |
| 32 | Edu | 0.036 | 1.247 | 1.057 | 0.374 | 0.089 | 0.743 | 0.630 | W |
| 33 | HaSW | 0.083 | 1.390 | 1.112 | 0.607 | 0.206 | 0.828 | 0.663 | W |
| 34 | SaPS | 0.297 | 1.589 | 1.537 | 0.882 | 0.736 | 0.947 | 1.916 | W,F |

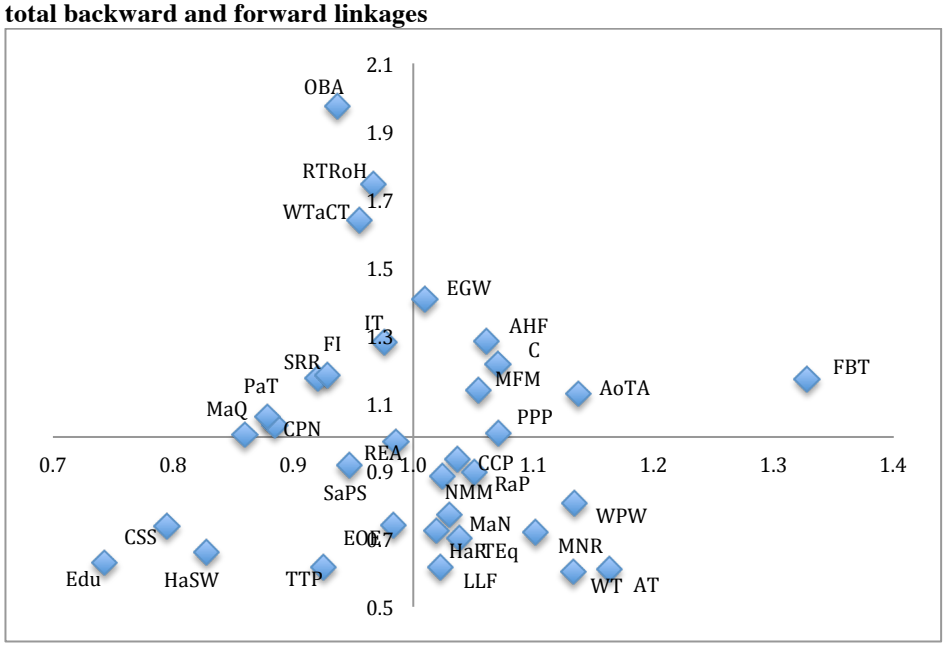
Source: own calculation

**Figure 11: Visualization of the results of key sectors analysis in 2004 – normalized direct backward and forward linkages**




Source: own calculation

**Figure 12: Visualization of the results of key sectors analysis in 2004 – normalized total backward and forward linkages**



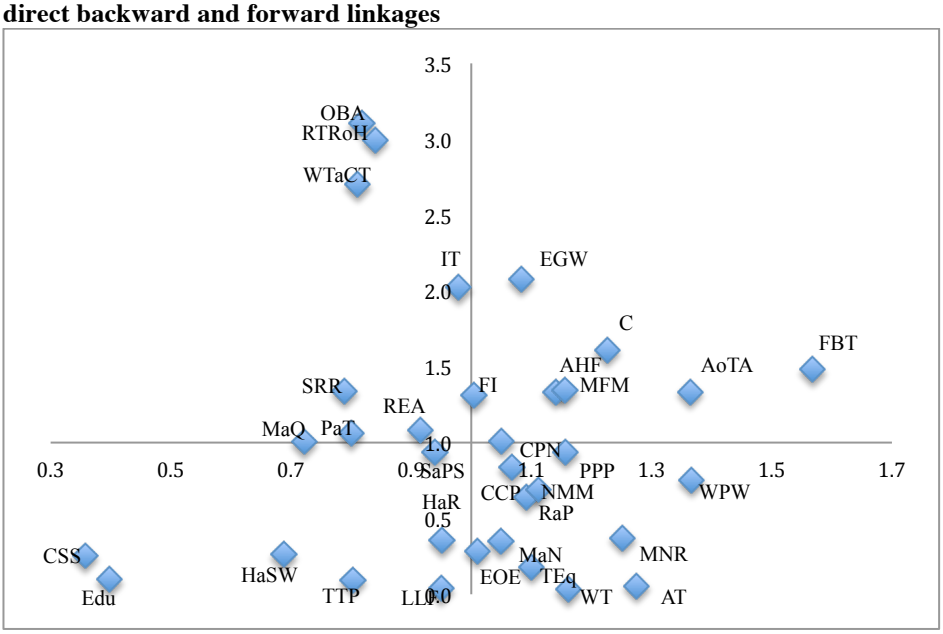

Source: own calculation

**Table 6: Direct and total backward and forward linkages and normalized direct and normalized total backward and forward linkages for the Polish economy for 2009**

| 2009 | Abbreviation | FL(d) | BL(t) | FL(t) | NBL(d) | NFL(d) | NBL(t) | NFL(t) | Result |
|---|---|---|---|---|---|---|---|---|---|
| 1 | AHF | 0.541 | 1.817 | 2.012 | 1.141 | 1.336 | 1.080 | 1.196 | K |
| 2 | MaQ | 0.408 | 1.486 | 1.760 | 0.723 | 1.008 | 0.883 | 1.046 | F |
| 3 | FBT | 0.600 | 2.151 | 2.031 | 1.568 | 1.482 | 1.278 | 1.207 | K |
| 4 | TTP | 0.038 | 1.530 | 1.059 | 0.803 | 0.095 | 0.909 | 0.629 | W |
| 5 | LLF | 0.015 | 1.644 | 1.017 | 0.950 | 0.038 | 0.977 | 0.604 | W |
| 6 | WPW | 0.305 | 1.974 | 1.450 | 1.367 | 0.753 | 1.173 | 0.861 | B |
| 7 | PPP | 0.380 | 1.783 | 1.651 | 1.157 | 0.938 | 1.059 | 0.981 | B |
| 8 | CPN | 0.410 | 1.681 | 1.722 | 1.050 | 1.011 | 0.999 | 1.023 | K,F |
| 9 | CCP | 0.340 | 1.715 | 1.510 | 1.068 | 0.838 | 1.019 | 0.897 | B |
| 10 | RaP | 0.260 | 1.736 | 1.413 | 1.092 | 0643 | 1.031 | 0.840 | B |
| 11 | NMM | 0.279 | 1.752 | 1.469 | 1.111 | 0.689 | 1.041 | 0.873 | B |
| 12 | MFM | 0.545 | 1.784 | 1.863 | 1.156 | 1.345 | 1.060 | 1.107 | K |
| 13 | MaN | 0.142 | 1.707 | 1.224 | 1.049 | 0.349 | 1.015 | 0.727 | B |
| 14 | EOE | 0.116 | 1.672 | 1.180 | 1.010 | 0.286 | 0.993 | 0.701 | B,W |
| 15 | TEq | 0.072 | 1.734 | 1.109 | 1.101 | 0.179 | 1.030 | 0.659 | B |
| 16 | MNR | 0.151 | 1.873 | 1.256 | 1.251 | 0.372 | 1.113 | 0.728 | B |
| 17 | EGW | 0.842 | 1.715 | 2.421 | 1.083 | 2.080 | 1.019 | 1.438 | K |
| 18 | C | 0.653 | 1.864 | 2.309 | 1.226 | 1.612 | 1.108 | 1.372 | K |
| 19 | SRR | 0.542 | 1.511 | 1.893 | 0.789 | 1.337 | 0.898 | 1.125 | F |
| 20 | WTaCT | 1.094 | 1.544 | 2.745 | 0.811 | 2.701 | 0.924 | 1.631 | F |
| 21 | RTRoH | 1.212 | 1.578 | 2.939 | 0.840 | 2.993 | 0.938 | 1.746 | F |
| 22 | HaR | 0.144 | 1.707 | 1.226 | 0.951 | 0.357 | 1.014 | 0.728 | W,B |
| 23 | IT | 0.819 | 1.651 | 2.427 | 0979 | 2.022 | 0.981 | 1.442 | F |
| 24 | WT | 0.012 | 1.820 | 1.016 | 1.161 | 0.029 | 1.081 | 0.604 | B |
| 25 | AT | 0.023 | 1.900 | 1.032 | 1.276 | 0.058 | 1.129 | 0.613 | B |
| 26 | AoTA | 0.541 | 1.945 | 1.750 | 1.365 | 1.336 | 1.156 | 1.040 | K |
| 27 | PaT | 0.429 | 1.516 | 1.750 | 0.800 | 1.060 | 0.901 | 1.040 | F |
| 28 | FI | 0.531 | 1.664 | 1.887 | 1.004 | 1.312 | 0.989 | 1.121 | K,F |
| 29 | REA | 0.438 | 1.633 | 1.819 | 0.916 | 1.082 | 0.971 | 1.081 | F |
| 30 | OBA | 1.260 | 1.540 | 3.253 | 0.818 | 3.110 | 0.915 | 1.933 | F |
| 31 | CSS | 0.102 | 1.240 | 1.182 | 0.358 | 0.253 | 0.737 | 0.701 | W |
| 32 | Edu | 0.040 | 1.266 | 1.062 | 0.398 | 0.099 | 0.752 | 0.631 | W |
| 33 | HaSW | 0.107 | 1.445 | 1.140 | 0.688 | 0.264 | 0.858 | 0.677 | W |
| 34 | SaPS | 0.378 | 1.634 | 1.677 | 0.939 | 0.934 | 0.971 | 0.996 | W |

