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INTERNATIONAL TRADE AND ECONOMIC GROWTH IN THE POLISH ECONOMY

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ABSTRACT

In this paper the results of linear and nonlinear causality examination performed for openness of Polish economy and its economic growth are presented. In order to extract the impact of world crisis on Polish economy we decided to apply two samples (containing quarterly data) – the full sample (Q1 1996 – Q3 2009) and pre-crisis sample (Q1 1996 – Q3 2008). The applied linear causality tests support the existence of feedback between growth rate of exports and GDP growth irrespectively of chosen time period. For both examined samples no direct causal links between growth rates of GDP and imports were detected, one can only suppose the existence of indirect links before the crisis. Bidirectional causality was found for growth rates of exports and imports only for pre-crisis sample. Some weak evidence of causal link running from growth rate of imports to exports growth rate was also found for data that covers crisis, which may somehow be interpreted as a confirmation of the fact that import growth precedes exports growth also in hectic periods. It results from our computations that in time of financial crisis of 2008 the main factor that caused Polish GDP to remain positive was the domestic demand. The results of nonlinear causality analysis provided only some weak evidence of causality running from GDP to exports, from GDP to imports and from imports to exports.

Keywords: *exports, imports, openness, economic growth, Granger causality*

STRESZCZENIE

W artykule przedstawiono wyniki badań nad przyczynowością liniową i nieliniową pomiędzy otwartością polskiej gospodarki a jej wzrostem. W celu zbadania wpływu kryzysu światowego na polską gospodarkę postanowiono przeprowadzić badanie w oparciu o dwie próby (zawierające dane kwartalne) – próbę w całym okresie (obejmującą kwartały Q1 1996 – Q3 2009) i próbę w podokresie nieobejmującym kryzysu (Q1 1996 – Q3 2008). Zastosowane liniowe testy przyczynowości wykazały istnienie sprzężenia zwrotnego pomiędzy stopą wzrostu eksportu a stopą wzrostu PKB w obu wybranych okresach. W przypadku obu podokresów nie stwierdzono bezpośrednich zależności pomiędzy stopami wzrostu PKB a stopami wzrostu importu. Można jedynie przypuszczać, że istniał związek pośredni i to tylko w okresie sprzed kryzysu. Znaleziono pewne słabe dowody związku przyczynowego od stopy wzrostu importu do stopy wzrostu eksportu dla danych obejmujących także okres kryzysu. Przemawia to na rzecz tezy, że wzrost stopy importu wyprzedza wzrost stopy eksportu również w burzliwych okresach na giełdzie. Z naszych obliczeń wynika, że w okresie światowego kryzysu gospodarczego 2008 czynnikiem podtrzymującym dodatni wzrost gospodarczy polskiego PKB był popyt wewnętrzny. Obliczenia dotyczące nieliniowej przyczynowości dostarczyły słabych dowodów istnienia przyczynowości nieliniowej od PKB do eksportu, od PKB do importu oraz od importu do eksportu.

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1. Introduction

Many economists try to find main factors that determine economic growth. There are many contributions concerning the role of investment, inflation, public expenditure, public deficit and many other macroeconomic variables in economic growth. Considerable attention is paid since more than two centuries towards the impact of foreign trade (exports and imports) on economic growth. The importance of exports for national economy was underlined in economic literature by mercantilists. They strongly believed that trade surpluses are most favorable advantages that can be derived from international trade relations. In the consequence they were for exports promotion and for protection of domestic industries.

The profitability of specialization in production and implied profitability of foreign trade was noticed and justified by classic economist David Ricardo in framework of well known theory of comparative costs. He has proven that there are possible such prices in foreign trade with two goods produced by two fully specialized countries, that both countries can draw profits from a such exchange i.e. increase their wealth.

In current economic literature there is widely accepted that openness of an economy may be one of the main sources of its growth. In the literature there are cited many reasons for influence of exports on GDP (export-led growth hypothesis). Rise in exports supports rise in GDP because exports (i.e. foreign demand), beside domestic demand, due to national income accounts, are by definition a part of GDP.

