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Correlation between the Level of Economic Growth and Foreign Trade: The Case of the V4 Countries

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Irena Łącka[1], Janusz Myszczyszyn[2],
Sylwia Gołąb[3], Beata Będzik[4], Błażej Suproń[5]

Abstract:

Purpose: *The main aim of this article is to search for long-term correlations between the level of economic growth and the level of export and import with cointegration analysis. To this end, the authors used the statistical data of the V4 countries which, since the 1990s, have been implementing market economy elements to different degrees.*
Approach/Methodology/Design: *Econometric methods were used, including stationariness testing using ADF and KPSS tests and Engle-Granger cointegration test.*
Findings: *The results obtained confirm that only in the case of Poland and Hungary there were two-way long-term interdependencies. For Poland, it was a pair of variables (GNP and export value), for Hungary (GNP and import value). No long-term correlation between economic growth and the value of foreign trade could be confirmed for Slovakia and the Czech Republic.*
Practical Implications: *The study of interdependence using statistical methods is an important element in testing economic theories in the field of economic growth research in the countries of the former communist bloc. It is also an important stage in the search for economic growth generators.*
Originality/Value: *Given the importance of trade, it is necessary to study the interaction of variables, check whether exports and imports had an impact on the level of economic growth and whether economic growth determined the increase in foreign trade turnover. The results obtained are the basis for the construction of a vector-autoregressive models (VAR).*

Keywords: *Visegrad countries (V4), economic growth, foreign trade, cointegration analysis.*

JEL classification: *F43,O11, O47*

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[1]*West Pomeranian University of Technology in Szczecin, Faculty of Economics, ORCID ID: 0000-0003-0762-8856, e-mail: irena.lacka@zut.edu.pl*
[2]*West Pomeranian University of Technology in Szczecin, Faculty of Economics, ORCID ID: 0000-0001-9578-5741, e-mail: jmyszczyszyn@zut.edu.pl*
[3]*West Pomeranian University of Technology in Szczecin, Faculty of Economics, ORCID ID: 0000-0002-6572-9201, e-mail: sylwia.golab@zut.edu.pl*
[4]*West Pomeranian University of Technology in Szczecin, Faculty of Economics, ORCID ID: 0000-0003-1052-0977, e-mail: beata.bedzik@zut.edu.pl*
[5]*West Pomeranian University of Technology in Szczecin, Faculty of Economics, ORCID ID: 0000-0002-7432-1670, e-mail: bsupron@zut.edu.pl*

1. Introduction

In the 1990s, the Visegrad Group countries (Poland, the Czech Republic, Slovakia, Hungary, hereinafter V4) began the transformation processes of political and socio-economic systems, under which they made many political and economic changes and decided in 1991 to establish an alliance focused on European integration. One of the transformation's priorities was to redirect foreign trade implemented in previous decades as part of the Mutual Economic Assistance Council (COMECON) from countries of the so called people's democracy to Western Europe, and recently also to China (Brada, 1991; Arghyrou, 2000; Augier *et al.*, 2005; Rynarzewski, 2013; Cieślik *et al.*, 2016).

In almost thirty years, they have undergone a transformation from a centrally planned economy to a market economy. An important step enabling and supporting international trade in the V4 countries was the signing of the CEFTA agreement in December 1992, under which a free trade zone was created between the countries of Central Europe, followed by integration with the European Union in 2004 (Stefaniak-Kopoboru and Kuczewska, 2016). Geopolitical changes, regional cooperation and integration allowed the V4 countries to expand into new markets and benefit from international exchange (Cieślik, 2019), which directly resulted in an increase in foreign trade turnover (Drews, 2016).

These countries are experiencing continuous economic growth, the level of which is fluctuating in market realities. Regardless of the presented theories of economic growth, one of the goals of which is the search for the factors of this growth, it is important to study the correlation between the analyzed variables, including economic growth.

Traditional econometric models often did not take into account the fact that the variables influence each other (two-way dependencies). To capture the relationships between variables, VAR (Vector AutoRegressive) models developed by Sims (1980) can be used as an alternative to the classic multi-equation model with interdependent equations. Hence, the study of stationariness of economic variables and interdependencies is of particular importance, even when using the Engle-Ganger test.

By adopting the assumptions appropriate for the Granger cointegration test, the authors undertook to examine whether the correlations between economic growth and exports and imports of individual V4 countries were long-term. They assumed the following research hypothesis:

H1: The increase in the value of trade exchange of individual V4 countries with foreign countries (import, export) had a positive impact on the level of economic growth of the country (GNP), while economic growth had a positive effect on the level of export and import.

2. Theoretical Background

Economic growth is one of the most frequently discussed categories in scientific literature. It is desired by every society, both backward and highly developed, being a key element in stimulating income, which is equated with increasing social well-being (Barro and Sala-i-Martin, 2004). The processes of economic growth have been dealt with for a long time, and examples can be economic classics such as Smith, Ricardo or Malthus (Barroa and Sala-i-Martin, 2004).

The basis for modern economic growth theory was the work of Ramsey (1928), in which he analyzed inter-period optimization decisions taken by households. And although the assumptions of the article were recognized by economists only three decades later, they became an impulse for the formulation of not only the theory of economic growth, but also the theory of consumption or asset valuation. The first half of the last century was also the work of Harrod (1939) and Domar (1946), which attempted to integrate elements of economic growth into the Keynesian framework and although they were received with recognition by contemporary economists, they do not matter much in today's economic theory, as described below.

Research work related to the Harrod and Domar models constituted the first stage of economists' interest in the issues of economic growth. Snowdon and Vane (2005) point to the stepwise interest of economists in the issues of economic growth, recognizing that after the first stage referred to above (Harrod and Domar models), the next stage was initiated by the neoclassical models of Solow and Swan in the 1950s. The third stage of focusing researchers' efforts on growth issues began in the mid-1980s with endogenous growth models using research and development (R&D) and human capital. Their authors are Lucas (1988), Romer (1990a, 1990b), Jones (1995), Eicher and Turnovsky (1999) and Aghion and Howitt (1992 and 1999).