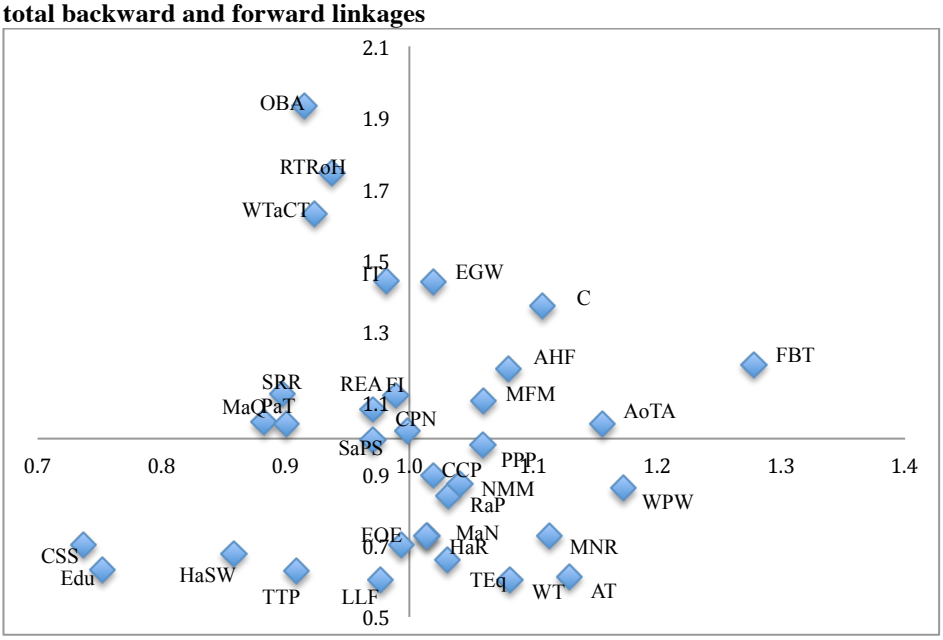
Source: own calculation

**Figure 13: Visualization of the results of key sectors analysis in 2009 – normalized direct backward and forward linkages**




Source: own calculation

**Figure 14: Visualization of the results of key sectors analysis in 2009 – normalized total backward and forward linkages**




Source: own calculation

If the backward linkages of sector *i* is greater than of sector *j* than the dollar's worth of expansion of sector *i* output would be more beneficial to the Polish economy than would an equal expansion in sector *j*'s output, in terms of the productive activity throughout the economy that would be generated by it. The same for the forward linkages, if these linkages of sector *i* is greater than of sector *j*, than a dollar's worth of expansion

of the output of sector *i* is more essential to the Polish economy than an expansion in output of sector *j*, from the point of view of the overall productive activity that it could support.

Using the indices of dispersion the most important sectors from the demand and supply side of view are showed in the tables 8 to 11. These tables show normalized direct and total backward and forward linkages.

**Table 8: Ranked normalized direct backward linkages for 1999-2009**

| Rank | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 24 | 25 | 25 | 24 | 24 | 25 | 6 | 6 | 6 | 6 | 6 |
| **2** | 25 | 6 | 24 | 25 | 6 | 24 | 25 | 25 | 25 | 25 | 25 |
| **3** | 3 | 24 | 6 | 6 | 25 | 6 | 16 | 16 | 16 | 16 | 16 |
| **4** | 6 | 16 | 16 | 16 | 7 | 16 | 24 | 24 | 24 | 24 | 24 |
| **5** | 26 | 15 | 7 | 7 | 16 | 7 | 7 | 10 | 10 | 10 | 7 |

Source: own calculation

**Table 9: Ranked normalized direct forward linkages for 1999-2009**

| Rank | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 20 | 20 | 30 | 21 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| **2** | 21 | 30 | 21 | 30 | 20 | 21 | 21 | 21 | 21 | 21 | 21 |
| **3** | 30 | 21 | 20 | 20 | 21 | 20 | 20 | 20 | 20 | 20 | 20 |
| **4** | 29 | 28 | 28 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| **5** | 23 | 19 | 23 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 19 |

Source: own calculation

**Table 10: Ranked normalized total backward linkages for 1999-2009**

| Rank | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 3 | 25 | 25 | 24 | 24 | 25 | 6 | 6 | 6 | 6 | 6 |
| **2** | 24 | 6 | 24 | 6 | 6 | 6 | 25 | 25 | 25 | 25 | 25 |
| **3** | 25 | 16 | 6 | 25 | 25 | 24 | 16 | 16 | 16 | 16 | 16 |
| **4** | 6 | 24 | 16 | 16 | 16 | 16 | 24 | 24 | 24 | 24 | 24 |
| **5** | 15 | 15 | 15 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 7 |

Source: own calculation

**Table 11: Ranked normalized total forward linkages for 1999-2009**

| Rank | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 20 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| **2** | 21 | 20 | 21 | 21 | 20 | 21 | 21 | 21 | 21 | 21 | 21 |
| **3** | 30 | 21 | 20 | 20 | 21 | 20 | 20 | 20 | 20 | 20 | 20 |
| **4** | 29 | 28 | 28 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| **5** | 23 | 19 | 23 | 19 | 28 | 28 | 28 | 28 | 28 | 28 | 19 |

Source: own calculation

Distinguish between direct and total normalized backward linkages it can be seen the small differences in importance of the sectors leading as buyers in the market. These differences are showed in the table 7 and 9. During eleven years the most active sectors for buyers were Agriculture, Hunting, Forestry and Fishing (3), Wood and Products of Wood

and Cork (6), Pulp, Paper Printing and Publishing (7), Rubber and Plastics (10), Transport Equipment (15), Manufacturing and Recycling (16), Water Transport (24), Air Transport (25) and Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26).