Even more important is indirect impact of exports on GDP. Exports constitute a leading factor of total growth since it influences increase of investment and a rise in labour productivity. Exports expose countries to the most advanced new ideas and methods of production resulted from international competitive behaviour and thus it enhances efficiency. So a rise in exports is mostly possible due to innovations of exported goods and production processes. The workers employed in exports sector enjoy the highest wages and firms earn highest profits, since only most efficient firms can operate in this sector. Because of lack of mineral resource or lack of modern technology GDP growth of many countries depends on imports of these production factors. Imports are usually limited by financial constraints, which can be overcome on the basis of growing exports. Exports are most important source of foreign currencies necessary for imports i.e. exports relax the binding foreign exchange constraint to allow increases in imports of capital goods and intermediate goods. Exports support in the long-run the diffusion of modern technology, through foreign buyers' advice and learning by doing. Exports enable a sustainable growth of an economy, prevent it from price distortion and support efficient allocation of resource through increased competition. The outstanding role of exports is reflected in exports-promotion strategies. Especially politicians in developing countries prefer exports to imports-substitution.

We should stress, that economic theory suggests also opposite relation between exports and output, namely that GDP growth is exogenous in respect to exports and it is precondition for the growth of exports. According to this theory a rise in output affect positively exports, when this rise is combined with increase of productivity and reduction of unit costs. This makes easier to sell goods abroad. The latest may be result of changes in technology that are independent of any factor accumulation and trade. It is clear that the comparative cost structure in economy will tend to adjust in a way that is consistent with growing exports (see e.g. Jung and Marshall [36]). In general causation in direction from GDP to exports is based on *internally generated* mechanism of economic growth that implies growth of exports. Another argument for this direction of causation supplied by Helpman and Krugman [32] is based on economies of scale which are *path dependent* and may lead exports growth. Through exports a country manage to overcome the small size of its domestic market and to minimize costs due to increasing returns to scale. Venables [53] argues that in case of no perfect competitive industries and vertical integration the growing output may cause fundamental changes in exports through so called *cumulated causation process*.

In reality the connection between exports and rise in GDP may be closer and deeper than cited one-way options. The variety of interrelationships between exports and growth rate may lead to feedback. This implies that causation between variables under study runs not only in two directions but also that it is influenced by another variable such as imports.

Balance of trade represents a difference in value for import and export for a country. There are some main reasons for which a country may decide to import a certain good or service. The first one is that a good or service may not exist in the country, e.g. gas or oil which is not in the country's soil, an agriculture product that can't be produced there because of too cold climate, and especially an innovation that has been introduced in other countries. Secondly, it does not exist at a desired level of quality. Therefore, a country imports better goods than domestic output, also as far as advertising or packaging are concerned. The third reasons of imports of a good may be that it is just cheaper abroad. The reason for that may be that producers there are more efficient. In addition, they are confronted with lower costs, better exploit economies of scale and/or accept lower profits. Another reason is that at the current domestic price, producers do not supply enough good or service as the demand requires, also because of ex ante coordination problems. Therefore, consumers buy abroad for insufficient domestic production.

In order to finance imports, an economy must base on exports, foreign credit, foreign direct investment and foreign aid. Countries with internationally accepted currency (as US dollar or euro) may pay with it. Imports are usually classified according to economic destination and to product classes. Imports contribute to domestic consumption, to domestic investment (increasing production capabilities through new installed equipment), to domestic current production (e.g. raw materials and spare parts). There is also an important stream of imports that first will be processed and then exported abroad. Import can also satisfy government expenditure (e.g. medical or military equipment). To

summarize, imports contribute to all GDP components, but they are usually left by central statistical offices apart as a stand-alone aggregate. Imports are usually seen as determined by level and dynamics of domestic income, level and dynamics of each GDP components (investment, private consumption, government consumption, exports) as differentiated drivers of imports, price competitiveness of domestic production (normally influenced by exchange rate level and fluctuations as well as by inflation differentials between the country and foreign nations), non-price competitiveness of domestic production (for example as far as product quality, technological innovativeness, design, promotion are concerned), national attitude toward foreign goods, shifts in domestic patterns of demand and supply, historical links with certain origin countries, structural trends toward economic integration with other countries.