The disadvantage of the Harrod-Domar model, because of which it was today considered erroneous, are the assumptions of a constant proportion of production factors and its constant capital intensity (Snowdon and Vane, 2005), which almost preclude achieving sustainable growth. The exogenous population growth rate assumed in the cited model, in order to maintain a constant proportion of production factors, enforces an adequate capital growth rate. On the other hand, the assumption of constant capital intensity of production determines the achievement of sustainable growth by equating the rate of economic growth with the rate of capital accumulation and the rate of population growth. According to Solow (1956), this model analyzes long-term problems using tools typical for a short period. The answer to the above drawbacks was the Solow model also called the Solow-Swan model, which key assumption is the neoclassical form of the production function (Barro and Sala-i-Martin, 2004) described by:

- permanent effects of scales, which means that an increase in inputs of production factors with unchanged technology leads to a proportional increase in production;
- positive but decreasing marginal productivity of production factors manifested in positive, though decreasing, production increases while increasing the input of one factor without changing the input of other factors;
- essentiality meaning zero production, if the input of any factor of production is zero, which results precisely from the significance of all factors in the context of production;
- Inada conditions, which mean the value of the end product of the factor of production equal to zero when the input of this factor tends to infinity.

These conditions make it possible to model sustainable economic growth.

However, the disadvantage of neoclassical models is the exogenous technical progress assumed by them, which means adopting it as if in advance and thus skipping its analysis under a given model. This imperfection is eliminated by endogenous growth theories, treating technical progress as an endogenous category. Endogenous models assume that technical progress is a key factor generating economic growth and that it creates incentives for permanent, i.e. continuous capital accumulation, which, together with progress, is largely responsible for product growth per man-hour (Romer, 1990a). An important assumption of endogenous growth models is treating technical progress as an intentional and conscious effect of individual units focused on making profits resulting from their involvement in research activities (Snowdon and Vane, 2005). Expenditure on this activity is therefore treated as a kind of investment.

According to endogenous growth models, ideas are uncompetitive goods, because as Romer said (1990a) they are "*independent of any physical object. It can be copied and used in as many different activities as desired."* Within endogenous models, ideas are characterized by the possibility of their accumulation without any restrictions, as they are not affected by decreasing marginal productivity (as is the case with physical capital). In addition, they are characterized by propagation due to the inability to apply exclusivity, i.e. using the idea only by its creator.

The presented theories of economic growth indicate only the direct determinants of economic growth, such as technical progress or capital accumulation. However, they do not explain the sources of international differentiation of per capita income or its dynamics in different periods. They are unable to identify factors conditioning the effectiveness of specific countries in generating technical progress and accumulating capital that stimulates economic growth. In view of the above, more researchers are making efforts to find other important causes of economic growth, because, as Acemoglu notes (2009), *"there must be other, deeper determinants that are referred to as the fundamental causes of growth. These are the factors that distract many countries from sufficient investment in technology, physical and human capital."*

According to Snowdon and Vane (2005, p. 596) they concern *"those variables that have an important influence on a country's ability and capacity to accumulate factors of production and invest in the production of knowledge."* In the literature on the subject, factors determining economic growth include, for example, population growth, the impact of the financial sector, macroeconomic conditions, trade regime, government size, income distribution, socio-political environment (Snowdon and Vane, 2005) and expenditure on R&D, as well as their size as subject and object structure (Czerniak, 2013).

Acemoglu (2009, p. 110) also tried to answer the needs indicated above by formulating four hypotheses indicating in his opinion the sources of economic growth: *luck hypothesis*, *geography hypothesis*, *culture hypothesis*, *institution hypothesis*. Trade, as one of the factors of growth, was articulated by Temple and Rodrik (2003), placing it in the so-called partly endogenous factors, along with endogenous and exogenous factors. Regardless of the theoretical aspects of sources of growth, the unquestionable determinant of economic growth is the increase in efficiency. And according to the conclusions of the theory of international trade, it is undertaken precisely because of these advantages. International trade based on specialization is part of the creation of Smithian growth, whose source is the division of labor, specialization and exchange, in contrast to Promethian growth based on technical progress and innovation (Snowdon and Vane, 2005).

The positive impact of international trade has been emphasized in classical trade theories, i.e., the theory of absolute costs by Smith (also known as the theory of absolute advantage) and the theory of comparative costs (also known as the theory of comparative advantage) (Misztal, 2010) attributed to Ricardo's economy, although the assumptions of this theory were formulated 9 years earlier by Torrens. Subsequent researchers (Dornbusch, Fischer and Samuelson, 1977; 1980; Eaton and Kortum, 2002; Heckschera, 1949; Ohlin 1967) expanded and supplemented the theory of comparative costs by building models that did not depart in their conclusions from the positive impact of trade on economic efficiency.

From among contemporary foreign trade theories, one can mention the technology gap theory, which emphasizes the diversity of economies in terms of the level of technical knowledge and the rate of technical progress (Topolewski, 2014). Developed countries, also in the context of technological advancement, may transfer technology to other partners (technology spillover) through foreign exchange (Domiter, 2008). Richards (2001), Balaquer and Cantavella-Jorda (2004), Lo (2004), Awokuse (2005), Siliverstovs and Herzer (2006), Li and Whalley (2012) and others also conducted empirical research verifying the interrelationships between foreign trade and economic growth. Some researchers only analyzed export as an element of trade increasing the productivity ratio, conducive to the growth of capital goods or through competition with foreign industries creating effective prices and leading to the allocation of resources in export industries (Suryanto, 2016; Ekananda and Parlinggoman, 2017; Dowrick *et al.*, 2004; Richards, 2001; Siliverstovs and Herzer,

2006). Summing up, one may quote Kotlewski (2013, p. 27), "*that, at a given moment of economic history, the growth of an economy is strictly related to its international and inter-regional trade, and this can be used to combat downturns".*

Despite the above theoretical assumptions regarding the impact of foreign trade results on economic growth, studies are available that show that there is no clear evidence for this causal relationship, which is particularly important for less developed economies or the ones in transition (Gurgul and Lach, 2010). Awokuse (2005) even points out that trade theory does not provide definitive guidelines for the causal relationship between exports, imports, and economic growth.