Sectors Pulp, Paper Printing and Publishing (7) and Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26) were active as purchaser from the direct backward linkages point of view and sectors Rubber and Plastics (10), Transport Equipment (15) and Air Transport (25) were active from the total backward linkages point of view. Rest were the same for both direct and total normalized indices.

Looking at the normalized forward direct and total linkages there were no differences, for both indices for all years the same sectors were active as sellers. These results are to be found in table 8 and 10. The most active sectors in supply were: Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel (19), Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles (20), Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Households Goods (21), Inland Transport (23), Financial Intermediation (28), Real Estate Activities (29), Renting of Machinery and Equipment and Other Business Activities (30).

The key sectors are shown in tables 12 and 13 and again distinguished between direct and total key sectors.

**Table 12: Key sectors from normalized direct backward and forward linkages for the Polish economy for 1999-2009**

| Rank | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 17 | 17 | 17 | 17 | 17 | 17 | 3 | 3 | 3 | 17 |
| **2** | 17 | 3 | 3 | 3 | 3 | 3 | 3 | 17 | 17 | 17 | 3 |
| **3** | 18 | 1 | 1 | 26 | 1 | 26 | 26 | 26 | 26 | 26 | 18 |
| **4** | 12 | 12 | 18 | 1 | 26 | 1 | 18 | 18 | 18 | 18 | 26 |
| **5** | 7 | 18 | 26 | 18 | 18 | 12 | 1 | 1 | 1 | 1 | 12 |
| **6** | | | 12 | 12 | 12 | 18 | 12 | 6 | 6 | 6 | 1 |
| **7** | | | | | | | | 12 | 12 | 12 | 7 |

Source: own calculation

**Table 13: Key sectors from normalized total backward and forward linkages for the Polish economy for 1999-2009**

| Rank | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 17 | 17 | 17 | 17 | 3 | 3 | 3 | 3 | 3 | 3 |
| **2** | 18 | 3 | 3 | 3 | 3 | 17 | 17 | 17 | 18 | 18 | 18 |
| **3** | 12 | 1 | 1 | 1 | 1 | 1 | 18 | 18 | 17 | 17 | 17 |
| **4** | 7 | 18 | 18 | 18 | 18 | 18 | 1 | 26 | 1 | 1 | 1 |
| **5** | | 12 | 12 | 26 | 26 | 26 | 26 | 1 | 26 | 26 | 26 |
| **6** | | 7 | 26 | 12 | 12 | 12 | 12 | 7 | 7 | 7 | 12 |
| **7** | | | 7 | 7 | 7 | 7 | 7 | 12 | | 12 | |

Source: own calculation

When a particular sector is a key sector then it influences the sellers and at the same time the purchasers. A normalized backward linkages greater than 1 mean that a unit change in final consumption in sector *j* will generate an above average expansion in activity in the economy, and analogously if normalized forward linkage is bigger than one, than a unit change in all sectors of the final consumption will build an above average increase in sector *i.*

Comparing the results of finding the leading sectors for the Polish economy through all analyzed period the most important sectors looking from direct and total point of view, were: Agriculture, Hunting, Forestry and Fishing (1), Food, Beverages and Tobacco (3), Pulp, Paper, Printing and Publishing (7), Basic Metals and Fabricated Metals (12), Electricity, Gas and Water Supply (17) Construction (18), Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26). And from direct indices the Wood and Products of Wood and cork (6) was a key sector in 2006 to 2008 too.

## Spatial linkages

Analysis of spatial linkages allows one to identify the sectors, which are more dependent on export or import or domestic transactions. In this measurement direct backward and forward linkages will play bigger role than total to find the spatial connectedness or interdependence.

Table 14 shows the spatial backward linkages intraregional for Poland and interregional for rest of EU countries for 1999, 2004 and 2009 and in the last column the average of these linkages.

**Table 14: Spatial direct backward linkages internal for Poland and external for EU countries in 1999, 2004 and 2009 in percentage**

| | 1999 | 2004 | 2009 | 1999 | 2004 | 2009 |
|---|---|---|---|---|---|---|
| | SBL EU | | | SBL POL | | |
| **1** | 9.4 | 10.9 | 11.5 | 90.6 | 89.1 | 88.5 |
| **2** | 14.8 | 20.4 | 19.7 | 85.2 | 79.6 | 80.3 |
| **3** | 6.6 | 8.1 | 8.3 | 93.4 | 91.9 | 91.7 |
| **4** | 32.5 | 38.2 | 32.0 | 67.5 | 61.8 | 68.0 |
| **5** | 21.5 | 27.0 | 30.6 | 78.5 | 73.0 | 69.4 |
| **6** | 11.6 | 17.4 | 14.3 | 88.4 | 82.6 | 85.7 |
| **7** | 20.9 | 23.5 | 21.7 | 79.1 | 76.5 | 78.3 |
| **8** | 9.0 | 10.1 | 9.6 | 91.0 | 89.9 | 90.4 |
| **9** | 17.7 | 27.8 | 28.1 | 82.3 | 72.2 | 71.9 |
| **10** | 28.7 | 29.8 | 29.0 | 71.3 | 70.2 | 71.0 |
| **11** | 16.7 | 17.5 | 15.1 | 83.3 | 82.5 | 84.9 |
| **12** | 21.5 | 28.5 | 26.9 | 78.5 | 71.5 | 73.1 |
| **13** | 23.0 | 29.2 | 26.8 | 77.0 | 70.8 | 73.2 |
| **14** | 27.9 | 33.7 | 18.0 | 72.1 | 66.3 | 72.0 |
| **15** | 25.1 | 38.2 | 35.3 | 74.9 | 61.8 | 64.7 |
| **16** | 20.8 | 24.1 | 19.8 | 79.2 | 75.9 | 80.2 |
| **17** | 8.1 | 8.3 | 9.2 | 91.9 | 91.7 | 90.8 |
| **18** | 14.4 | 18.3 | 14.5 | 85.6 | 81.7 | 85.5 |
| **19** | 18.9 | 16.6 | 15.2 | 81.1 | 83.4 | 84.8 |
| **20** | 9.6 | 12.6 | 13.0 | 90.4 | 87.4 | 87.0 |
| **21** | 10.1 | 11.2 | 10.5 | 89.9 | 88.8 | 89.5 |
| **22** | 7.2 | 7.7 | 7.5 | 92.8 | 92.3 | 92.5 |
| **23** | 13.1 | 16.6 | 16.0 | 86.9 | 83.4 | 84.0 |
| **24** | 12.8 | 19.0 | 23.3 | 87.2 | 81.0 | 76.7 |
| **25** | 12.8 | 19.0 | 23.3 | 87.2 | 81.0 | 76.7 |
| **26** | 12.1 | 11.5 | 13.7 | 87.9 | 88.5 | 86.3 |
| **27** | 13.1 | 16.9 | 15.1 | 86.9 | 83.1 | 84.9 |
| **28** | 7.0 | 11.2 | 9.9 | 93.0 | 88.8 | 90.1 |
| **29** | 3.1 | 5.8 | 5.6 | 96.9 | 94.2 | 94.4 |
| **30** | 10.0 | 14.5 | 14.0 | 90.0 | 85.5 | 86.0 |
| **31** | 8.1 | 13.8 | 25.0 | 91.9 | 86.2 | 75.0 |
| **32** | 7.1 | 9.0 | 8.8 | 92.9 | 91.0 | 91.2 |
| **33** | 8.8 | 17.5 | 17.0 | 91.2 | 82.5 | 83.0 |
| **34** | 7.1 | 13.7 | 12.1 | 92.9 | 86.3 | 87.9 |