Due to economic theory, imports should grow when consumers' disposable income increases. This concerns especially *luxury goods*, i.e. their demand grows more than proportionally when income rises. According to economic theory gross domestic product (GDP) at large increases, when an elasticity of 1 is assumed. However from empirical results it follows that growth rates of imports are systematically different from GDP rates, what contrasts with the hypothesis of elasticity one. Private consumption, investment, exports and government consumption rise, where different elasticity of imports to GDP components may reasonably appear, a revaluation takes place and national currency rises against foreign ones, inflation abroad is lower than domestically, so that foreign products become cheaper and cheaper, with the widening technological and quality distance of domestic production in comparison to foreign one. Also increase in imports depends on general perception by domestic buyers foreign goods (e.g. "foreign is better"). Size of imports depends on integration with other countries, e.g. on a national specialization, what implies that the world becomes systematically interdependent. Empirical results confirm that imports have systematically grown faster than GDP in the long-term, so that their share in GDP is much higher now than some decades ago. The process of economic integration has been particularly intensive in Western Europe, but it is a quite general observation.

Another feature is that imports are pro-cyclical. Moreover there is well known fact that in a deep recession, a phenomenon called *inversion* takes place. In this time period imports fall. It becomes the largest positive contributor to growth of income. As result, trade balance significant improves and may turn out to be decisive for recovery.

The economies with high relation of trade to GDP are called *opened economies*. All economies are open to some extent, with the degree of openness varying substantially from one country to the other. How openness is defined depends on the objective of empirical analysis and country under study. In this respect at least three definitions can be found in the literature. First of them identifies openness with imports, another with exports (*narrow definitions*) and a third one (*broad definition*) with imports plus exports, all expressed as GDP ratios. These three definitions have been used in studies of public finance mostly in developing countries in connection with government revenue collections. The

general premise of these tax effort studies was that for reasons of administrative efficiency, there was a preference for indirect taxes in these countries. The most of them were imposed on internationally traded goods that pass through a limited number of well-guarded points of entry (Lotz and Morss [39]; Chelliah [11]).

In order to prove the bidirectional relationship between export growth and GDP growth we use the specific modification of broad definition of openness. Namely, we do not consider simple formula of exports plus imports but we examine the linear function of growth rates of imports and exports. Therefore, we allow the possibility of testing whether the relationship between GDP and openness is based (mostly) on strong influence of only one component – exports or imports (obviously, this is not testable when sum of exports and imports is considered). Furthermore, for reasons of analytical completion the bidirectional causal relationship between export growth and import growth is proven in order to find out which one of the two variables pull stronger as a result of their long-term tendency to move together during the process of economic development.

To summarize, the main goal of this paper was to prove the dynamic relationships between real growth rates of GDP, exports and imports in case of Polish economy, which is still in the transitory phase. All the causality tests were performed not for original macroeconomic subcategories, but by means of their growth rates.

The rest of the paper is organized as follows. Section 2 contains literature overview. In part 3 we describe main conjectures. In section 4 the dataset and methodology are characterized. In section 5 we present and interpret the empirical results. Section 6 concludes the paper.

2. Literature overview

Because of importance of exports–GDP relation in our overview we will cite most important results concerning mainly these two categories. The known empirical evidence of relationship between openness and GDP are mostly based on testing of causality between exports and output. The results are mostly mixed and frequently almost at the first glance contradictory. Some studies support the export-led growth hypothesis (e.g. Michaely [42]; Balassa [6], [7]; Tyler [52]; Feder [23]; Ram [44]; Chow [14]; Giles et al. [24]; Bahmani-Oskooee and Alse [5]; Thornton [49]; Doyle [22]; and Xu [54]). However, the empirical results from the causality tests reported in other studies did not supply evidence in favour of a positive causal relation running from exports to economic growth (e.g. Granger [28]; Sims [47]; Jung and Marshall [36]; Darrat [15]; Hsiao [35]; Ahmad and Kwan [1]; Dodaro [20]; Shan and Sun [46]; Giles and Williams [26]).