For example, Jung and Marshall (1985) studied, using Granger causality tests, the directions of causality between exports and economic growth for 37 developing countries (data for 1951-1981). Test results showed only one-way causality, exports towards economic growth, but only for the four countries analyzed (Indonesia, Egypt, Costa Rica and Ecuador). Thus, the research results questioned the validity of the hypothesis regarding the promotion of export as a growth factor. Ramos (2001) studied Granger's causality between exports, imports and long-term economic growth in Portugal (1865-1998). The results led to the conclusion that there is no one-way relationship, but there is feedback between the level of economic growth and exports, and between economic growth and imports. At the same time, the relationship between exports and imports has not been confirmed.

Awokuse (2007) analyzed the causality between exports, imports and economic growth in Bulgaria, the Czech Republic and Poland using the VAR model. Research results show a two-way causal relationship between export and economic growth in Bulgaria, and a one-way causal relationship from import to economic growth for the Czech Republic and Poland. Zang and Baimbridge (2012) studied the interrelationship between exports, imports and economic growth in South Korea and Japan, constructing the VAR model. The results provide evidence of two-way causality between imports and the level of economic growth for both countries. In addition, it can be concluded that Japan experienced an increase in export-driven production, and an increase in GDP in South Korea had a negative impact on export growth.

3. Analysis of the Level of Economic Growth, Import and Export Structure of the V4 Group Countries

Countries belonging to the V4 Group largely carried out their production and trade under the Comecon grouping until 1991. Its breakup and socio-economic changes forced Poland, the Czech Republic, Slovakia and Hungary to change the main directions of export and import. The next stage that contributed to the structural changes in foreign trade of the V4 countries was the integration process as part of European Union membership and access to the common market. The changes resulted in the inflow of foreign direct investment and the orientation of trade

exchange to Western Europe. Tables 1-3 present the most important information on economic growth and foreign trade conducted by individual countries in the years 1996-2018, broken down into main goods, which form the basis of the analysis. The data was additionally supplemented with detailed information from the World Bank database, The World Integrated Trade Solution.

Table 1. *Annual growth GDP (constant 2010 USD) in V4 countries (%)*

Year	Czech Republic		Slovak Republic		Hungary		Poland	
	GDP	GDP *per*	GDP	GDP *per*	GDP	GDP	GDP	GDP *per*
1997	-0.6	-0.5	5.9	5.7	3.1	3.4	6.5	6.4
1998	-0.3	-0.2	4.1	3.9	3.9	4.1	4.6	4.6
1999	1.4	1.5	-0.1	-0.2	3.1	3.4	4.6	4.7
2000	4.3	4.6	1.2	1.3	4.5	4.8	4.6	5.7
2001	2.9	3.3	3.3	3.4	4.1	4.3	1.2	1.3
2002	1.7	1.8	4.5	4.5	4.7	5.0	2.0	2.1
2003	3.6	3.6	5.5	5.6	4.1	4.4	3.6	3.6
2004	4.9	4.9	5.3	5.3	4.8	5.1	5.1	5.2
2005	6.5	6.4	6.6	6.6	4.2	4.5	3.5	3.5
2006	6.9	6.6	8.5	8.5	4.0	4.2	6.2	6.2
2007	5.6	5.0	10.8	10.8	0.2	0.4	7.0	7.1
2008	2.7	1.8	5.6	5.5	1.1	1.2	4.2	4.2
2009	-4.8	-5.3	-5.5	-5.6	-6.7	-6.6	2.8	2.8
2010	2.3	2.0	5.7	5.6	0.7	0.9	3.6	3.9
2011	1.8	1.6	2.9	2.7	1.8	2.1	5.0	5.0
2012	-0.8	-0.9	1.9	1.7	-1.5	-1.0	1.6	1.6
2013	-0.5	-0.5	0.7	0.6	2.0	2.2	1.4	1.5
2014	2.7	2.6	2.8	2.7	4.2	4.5	3.3	3.4
2015	5.3	5.1	4.8	4.7	3.8	4.1	3.8	3.9
2016	2.5	2.3	2.1	2.0	2.2	2.5	3.1	3.1
2017	4.4	4.1	3.0	2.9	4.3	4.6	4.9	4.9
2018	3.0	2.7	4.0	3.9	5.1	5.3	5.1	5.1
Average	2.5	2.4	3.8	3.7	2.6	2.9	4.0	4.1
Median	2.7	2.4	4.1	3.9	3.9	4.1	4.0	4.1
Min	-4.8	-5.3	-5.5	-5.6	-6.7	-6.6	1.2	1.3
Max	6.9	6.6	10.8	10.8	5.1	5.3	7.0	7.1

Source: *Own study based on The World Bank database.*

The Slovak economy recorded real GDP growth of 124.7% in 2008 compared to 1996, reaching an average annual growth rate of 3.8%. With the exception of two periods, i.e., 1999 and 2009, its economic growth rate was positive. In both periods indicated, the Slovak economy was in recession, showing a negative growth value of -0.1% and -5.5% respectively. The highest growth rate occurred in 2007 (10.8%). In terms of GDP per capita, Slovakia's economic growth remained in the years 1996-2018 at an average annual level of 3.7%. In 2018, GDP per capita increased by 85.4% compared to 1996. At the same time, in the examined perspective in 1999 (-

0.2%) and 2009 (-5.6%) the growth rate of GDP per capita was negative. This situation caused that Slovakia took the second position in the V4 group in terms of growth rate and long-term stability. An unquestionable success was also the highest GDP per capita growth among all V4 countries in the years 1996–2018, which amounted to USD 11,308.96.