Source: own calculation

Table 15 displays the spatial forward linkages intraregional for Poland and interregional for other EU members in the years 1999, 2004 and 2009. In the last column the average of these free years is shown.

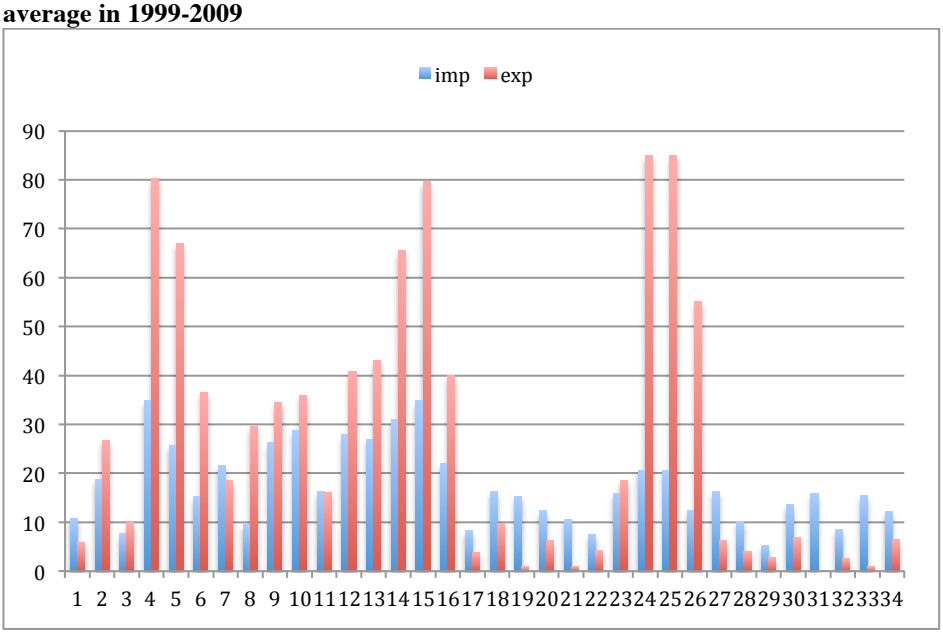
**Table 15: Spatial direct forward linkages internal for Poland and external for EU countries in 1999, 2004 and 2009 in percentage**

| | 1999 | 2004 | 2009 | 1999 | 2004 | 2009 |
|---|---|---|---|---|---|---|
| | SFL EU | | | SFL POL | | |
| **1** | 5.7 | 7.4 | 8.1 | 94.3 | 92.6 | 91.9 |
| **2** | 25.8 | 28.2 | 21.0 | 74.2 | 71.8 | 79.0 |
| **3** | 13.3 | 9.2 | 10.0 | 86.7 | 90.8 | 90.0 |
| **4** | 55.8 | 88.6 | 76.6 | 44.2 | 11.4 | 23.4 |
| **5** | 84.1 | 51.1 | 67.8 | 15.9 | 48.9 | 32.2 |
| **6** | 35.8 | 44.9 | 27.8 | 64.2 | 55.1 | 72.2 |
| **7** | 15.3 | 19.8 | 21.1 | 84.7 | 80.2 | 78.9 |
| **8** | 13.2 | 32.1 | 25.5 | 86.8 | 67.9 | 74.5 |
| **9** | 35.3 | 31.9 | 35.6 | 64.7 | 68.1 | 64.4 |
| **10** | 20.6 | 37.1 | 44.4 | 79.4 | 62.9 | 55.6 |
| **11** | 13.4 | 17.3 | 16.1 | 86.6 | 82.7 | 83.9 |
| **12** | 33.5 | 42.4 | 36.4 | 66.5 | 57.6 | 63.6 |
| **13** | 29.9 | 45.0 | 54.9 | 70.1 | 55.0 | 45.1 |
| **14** | 46.4 | 67.3 | 74.7 | 53.6 | 32.7 | 25.3 |
| **15** | 62.1 | 82.1 | 87.1 | 37.9 | 17.9 | 12.9 |
| **16** | 44.7 | 41.4 | 34.1 | 55.3 | 58.6 | 65.9 |
| **17** | 1.7 | 4.4 | 3.7 | 98.3 | 95.6 | 96.3 |
| **18** | 10.5 | 9.7 | 10.0 | 89.5 | 90.3 | 90.0 |
| **19** | 1.2 | 1.2 | 0.6 | 98.8 | 98.8 | 99.4 |
| **20** | 2.0 | 7.4 | 7.7 | 98.0 | 92.6 | 92.3 |
| **21** | 1.1 | 0.9 | 1.3 | 98.9 | 99.1 | 98.7 |
| **22** | 16.4 | 3.5 | 3.7 | 83.6 | 96.5 | 96.3 |
| **23** | 1.0 | 21.7 | 24.9 | 99.0 | 78.3 | 75.1 |
| **24** | 82.1 | 83.5 | 81.8 | 17.9 | 16.5 | 18.2 |
| **25** | 82.1 | 83.5 | 81.8 | 17.9 | 16.5 | 18.2 |
| **26** | 92.4 | 53.3 | 54.0 | 7.6 | 46.7 | 46.0 |
| **27** | 7.7 | 6.2 | 5.2 | 92.3 | 93.8 | 94.8 |
| **28** | 8.2 | 3.5 | 1.7 | 91.8 | 96.5 | 98.3 |
| **29** | 0.9 | 3.9 | 2.1 | 99.1 | 96.1 | 97.9 |
| **30** | 2.6 | 5.7 | 12.6 | 97.4 | 94.3 | 87.4 |
| **31** | 1.4 | 0.1 | 0.1 | 98.6 | 99.9 | 99.9 |
| **32** | 10.7 | 1.1 | 3.1 | 89.3 | 98.9 | 96.9 |
| **33** | 0.7 | 1.4 | 1.4 | 99.3 | 98.6 | 98.6 |
| **34** | 2.2 | 7.9 | 9.0 | 97.8 | 92.1 | 91.0 |

Source: own calculation

Summarizing the obtained results about 60% of sectors are relatively self-sufficient in the Polish economy, however about 30% of sectors are dependent on import and export. If an industry on average had greater than 20% aggregated spatial backward or forward linkages, than this industry it ranks to the import or export dependent. Figure 15 displays the sectors with aggregated spatial backward and forward linkages. Normalized backward and forward direct spatial linkages give the relative strength of external dependence of industries upon international trade.

**Figure 15: Spatial linkages for interregional relation of Poland with EU members on average in 1999-2009**



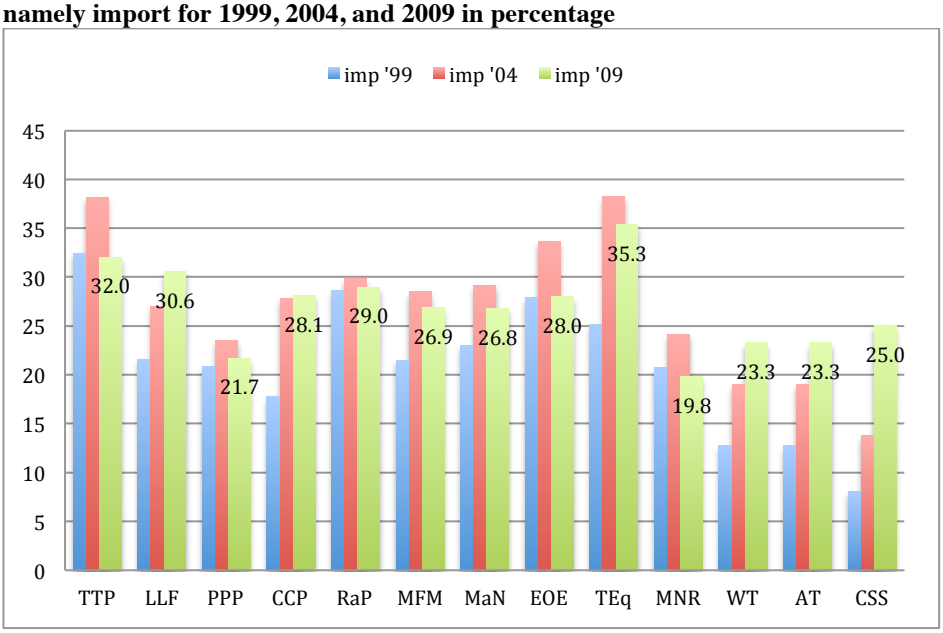

Source: own calculation

The following industries are import and export dependent, that is the aggregated value on average of spatial backward and forward direct linkages for European Country as region *s* comparing with domestic country Poland as region *r* is bigger than 20%: Textiles and Textile Products (4), Leather, Leather and Footwear (5), Chemicals and Chemical Products (9), Rubber and Plastics (10), Basic Metals and Fabricated Metal (12), Machinery (13), Electrical and Optical Equipment (14), Transport Equipment (15), Manufacturing, Recycling (16), Water Transport (24), Air Transport (25), Wood and Products of Wood and Cork (6) and Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26) belong to the export dependent sectors. Whereas sector Pulp, Paper, Printing and Publishing (7) belongs to the export's dependent industry.

Figures 16 and 17 show the most important sectors for Polish import and export with EU countries for the years 1999, 2004 and 2009 and their changes during these three years. Polish sectors, which were active in importing the goods from EU countries, have quite stabile changes over the three analyzed years. The greatest change was 13.1% between 1999 and 2004 in "Transport Equipment" (15) and this sector had the biggest

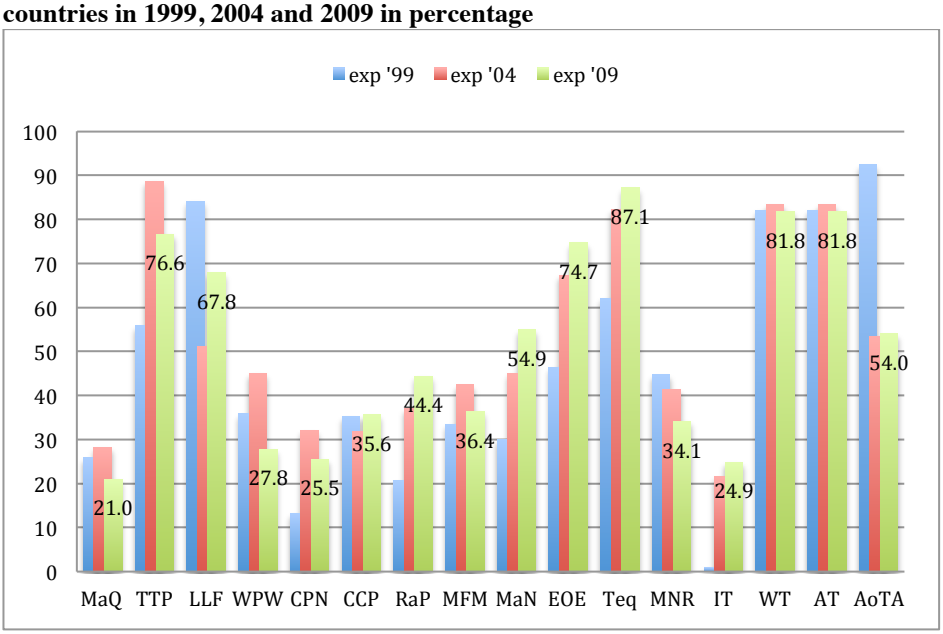
share from importing goods and it was 38.2% in 2004, rest of the sectors varying about 10% during these years.

**Figure 16: Most important sectors for Poland dependent on external strength namely import for 1999, 2004, and 2009 in percentage**




Source: own calculation

**Figure 17: The most important sectors for Poland dependent on export from EU countries in 1999, 2004 and 2009 in percentage**



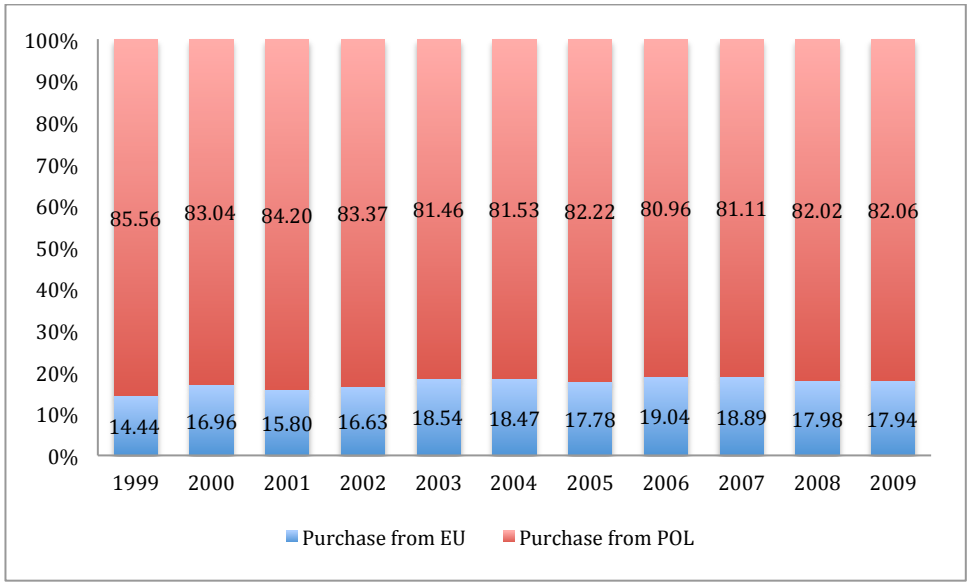

Source: own calculation

Sectors active in exporting of the goods had bigger variations, namely in Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26) the value of exported goods was 92.4% in 1999,

whereas it decreased up to 53.1% in 2004 and Textiles and Textile Products (4) increased from 55.8% in 1999 to 89.7% in 2004 what gives 33.9% change in exporting these goods. It should be said that sectors Transport Equipment (15), Water Transport (24), and Air Transport (25) had very high share in exporting goods to other EU members, explicitly for 2004 and 2009 varying at about 83%.