Table 2. *Share of export selected products in 1996 and 2018 (%)*

Details	Czech Republic		Slovak Republic		Hungary		Poland	
	1996	2018	1996	2018	1996	2018	1996	2018
Animal	1.5	0.9	0.9	0.8	7.5	1.8	3.1	4.3
Chemicals	6.8	4.3	8.1	2.5	7.2	9.1	6.9	6.7
Food Products	2.6	2.3	2.4	1.5	8.5	3.7	5.5	6.8
Footwear	1.7	0.5	1.9	1.3	2.6	0.6	1.4	0.9
Fuels	4.5	1.9	5.6	3.0	3.4	2.8	6.9	2.6
Hides and Skins	0.7	0.3	0.6	0.4	1.2	0.5	0.8	0.5
Mach and Elec	22.3	37.9	15.0	31.3	21.3	38.6	13.0	24.2
Metals	15.1	8.8	14.6	10.3	9.8	5.2	14.5	10.0
Minerals	1.4	0.1	1.9	0.4	0.1	0.1	1.5	0.2
Miscellaneous	6.6	7.4	4.9	4.2	4.9	5.9	8.6	9.0
Plastic or Rubber	5.4	5.6	8.5	5.9	6.2	6.5	3.4	7.2
Stone and Glass	5.4	2.0	3.2	1.3	2.2	1.6	2.9	2.4
Textiles and Clothing	7.1	2.7	7.7	2.1	10.8	1.3	12.0	3.8
Transportation	11.2	21.0	12.5	30.7	4.7	17.3	10.8	13.8
Vegetable	1.6	1.0	2.0	1.3	5.2	2.7	2.7	2.2
Wood	6.0	3.2	10.1	3.0	4.4	2.2	6.2	5.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Own study based on The World Integrated Trade Solution database.*

Table 3. *Share of import selected products in 1996 and 2018 (%)*

Details	Czech Republic		Slovak Republic		Hungary		Poland	
	1996	2018	1996	2018	1996	2018	1996	2018
Animal	0.8	1.3	0.8	1.4	0.6	1.3	1.6	2.5
Chemicals	8.9	7.7	11.2	6.0	11.3	9.7	10.3	9.2
Food Products	3.7	2.7	4.8	2.8	3.2	3.0	3.8	3.6
Footwear	0.9	0.8	0.7	1.2	1.2	0.8	0.7	1.2
Fuels	8.7	6.1	13.5	8.1	13.7	8.2	9.1	8.8
Hides and Skins	0.9	0.4	0.7	0.5	1.7	0.5	0,9	0.6
Mach and Elec	30.3	36.6	21.5	33.1	23.3	35.9	25.3	23.8
Metals	9.9	10.8	8.3	9.9	9.2	8.9	7.0	10.8
Minerals	1.3	0.5	2.1	0.9	0.8	0.5	1.6	0.7
Miscellaneous	6.0	5.8	6.0	5.4	4.7	4.6	4.5	6.9
Plastic or Rubber	5.8	6.9	5.2	6.1	5.4	6.8	6.5	7.5
Stone and Glass	1.9	1.5	2.0	1.6	1.8	1.3	2.2	1.5
Textiles and Clothing	6.1	3.5	3.6	2.7	8.6	2.7	8.4	5.0
Transportation	7.9	11.1	12.5	16.6	7.2	11.9	7.6	11.5
Vegetable	3.0	1.7	3.0	1.6	2.0	1.5	5.4	2.7
Wood	3.9	2.6	4.0	2.1	5.3	2.4	4.9	3.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: *Own study based on The World Integrated Trade Solution database.*

In 2018, the Slovak Republic turned out to be the weakest export economy among all Visegrad Group countries. According to the World Bank ranking, the strength of the Slovak economy placed it 39th in terms of export volume in the world and 16th in the ranking of the most complex economies by economic complexity index (ECI). In 1996, the main export goods in terms of share were electrical machinery and equipment, which accounted for 15.0% of the value of all exported goods, metals (14.6%) and means of transport (12.5%). In 2018, 33.3% of the country's exports were electrical machinery and equipment. Another type of goods with the largest share in exports were means of transport (30.7%). In 2018, the largest decrease in the share in exports, compared to 1996, occurred in the case of chemical products (by 5.6%) as well as textiles and clothing (by 5.6%).

In 1996, Slovakia imported electrical machinery and equipment (21.5%) and fuels (13.5%). In 2018, the share of imports of electrical machinery and equipment increased by 11.6% and textiles and clothing by 4.1%. The main types of products that were imported in 2018 were car parts (9.5%), telecommunications equipment (6.1%) and natural gas (2.9%), while export concerned cars (20.0%), semi-finished products car production (7.1%) as well as screen displays and TVs (6.4%). The main export partners in Slovakia in 1996 were the Czech Republic (31.2%), Germany (22.2%) and Austria (6.5%). In 2018, most goods were exported to Slovakia from Germany (22.1%), the Czech Republic (11.7%) and Poland (7.6%). In 1996, goods were imported mainly from the Czech Republic (26.4%), Germany (15.96%) and Russia (12.2%). In 2018, Germany was still in the first place in terms of share (18.1%). However, the share of the Czech Republic fell (10.2%), and the third country from which most products were imported was China (5.9%).

The Hungarian economy in 1996-2018 was characterized by an average annual GDP growth of 2.5%. In the two years of the adopted research period, the economic growth rate was negative - in 2009 (-6.7%) and in 2012 (-1.5%). At the same time, the volume of GDP in 2018 compared to 1996 increased by 75.6%, and GDP per capita increased by 85.4%. The average annual GDP growth rate per capita in the period considered was 2.9%. A negative GDP per capita growth rate was recorded in 2009 (-6.6%) and in 2012 (-1.0%). The highest GDP growth occurred in 2018 and amounted to 5.1%. The characteristic feature of the Hungarian economy in 1996-2018 was the lowest among V4 countries, GDP per capita increase by USD 7667.45.

Hungary was a stronger economy in terms of trade relative to Slovakia. In 2018, Hungary was the 35th largest export economy in the world and the 15th most complex economy according to the Economic Complexity Index (ECI). In 1996, Hungary mainly exported electrical machinery and equipment, which accounted for 21.3% of exports of goods as well as textiles and clothing (10.8%). In addition, food (8.5%) and metals (9.8%) were important export goods. In 2018, compared to the base period, there were significant changes in the structure of exports, - the share of food decreased by 4.8% (3.7% in 2018) and textiles by 9.5% (1.3% in 2018). On the other

hand, the share of exported electrical machinery and equipment increased (38.6% of total export value in 2018) and transport means by 12.6% compared to the base period (in 2018 the share was 17.3%).

In terms of goods imported by Hungary, in 1996 electrical machines and devices (23.3%) and fuels (13.7%) had the largest share in value. In 2018, the share in the import of electrical machinery and equipment increased by 12.6% and fuel share decreased by 5.5%. In 2018, the main export products were cars (10%), car parts (6.1%) and car engines (3.4%). On the other hand, car parts (5.2%), vehicles (3.5%) and medicines (2.8%) were exported.

In 1996, Hungary sold goods primarily to Germany (29.7%), Austria (10.3%) and Italy (7.94%). In 2018, Germany was the largest export partner (27.3%), and Slovakia was the second most important export destination (5.2%). Italy remained the third country with the largest share in exports (5.1%). Goods in 1996 were imported most often from Germany (23.7%), Russia (12.4%) and Austria (9.5%). In 2018, the share of goods imported from Germany increased, which constituted 25.9% of the value of all imported goods. Austria was the second country from which most goods were imported (6.1%), while Poland came in third (5.8%).

In the years 1996-2018, the Czech Republic had the lowest average annual GDP growth rate, which amounted to 2.5%. During this period, it also achieved the lowest annual average GDP per capita growth of 2.4% in the V4 Group. The Czech economy in the analyzed period had a negative GDP growth rate in the following years: 1997 (-0.6%), 1998 (-0.3%), 2009 (-4.8%), 2012. (-0.8%) and 2013 (-0.5%). GDP per capita in the periods indicated also decreased and amounted to: in 1997 (-0.5%), 1998 (-0.2%), 2009 (-5.3%), 2012. (-0.9%) and 2013 (-0.5%). At the same time, among all V4 countries, the Czech economy achieved the lowest GDP growth in 2018 compared to 1996 by 71.3% and GDP per capita by 66.3%. The highest GDP growth took place in 2006 and amounted to 6.9%. At the same time, the GDP per capita of the Czech Republic was the highest in the entire analyzed period, among all countries belonging to the Visegrad Group.

Despite the lowest growth rate among V4 countries, the Czech Republic in 2018 was the 28th largest export economy in the world and the 9th economy according to the economic complexity index (ECI). The export structure underwent significant changes during the period considered. In 1996, the structure of exports was dominated by electrical machinery and equipment (32.3%), metals (15.1%) and means of transport (11.2%). In subsequent years, there was a further increase in the share in the export of electrical machines and devices, which in 2018 accounted for 37.9% of all goods and transport means sold (21.0% in 2018). At the same time, in 1996-2018 participation in the export of textiles fell by 4.4% and metals by 6.3%. Electrical machines and devices (30.3%), chemical products (8.9%) and fuels (8.7%) had the largest share in imports in 1996. In 2018, the share of electrical machinery

and equipment increased, which accounted for 36.6% of all imported goods, while fuel import decreased by 2.7%.

In 1996, the main countries to which the Czech Republic exported its goods were Germany (36.2%), Slovakia (14.2%) and Austria (6.4%). In terms of imports, the most important partners were Germany (29.8%), Slovakia (9.5%) and Russia (7.4%). In 2018, the main export directions remained similar to those of 1996. Still the most goods were sent to Germany (32.4%) and Slovakia (7.5%). Germany remained the main partner in the import structure (25.1%). The second country from which most goods were imported was China (14.9%). The most important export goods in 2018 were cars (12%), car parts (8.4%) and computers (4.2%), while for import these were car parts (6.1%), office and telecommunications equipment (3, 9%) and cars (2.9%).

The highest rate of GDP growth and GDP per capita among the V4 countries in 2008-2014 was characteristic for the Polish economy. The average annual GDP growth rate was 4.0%, and the average annual GDP growth per capita 4.1%. At the same time, GDP in 2018 increased compared to 1996 by 136.3%, and GDP per capita by 140.4%. In the whole period under review, the growth rate of GDP and per capita GDP was positive, which distinguished the Polish economy in terms of stability compared to other countries belonging to the Visegrad Group. The highest rate of GDP growth occurred in 1997 (6.5%), and the lowest in 2001 (1.2%). It should be emphasized that the Polish economy in 1996 had the lowest GDP per capita among all V4 countries, and its value was half the GDP per capita of the Czech Republic. In 2018, this ratio for Poland already accounted for 71.3%, Czech, which was due to stable, long-term economic growth.

Poland also had the most developed export economy among the V4 countries, which meant that in 2018 it was classified by the World Bank as the 24th largest export economy in the world and the 23rd most complex economy according to the economic complexity index (ECI). The main Polish export goods in 1996 were metals (14.5%), electrical machinery and equipment (13.0%) as well as textiles and clothing (12.0%). In 2018, the share in the export of electrical machinery and equipment (24.2%) and transport means (13.8%) increased. The third group of goods in terms of share in exports were plastic and rubber products (7.2%).

The main import goods in 1996 were electrical machinery and equipment (25.3%), chemical products (10.3%) and fuels (9.1%). In 2018, electrical machinery and equipment were still imported (23.8%). The share of transport means (11.5%) in imports increased. Chemical products (9.2%) were the third type of goods in terms of share in imports. The structure of exported goods in 2018 was dominated by car parts (6.2%), cars (3.2%), and furniture and wooden products (4.4%). However, cars (4.0%), car parts (3.4%) and gasoline (3.7%) were imported. As in the case of other

V4 countries, the main directions of trade changed in the years 1996-2018. In 1996, goods from Poland were mainly exported to Germany (34.5%), Russia (6.8%) and Italy (5.5%). In 2018, Germany was still the most important export destination (8.2%). It was followed by the Czech Republic (6.3%) and the United Kingdom (6.9%).

In 1996, goods were imported to Poland mainly from Germany (24.7%), Italy (9.9%) and Russia (6.8%). In turn, in 2018 the share of Germany slightly decreased, which amounted to 22.4%. China was in second place in terms of the value of imported goods (11.5%). Russia remained the third destination from which Poland imported the most goods with a 7.3% share. Analysis of the structure of exports and imports of V4 countries indicates the following conclusions:

- in the years 1996–2018, there was a change in the main directions of exports and imports of goods. The importance of Western European countries (including Germany in particular) increased, while the share of foreign trade with Russia dropped significantly, especially in the field of consumer goods. Imports from China also increased in importance;
- Germany remained the main partner in terms of imports and exports of all V4 countries. The consequence of this was the high dependence of members of the Visegrad Group on the economic situation of Germany;
- the main export and import goods were machines, electrical devices and means of transport, which results from the production structure of the V4 Group, which specialize in the production of semi-finished products for the automotive, machine and electrotechnical industries. Production for the indicated industries is related to direct investments of concerns from Western European countries, including mainly Germany;
- a significant part of economic exchange was carried out with neighboring countries. In 1996-2018, an increase in trade turnover between individual members of the Group was also visible.