The last effect of spatial linkages is the measure, which ignores the sectoral detail and shows regional's direct backward and forward linkages to itself and to the EU countries, by averaging over all sectors. The results for averaged internal and external spatial direct backward linkages are shown in Figure 18. The intermediate goods in Poland purchased by this country from itself and from other EU members were at about 14.4% in 1999 bought from abroad and 85.6% was bought from domestic economy, whereas in 2009 17.9% of all intermediate goods purchased by Poland came from EU countries and 82.1% came from the domestic industries.

**Figure 18: Averaged internal and external spatial direct backward linkages for 1999-2009**

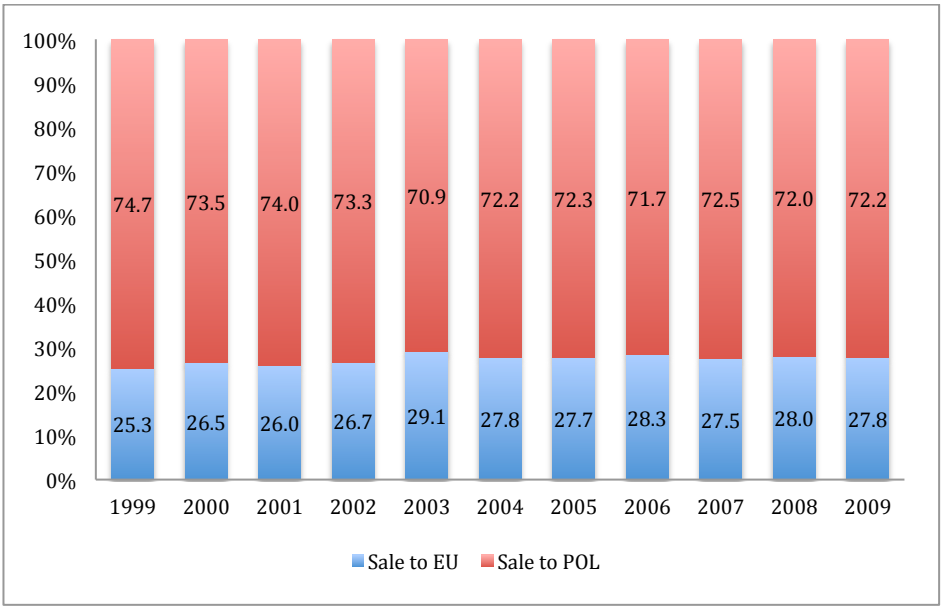



Source: own calculation

The averaged internal and external spatial forward linkages are shown in Figure 19. The share of intermediates goods sold to Poland and to EU countries was varying on about 75% in 1999 to 72% in 2009 for Polish

domestic economy and 25% in 1999 to 28% in 2009 for Polish interregional economy.

**Figure 19: Averaged internal and external spatial direct forward linkages for 1999-2009**




Source: own calculation

The spatial linkages are resulting in the fact that sale the goods from Poland to EU members is bigger than purchasing the goods by Poland from EU countries, so that Poland had a trade surplus in exchanging trade with other EU partners. The same result was shown in figure 4.

## Vertical specialisation – import content of export

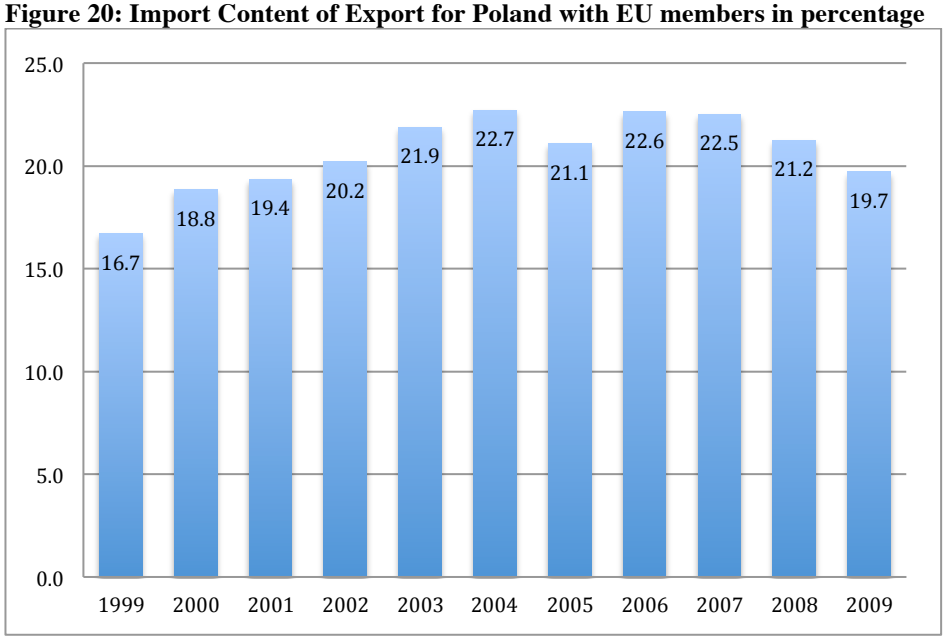
The process of expansion the Polish economy started in the end of XX century. Poland together with the accession to the European Union got the possibility to improve its economy with countries belonging to this Union.

As mentioned earlier Poland in exchanging trade with European Union partners had a trade surplus through all analyzed years. Vertical specialisation will answer the question how big is the share of imported goods from EU in process of producing domestic goods, which are later on exported back to EU members.

The indicator of the import content of export shows the degree of vertical specialisation. In another way it expresses the contribution that import is making in the production of exported goods and services. Vertical specialisation gives the value of imports required to produce one dollar of exports and answers the question how much imports are required for the exports.

During the analyzed period the import content of export increased slowly from 16.7% in 1999 to 19.7% in 2009. Whereas one year after joining to EU vertical specialisation in Poland had decreased from 22.7% in 2004 to 21.1% in 2005. In 2006 it improved to 22.6% and started to decrease up to 19.7% in 2009. These results are shown in the Figure 20.