4. Research Objective, Methodology and Data

An extremely important issue in economic analysis, including the study of factors determining economic growth, is the need to combine conclusions regarding short-term dynamics and long-term balance. The traditional approach to modeling short-term imbalances is based on the partial adjustment model, and its development is the error correction model (ECM), taking into account the imbalance in past periods (Maddala, 2008). Importantly, the long-term versions of economic models correspond to the stationary state (McAdam, 1998; Granger, 1991).

Stationary processes are characterized in, among others, the fact in that they have a constant variance, and their values at particular moments are around a relatively

constant level (average). A priori assumption that the studied variables are stationary may be associated with the problem of apparent regression, because the time series used in economic analyzes are usually non-stationary, so that explanatory models can give seemingly good results (e.g. high level of determination coefficient, important equation parameters etc.) and as a result false conclusions can be made. The time series stationariness is tested using many statistical tests. The most popular stationariness tests are the extended Dickey-Fuller test (ADF) and the test of Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (Maddala, 2008; Osińska, 2006). Importantly, the cointegration relation equation can be used to present the state of long-term equilibrium. Co-integration is usually assessed using the Engle-Granger test or Johansen method (Johansen, 1988). Regardless of the method, each of them requires that the analyzed variables are integrated to the same degree. As already mentioned, most of the variables used in economic models are characterized by non-stationary waveforms. Formulated by Granger and developed by Engle and Granger, the theory of cointegration eliminates the main obstacle in modeling non-stationary series (Granger 1981; Granger and Engle, 1987). According to theory, two processes y_t , x_t s are cointegrated (d, b), (y_t) if:

– d degree of integration for both processes (y_t, x_t) is the same;
– there is a linear combination of these processes $u_t = \beta_1 x_t + y_t$, which is d–b integrated.

Therefore, it can be stated that $Y_t \sim I(d)$ *and* $X_t \sim I(d)$, then $Y_t \, i \, X_t \sim CI(d, b)$, if $y_t - \beta x_t \sim I(d - b)$, where $b > 0$.
This means that the regression equation:

$$y_t = \beta x_t + u_t$$

makes sense because the: x_t and y_t variables over time, do not move too far apart, which means that there is a long-term balance between them. Therefore, a necessary condition in the study of time economic values series is testing the degree of integration of time series using the so-called unit root test. For the analyzed interdependence, cointegration occurs if each, e.g., from two time series x_t and y_t is integrated in the first degree, which we write symbolically (I(1)), i.e., the null hypothesis with a unit root is not rejected, and the residuals u_t from the cointegrating equation, I(1) are not integrated, i.e., the null hypothesis with a unit root is rejected. For this purpose, you can use e.g., Dickey-Fuller, Kwiatkowski-Philips-Schmidt-Shin (KPSS) tests (Dickey and Fuller, 1979, Kwiatkowski, Phillips, Schmidt, and Shin, 1992). To achieve the purpose of this study, a cointegration study was conducted for each country, a V4 member, using data from the period 1996-2018:
– economic growth as a GDP level (USD million);
– import and export values (USD million).
The research consisted of the following stages:

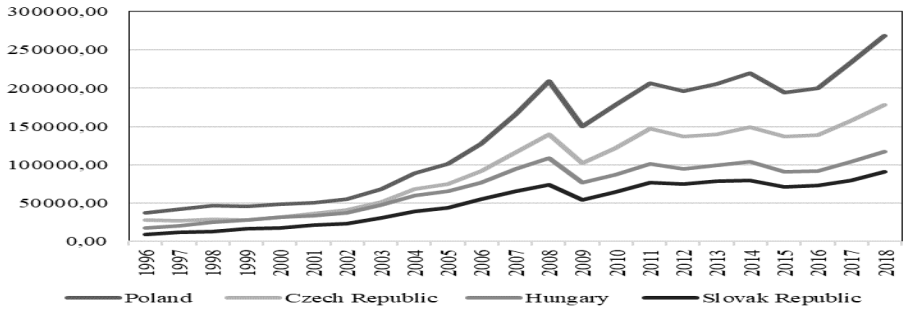
- graphic analysis of the analyzed variables,
- calculations of Pearson correlation coefficients,
- unit root tests: ADF and KPSS tests,
- determining the degree of integration of the analyzed variables,
- estimation of the cointegrating equation for integrated variables I(1) (Engle-Granger test),
- testing the significance of assessments of the parameters of the cointegrating equation,
- determining the residuals of the cointegrating equation,
- the unit root test for the residuals of the cointegrating equation,
- analysis of the results obtained.

The research was carried out using the GRETL v. 2018a program. Following generally accepted practice, data were logged in individual time series in order to "smooth" them (prefix I before variable) (Enders, 2010; Marona and Bieniek, 2013).

5. Research Results

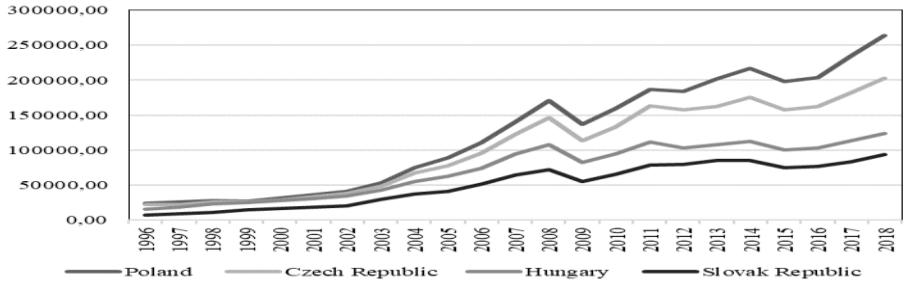
At the initial stage of the study of individual time series, their course was graphically presented (Figures 1-3).

Figure 1. *Import volumes in the countries studied in the years 1996-2018 (M USD)*



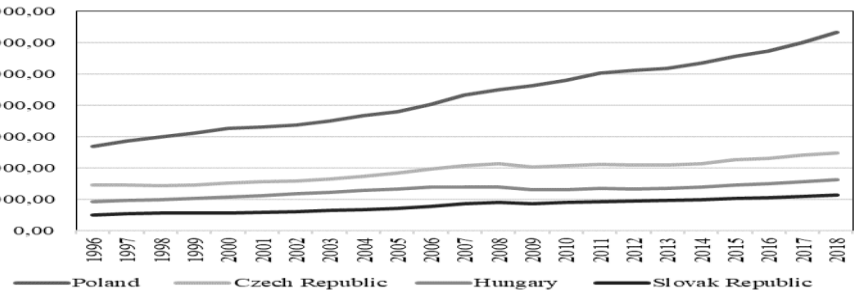
Source: *Own study based on The World Bank database.*

Figure 2. *Export volumes in the countries studied in the years 1996-2018(M USD)*



Source: *Own study based on The World Bank database.*

Figure 3. *GDP volumes in the countries studied in the years 1996-2018 (M USD)*



Source: *Own study based on The World Bank database.*

Correlation coefficients between the analyzed variables were also calculated for the analyzed countries. Examples of correlation coefficients for Poland are included in Table 4. The calculated correlation coefficients are very high, close to unity. The lowest correlation coefficient was 0.9914 (between l_GDP_Poland and l_Ex_Poland), the highest i.e. 0.9966 between l_Im_Poland and l_GDP_Poland. For the other countries of the Visegrad Group, the index also rose above 0.94. This could indicate a strong dependence of variables.

Table 4. *Pearson correlation coefficients for the analyzed data (1996-2018)*

Variable	l_Ex_Poland	l_Im_Poland	l_GDP_Poland
l_Ex_Poland	**1.0000**	0.9966	0.9914
l_Im_Poland	0.9966	**1.0000**	0.9957
l_GDP_Poland	0.9914	0.9957	**1.0000**

Source: *Authors' calculations.*

However, a cursory analysis of the above drawings leads to the conclusion that the analyzed variables are non-stationary. The degree of integration of the studied time series was tested using the extended Dickey-Fuller Test (ADF). It was assumed that the level of significance tested was $\alpha = 5\%$.

Table 5 presents the results of the ADF test for the variables tested. The conclusion is that all analyzed time series are non-stationary (for $\alpha = 5\%$), which only confirms previous assumptions. The time series for the first differences are in principle stationary, which would give the basis to conclude that the variables are integrated in grade I(1). The exception were two analyzed variables regarding the GNP level of Hungary and GNP of Slovakia, in this case there are grounds to conclude that the variables l_GDP_Hungary and l_GDP_Slovakia were integrated in the second degree I(2).

***Table 5**. The ADF test for checking the unit root of the analyzed variables (1996-2018) with a free expression*

Variable	ADF test for variable (p value)	ADF test over first differences (p value)	Conclusion
l_Ex_Poland	0.6919	1.33E-02	I(1)
l_Im_Poland	0.7126	3.72E-03	I(1)
l_Ex_Czech	0.6347	7.87E-03	I(1)
l_Im_Czech	0.7712	3.51E-03	I(1)
l_Ex_Germany	0.717	6.07E-03	I(1)
l_Im_Germany	0.7522	3.43E-03	I(1)
l_Ex_Hungary	0.1354	0.5203	I(1)
l_Im_Hungary	0.1975	5.88E-03	I(1)
l_Ex_Slovakia	0.08029	1.03E-02	I(1)
l_Im_Slovakia	0.1146	7.11E-03	I(1)
l_GDP_Poland	0.7728	6.61E-03	I(1)
l_GDP_Czech	0.6051	3.93E-02	I(1)
l_GDP_Hungary	0.2595	0.2089	I(2)
l_GDP_Slovakia	0.5789	0.06159	I(2)
l_GDP_Germany	0.874	7.08E-03	I(1)

***Source:** Authors' calculations.*

The degree of integration of variables was simultaneously critically assessed by an inverse hypothesis test; i.e. the KPSS test (Myszczyszyn and Mickiewicz, 2019). The results are presented in Table 6. The unit root tests carried out using the ADF and KPSS tests have proved that both the variables regarding economic growth as well as the export and import values of the Visegrad countries are non-stationary series. According to the results of the KPSS test, all the analyzed series are integrated in the first stage I(1) (for $\alpha=0,05$), and in the case of the extended ADF test, there is a suspicion that two variables are integrated I(2). Considering that the identical degree of integration of the analyzed time series enabled the authors to conduct the Granger causality test, it was assumed, according to the results of the KPSS test, that all variables are integrated I(1). According to the cointegration method described by Engle and Granger, in every step it was necessary to:

- estimate the regression equation of a given dependent variable against another dependent variable using the least-square method and examine the significance of the estimated equation parameters,
- determine the regression residues and use a unit root test, e.g. ADF, to determine the stationariness of these residues.

In the event that the ADF test reveals that the model residues are stationary, then the vector would be a cointegrating vector (Granger, Engle, 1987). The results of calculations for individual pairs are presented in Table 7. Based on the Granger causality tests of individual variable groups for the Visegrad Group countries, the following results were determined:

Table 6. *KPSS test for checking the unit root of the analyzed variables (1996-2018) with a free expression*

Variable	KPSS test for variable (p value)	KPSS test over first differences (p value)	Conclusion
Wartość krytyczna (α = 5%) = 0.462			
l_Ex_Poland	0.643692	2.06E-01	I(1)
l_Im_Poland	0.641991	1.47E-01	I(1)
l_Ex_Czech	0.638841	0.207899	I(1)
l_Im_Czech	0.630737	0.170266	I(1)
l_Ex_Germany	0.615841	0.154862	I(1)
l_Im_Germany	0.615637	0.133016	I(1)
l_Ex_Hungary	0.630819	0.394739	I(1)
l_Im_Hungary	0.619228	0.35186	I(1)
l_Ex_Slovakia	0.635221	0.46220	I(1)
l_Im_Slovakia	0.630077	4.11E-01	I(1)
l_GDP_Poland	0.624121	1.37E-01	I(1)
l_GDP_Czech	0.591716	1.30E-01	I(1)
l_GDP_Hungary	0.571197	1.63E-01	I(1)
l_GDP_Slovakia	0.601959	1.75E-01	I(1)
l_GDP_German	0.570325	0.127939	I(1)