**Figure 20: Import Content of Export for Poland with EU members in percentage**

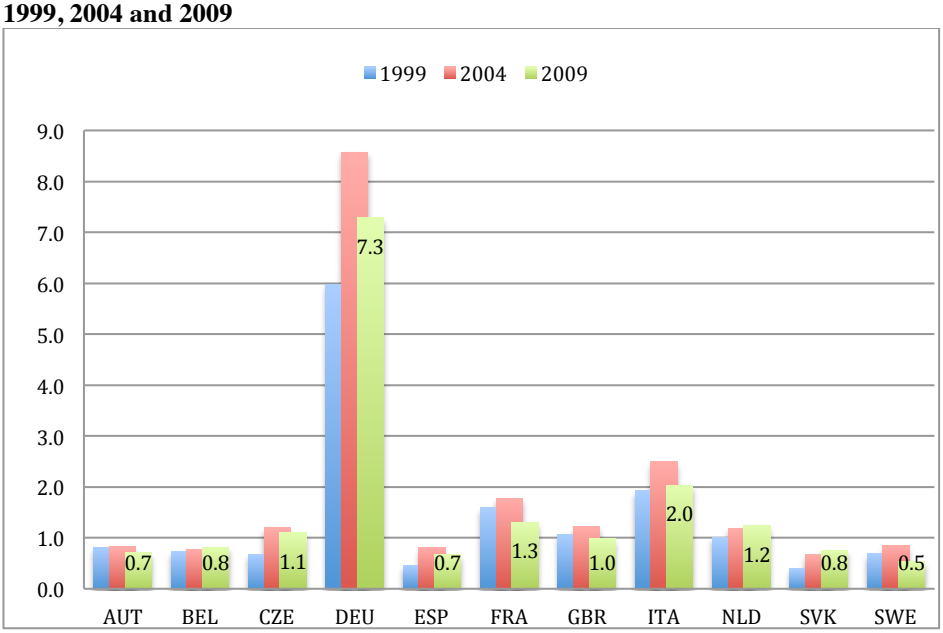



Source: own calculation

Using the measurement of import content of export it was found ten most important countries of EU with the highest share of imported goods by Poland used to producing exported goods by this country to other EU members. In 1999, 2004 and 2009 the most important role as countries that increasingly link sequentially to produce goods had Germany, Italy and France. Ten most importing countries in terms of import content of export for 1999, 2004 and 2009 are shown in the Figure 21. For Germany it was 6.0% in 1999, it rose in 2004 up to 8.6% and decreased up to 7.3%

in 2009. The vertical specialisation for Poland with Italy was 1.9% in 1999, in 2004 was increasing to 2.5% and felt to 2.0% in 2009. With France the results was 1.6% in 1999, 1.8% in 2004 and 1.3% in 2009, so the import content of exports for Poland with France has increased and decreased as with other countries too.

**Figure 21: Import Content of Export with 10 most important EU countries in 1999, 2004 and 2009**




Source: own calculation

Other countries with the biggest shares in vertical specialisation for Poland were: England, Netherlands, Czech Republic, Belgium, Slovakia, Sweden, Austria and Spain. These countries were in the eleven most important countries for the Poland in terms of vertical specialisation.

Comparing my results for Poland to other researches of import content of export, the results coincide with other studies. Only for Poland the shares of import in export were relatively small comparing to calculation for couple European countries in 2000. In 2000 import content of export was 19.2%, whereas in Germany and Italy it was 27-28% for Belgium 47% and for Netherlands 37%. Nevertheless the results fulfil the thesis that for smaller countries the imported goods in producing exported goods are higher than in bigger countries, because the smaller countries quite often

do not have such a various domestic intermediate inputs like bigger countries and that is why they have to import these inputs from abroad.

## VII. Conclusions

The aim of my work was to analyze the structural changes in the Polish industries using the input-output analysis for the years 1999-2009. Firstly the amounts of average growth rate, gross output, imports and exports for Poland with EU and Non-EU countries have been shown. After this the measurement of backward and forward linkages was used, which was helpful to find the key sectors of Polish economy during analyzed period.
The input-output analysis in general helped to compare the sectoral changes in the Polish economy during eleven years. After doing all measurements I found the most important sectors from the domestic and international point of view. I found the sectors active in the Poland's trade inside the country and in trade with EU members.

The analysis of key sectors is very important for the government and for private consumers. From one side the results from this analysis should be helpful for the national economic development strategy and government policy of regional development, from other side key sectors analysis should help entrepreneurs in making their investment decisions.
In the analysis of key sectors the Rasmussen method (Index of the Power of Dispersion and Sensitivity Index of Dispersion) was used.
In the domestic economy the most important sectors from perspective eleven examined years were Agriculture, Hunting, Forestry and Fishing (1), Food, Beverages and Tobacco (3), Electricity, Gas and Water Supply (17) and Construction (18).

For the policy makers these results are very helpful to know in which sectors the government should invest in domestic trade and in international

trade. The policy makers have a very clear view of which industries are the most beneficent for the Polish economy. To answer the question, which sectors of the economy to stimulate, they could use the results of this thesis. For example policy makers may use the outcomes of this work to take a decision about creating additional final demand, decreasing taxes, or with the help of subsidizing in order to improve the results in the range of economic expansion of Poland. So for the expansion strategy it is very important to define which industries have high backward and forward linkages. Then stimulating final demand or primary inputs might positively affect the economic activity of Poland.

Spatial perspective was used to compare the sectors active in import and export with EU countries.
From the perspective of external spatial linkages an import and export dependency for Poland was found. In general Poland is a region self-sufficient, this is shown by averaged spatial linkages. On average Poland economy throughout the examined period was dependent on export in 27.4%, whereas on import in 17.4%.

The sectors that had the strongest dependency on selling to EU countries were Air Transport (25) dependent on average in 84.9%, Water Transport (24) with 84.89%, Textiles and Textile Products (4) with 80.4%, Transport Equipment (15) with 79.6%, Leather, Leather and Footwear (5) with 67.0%, Electrical and Optical Equipment (14) with 65.5% and Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies (26) with 55.2%.

The most dependent sectors in Polish economy on purchasing the intermediates from EU countries were: Transport Equipment (15) with 34.8%, Textiles and Textile Products (4) with 34.8%, Electrical and Optical Equipment (14) with 31.0%, Rubber and Plastics (10) with 28.7%, Basic Metals and Fabricated Metals (12) with 27.9%, Machinery not elsewhere classified (13) with 26.9%, Chemicals and Chemical Product (9) with 26.2% and Leather, Leather and Footwear (5) with 25.7%.

At the end the vertical measurement was applied to check how much of imported intermediates from EU countries are used in producing the goods, which are next exported to EU from Poland.
The biggest change in the vertical specialisation in Poland with EU members was an increase at 6% from 1999 to 2004.

As mentioned earlier the bigger country the smaller the vertical specialisation is. In practical point of view it is true, because the bigger the country, the more primary inputs it has. The smaller the country the bigger the vertical specialisation is, so the more goods such a country has to import from abroad to produce other goods, which are later on exported.

Polish economy improved a lot during analyzed period and collapsed after world crisis in 2007. Thanks the membership to European Union Poland expands its trade with abroad neighbours and in domestic scale too.
Most trade is done with EU countries rather than Non-EU countries but despite this Poland is self-sufficient and not very dependent on import and export. However, for a couple sectors selling and purchasing from EU countries plays a big role for Poland.