Source: *Authors' calculations.*

- two-way long-term interdependencies:

a) between l_GDP_Poland and l_Ex_Poland (equations 2 and 3). In these two cases, the impact of the l_GDP_Poland variable on the dependent variable (export value) was stronger (coefficient βˆ amounted to 1.70825, R2=98.21% (equation 3), and for equation 2 – 0.57541;

b) between l_GDP_Hungary and l_Im_Hungary (equations 19 and 20). In these two cases, the influence of the l_GDP_Hungary variable on the dependent variable (import value) was stronger (coefficient βˆ amounted to 1.28933, R2=96.18% (equation 19), and for the equation 20 – 0.74732);

- long-term unidirectional impact - not found;
- the long-term relationship for the remaining equations has not been confirmed.
-

Table 7. *Granger causality test results for the analyzed variables*

#	Dependent variable	Independent variable	$\hat{\beta}$ factor	T-student p value	P value	Determination factor R2	ADF test statistics for residues	p-value of the ADF test for residues	Coint. vector (Yes/No)
Poland									
1.	l_GDP_Poland	l_Ex_Poland l_Im_Poland	0.8169 −0.0775	4.517 −0.534	0.0002 0.5990	0.9907	-1.58206	0.8774	N
2.	l_GDP_Poland	l_Ex_Poland	0.5754	34.79	0.0000	0.9821	-3.66724	0.0202	Y
3.	l_Ex_Poland	l_GDP_Poland	1.7082				-3.92406	0.00916	Y
4.	l_GDP_Poland	l_Im_Poland	0.7206	49.30	0.0000	0.9910	-1.69359	0.6812	N

5.	l_Im_Poland	l_GDP_Poland	1.3759				-1.67792	0.6883	N
Czech Republic									
6.	l_GDP_Czech	l_Ex_Czech l_Im_Czech	−0.4508 1.2804	−1.019 2.497	0.3205 0.0214	0.9762	-1.7393	0.8326	N
7.	l_GDP_Czech	l_Ex_Czech	0.65283	26.84	0.0000	0.9703	-2.74357	0.1843	N
8.	l_Ex_Czech	l_GDP_Czech	1.48842				-2.6801	0.2068	N
9.	l_GDP_Czech	l_Im_Czech	0.75867	30.06	0.0000	0.9762	-2.08036	0.4859	N
10.	l_Im_Czech	l_GDP_Czech	1.2882				-2.07392	0.4893	N
Slovakia									
11.	l_GDP_Slovakia	l_Ex_Slovakia l_Im_Slovakia	−0.0577 0.7682	−0.084 1.000	0.9337 0.3293	0.955	-2.2718	0.6036	N*
12.	l_GDP_Slovakia	l_Ex_Slovakia	0.62722	21.63	0.000	0.955	-2.2212	0.4127	N
13.	l_Ex_Slovakia	l_GDP_Slovak	1.5258				-2.4132	0.3184	N
14.	l_GDP_Slovakia	l_Im_Slovakia	0.7036	22.18	0.0000	0.9571	-2.2656	0.3901	N
15.	l_Im_Slovakia	l_GDP_Slovak	1.3631				-2.4459	0.3034	N
Hungary									
16.	l_GDP_Hungary	l_Ex_Hungary l_Im_Hungary	−0.1845 0.9549	−0.431 1.977	0.6712 0.0620	0.9603	-3.4872	0.09232	N
17.	l_GDP_Hungary	l_Ex_Hungary	0.6603	21.57	0.0000	0.9548	-3.1095	0.0864	N
18.	l_Ex_Hungary	l_GDP_Hunga	1.4490				-3.09527	0.0893	N
19.	l_GDP_Hunga	l_Im_Hungary	0.7473	23.56	0.0000	0.9618	-3.37165	0.0456	Y
20.	l_Im_Hungary	l_GDP_Hunga	1.2893				-3.46002	0.0361	Y

Note: *Shaded table row- cointegration occurs.*
Source: *Authors' calculations.*

According to Granger's theorem on representation, if the Yy and Xt variables are integrated in the first degree (I(1)) and are cointegrated, the relationship between them can be presented as the VECM - vector error correction model and impulse response (Maddala, 2008), which will be the subject of further research.

6. Conclusion

Engle and Granger's cointegration method, despite its simplicity, allows obtaining measurable effects in establishing long-term correlations between the analyzed time series for economic variables, usually being non-stationary. In this regard, it became important to study the correlation between the level of economic growth of the V4 countries and the level of exports and imports. The authors, after establishing (ADF and KPSS tests) that the variables are integrated in the first degree (I), used the two-stage Engle and Granger test for further study. Studies have proven that:

- only in the case of Poland and Hungary there were two-way long-term interdependencies, while for Poland it was a pair of variables (GNP and export value), and for Hungary (GNP and import value). In addition, Engle and Granger

cointegration test showed that Poland's GDP was greatly influenced by imports from Germany, which is hardly surprising;

- no long-term relationship between economic growth and the value of imports and exports could be confirmed for all countries of the group, while in the case of Slovakia and the Czech Republic no correlation between pairs of GNP variables - export, GBP - import (coefficient $\beta\hat{}$, interpreted as a degree of flexibility amounted to 1.20259, the determination coefficient was 98.5, and the residual component was stationary (-4.07523, p=0.00554).

Thus, the obtained research results do not confirm the hypothesis about the long-term interdependence of the time series of the variables considered (economic growth versus the level of export and import), being at the same time the starting point for further research using a larger number of variables and using Johansen's tests as well as VECM and VAR (Kusideł, 2000; Tsay, 2010). It is worth adding that the research results are consistent (in relation to Poland) with the results obtained by Awokuse (2007). The authors hope that the study will become an inspiration for in-depth research on the links between economic growth and foreign trade.

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