## References


1. Amador J. and Cabral S., "*Vertical specialization across the World: A relative measure"*. Banco de Portugal, Working Papers No. 10, pp. 1-28, July 2008
2. Aydin H. "*An analysis of Input-Output Inter Industry linkages in the Turkish Economy"*. Paper presented at the 16th International Input Output Conference, Istanbul, 2-6 July 2007
3. Blair P.D. and Miller R. E. "*Input-Output Analysis: Foundations and Extensions"*. Cambridge, 2009.
4. Breda E., Cappariello R and Zizza R., "*Vertical specialization in Europe: evidence from the import content of exports"*. Working paper, Bank of Italy. 2008
5. Chenery H., Watanabe T., "*International comparison of the structure of production"*. Econometrica, vol. XXVI, no. 26, pp. 73-83, 1958
6. Dietzenbacher E., van der Linden J. A., "*Sectoral and Spatial Linkages in the EC Production Structure"*. Journal of Regional Science, No. 37, pp. 235-257, May 1997
7. Dietzenbacher E., "*Vertical specialization in an intercountry input-output framework"*. Lett Spat Resour Sci 2010
8. Guilhoto J., Siroën J-M. and Yucer A. "*Internal and international vertical specialization – estimations for Brazil and new approach to gravity models"*. Annual Doctoral Conference of the Association for the Development of Research in Economics and Statistics (ADRES), Strasbourg, 2013
9. Gurgul H., Majdosz P., "*Key sector analysis: A case of the transited Polish economy"*. Managing Global Transitions – Fakulteta za Management, pp. 95-111, Vol. 3. 2005
10. Hummels et al, "*The nature and growth of vertical specialisation in world trade"*. Journal of International Economics 54, pp. 75-96, 2001
11. Johnson R. C. and Noguera G., "*Proximity and Production Fragmentation"*. American Economic Review, pp. 407-411, 2012
12. Kula M. "*Supply-use and input-output tables, backward and forward linkages of the Turkish economy"*. The 16th Inforum World Conference in Northern Cyprus, 1-5 September 2008
13. Leontief E., "*Essays in economics. Theories, theorizing, facts and policies"*. New Brunswick and Oxford, 1985.
14. Loschky A. and Ritter L., "*Import content of export"*. Paper presented at the 16th International Input Output Conference, Istanbul, 2-6 July 2007
15. Olczyk M., "*Structural changes in the Polish economy – the Analysis of input-output"*. Volkswirtschaftliche Fakultät, Ludwig-Maximilians-Universität, Working Paper. 2011
16. Raa T. T., "*Input-output economics: theory and applications: featuring Asian economies",* World Scientific, 2009
17. Rodriguez-Clare A., "*Multinationals, Linkages and Economic Development"*. The American Economic Review, Vol. 86, No. 4, pp. 852-873, September 1996

18. Temurshoev U. "*Key sectors in the Kyrgyzstan economy*". Discussion Paper No. 2004 – 135, November 2004
19. Temurshoev U., Oosterhaven J., "*On input-output linkage measures*". International Input-Output Association, European Commission. 2010
20. Tohmo T., Littuen H. and Tanninen H., "*Backward and forward linkages, specialization and concentration in Finnish manufacturing in the period 1995-1999*". European Journal of Spatial Development, No. 19, April 2006
21. Tzimos C., Papadimitriou I. and Adamou N., "*The measurement of interindustry linkages with data analysis methods*". Paper presented at the 16th International Input Output Conference, Istanbul, 2-6 July 2007

**Sources:**

http://www.wiod.org
http://epp.eurostat.ec.europa.eu
http://www.econ.brown.edu

## VIII. Appendix

### Abstract

The main aim of my thesis is to analyze the structure of the Polish economy using the World Input Output Tables for the period of eleven years between 1999 and 2009.

The introduction describes the Polish economy in general, showing that during the period of interest Poland had the fifth highest average growth rate in the EU.

The thesis proceeds to discuss the general assumptions of Input-Output tables and explains what Backward Linkages (when the industry uses products from other industries in its own production process) and Forward Linkages (when the sector stream the own products to other sectors) are. In this chapter the methods of calculation of coefficients in Input-Output tables are defined. These methods allow for the calculation of key sectors (the most important industries) and spatial linkages (the most important sectors for import and export) in the Polish economy.

In the next stage the notion of vertical specialisation is discussed, and in particular that used in this study, namely the import content of exports (how much the imported goods are used to produce the goods, which are later on exported).

The thesis goes on to discuss existing literature and presents information on the database (i.e. the World Input Output Database) used in this study. Following this discussion, the thesis presents information on and developments in the major variables of interest that are described above. Conclusions discuss the results obtained and how the measures calculated are helpful for policymakers to better manage the Polish economy.

## Zusammenfassung

Das Hauptziel meiner These ist, die Struktur der polnischen Wirtschaft zu analysieren mittels Input-Output Tabellen für die Periode von 1999 bis 2009.

Die Einführung beschreibt die polnische Wirtschaft und es ist interessant, dass Polen während der Periode von 1999 bis 2009, die fünfte höchste durchschnittliche Wachstumsrate in der Europäischen Union hatte.

Die These bespricht die allgemeinen Annahmen von Input-Output Tabellen und erklärt, was das Backward Linkages (wenn die Industrie, Produkte von anderen Industrien in seinem eigenen Produktionsprozess benutzt) und das Forward Linkages (wenn der Sektor die eigenen Produkte an andere Sektoren übergibt) ist. In diesem Kapitel werden die Methoden der Berechnung von Koeffizienten der Input-Output Tabellen definiert. Diese Methoden berücksichtigen die Berechnung von Key Sectors (die wichtigsten Industrien) und Spatial Linkages (die wichtigsten Sektoren für Import und Export) in der polnischen Wirtschaft.

Im folgenden Abschnitt wird der Begriff ein vertikale Spezialisation besprochen und insbesondere benutzte diese Studie den Import Content of Export (wieviel die importierten Waren verwendet werden, um die Waren zu erzeugen, die später exportiert werden).

Die These bespricht weiter existierende Literatur und liefert derzeitige Informationen der Datenbank (d.h. die World Input Output Datenbank) welche in dieser Studie verwendet wird. Nach dieser Diskussion liefert die These Informationen über die Entwicklung der Hauptvariablen welche oben beschrieben werden. Der letzte Teil bespricht wie die Berechnungen für den Gesetzgeber nützlich sein kann, um die polnische Wirtschaft besser führen zu können.



**Key words:** backward linkages, forward linkages, key sectors, spatial linkages, and vertical specialisation

Backward Linkages, Forward Linkages, Key Sectors, Spatial Linkages, vertikale Spezialisation

## CURRICULUM VITAE

### PERSONAL INFORMATION

Name: Malgorzata Mrowiec
Nationality: Polish
Telephone number: +43 676 735 32 57
Email: malgorzata@mrowiec.eu

### EDUCATION

Master Program in Economics
University of Vienna, Austria (2013)

Bachelor in International Trade
Cracow University, Poland (2007)

### OTHER QUALIFICATIONS

ECDL Core, Vienna (2011)
Office Assistant – BFI, Vienna (2011)

### CAREER EXPERIENCE

Beskid Culture Week, Beskid, Poland, 2008 – 2013

**Service Manager**

As Service Manager of the Beskid Culture week. I have been in charge of coordinating the entire event, including account and staff management

*Key Tasks:*

- Analysis of historical sales in order to maximize current sales
- Overall control of Budget, Forecast and Analysis of regional trends
- Staff Management
- Stock Control
- Cash Management
- Sales Analysis

Oasis, Zywiec, Poland, 2004 – 2007

**Restaurant Manager**

Overall control and management of both Restaurant and Bar in thriving privately owned business. Including Staff, Stock and Cash Management.

*Key Achievements:*

- Analysis and Overall of purchase policy, saving over 10% of purchase cost
- Increase of sales revenue by over 20%
- Analysis of Project Management (in order to have effective financial control)
- Resource Management

## LANGUAGES

Polish: Mother tongue
English: Advanced
German: Advanced

## INTERESTS

Traveling, trekking, biking, reading