The empirical contributions concerning the export-led growth hypothesis can be classified into three groups. The authors who constituent the first group apply cross-country correlation coefficients to test the export-led growth hypothesis. The second group of studies, which typically uses OLS method, also uses cross-country data. The recent group of works applies various time-series techniques to test the exports–growth relation. Typical problems with the cross-country methods are

widely described in the literature. First of all a number of previous studies (e.g. Michaely [42]; Balassa [6]; Feder [23]), which are based on cross-sectional data, accept the implicit assumption that developing countries share common characteristics. This assumption may be false, because countries differ not only in their institutional, political and economic structure but also they react differently to external shocks. Therefore, the estimates computed by cross-sectional regressions are misleading. In framework of this approach there is not possible to take into account country-specific features. The empirical studies (Toda [50]; Bewley and Yang [8]; Giles and Mirza [25]; Giles and Williams [26]) based on time series are also not free from some problems arising from the applied causality methodology like the arbitrariness in the choice of the lag length (e.g. Jung and Marshall [36]; Chow [14]) and the application of *F*-test statistics to causality tests (e.g. Thornton [49]; Xu [54]). It is obvious that the *F*-test statistic is not valid for testing *export-led growth* hypothesis if time series are integrated (Toda and Yamamoto [51]; Zapata and Rambaldi [55]) and causality tests are sensitive to model selection (Giles and Williams [26]). This paper attempts to explore the causal link between exports and output by examining unit root properties and the Granger non-causality tests. In particular, the procedure developed by Toda and Yamamoto [51] is expected to improve the standard *F*-statistic in the causality test process.

The relationship between foreign trade and GDP is especially important for the transitional economies. However, the majority of previous contributions were related with the analysis of advanced markets. There are few papers that contain the examination of GDP–trade openness links for less developed countries. Ramos [45] performed the analysis of dynamic links between GDP and trade openness for Portugal for the period 1865-1998. His findings confirmed that during considered period of development of the Portuguese economy there was a feedback effect between exports–output growth and imports–output growth. Furthermore, no kind of significant causality between imports and exports growth was found. Awokuse [3] examined the nature of causal links between foreign trade and GDP for three Central European countries. The main conclusion of this paper is that trade stimulates GDP growth. Çetintaş and Barişik [10] examined GDP–trade openness relationships for 13 transitional economies using panel data. Empirical results showed that there is a unidirectional causality from economic growth to exports (production-led exports). Empirical findings show that the growth-led export hypothesis is valid in those countries and growth is rather shaped by increase in import demand. It is also worth mentioning that in all these papers the imports were believed to be an important variable that should not be omitted in order to conduct properly the analysis of GDP-foreign trade links. Moreover, mentioned authors claimed that indirect causal links between GDP and exports may exist due to the impact of imports.

This paper fills the mentioned gap in the literature as it contains the results of analysis of dynamic links between economic growth and trade openness in case of new EU–member country. Furthermore, we aimed to provide some description of the influence of global financial crisis (which begun in September 2008) on the structure of GDP-foreign trade links in Poland.

3. Main conjectures

The main attention in context of pairwise causation between GDP and foreign trade (exports and imports) is paid to relation between exports and economic growth. According to literature overview the last causation is most important. The above discussions about the role of exports in economic growth belong to one of two extremes: either exports are the engine of growth (the *exogenous growth* hypothesis) or exports are the handmaiden of growth (the *endogenous growth* hypothesis). The exogenous growth hypothesis suggests that export expansion would stimulate economic growth through augmented domestic production. This kind of causality between exports and growth was widely reported in the reviewed literature. It may be justified by David Ricardo's model of comparative advantage. By opening to world markets, a country can increase its income by producing those goods that it can produce most cheaply. The economic development literature is based on Ricardo's model. Export expansion generates foreign exchange earnings, finances capital goods and intermediate imports and hence induces more production. Because potential markets offer greater economies of scale, the exporting economy enhances its productivity by better resource allocation and technology innovation. The contributors point out that production of non-export goods can also be enhanced through various channels, such as technology spillover, learning-by-doing and externalities. In sum, exports expansion contributes to growth of GDP. This view seems to be supported by the success of East Asian economies where, between 1960's and 1980's, rapid GDP growth followed aggressive trade policies. Also in case of emerging economies like Poland the FDI, lower production costs, foreign aid and advantages of EU accession supported significantly exports growth and nowadays it became important factor of GDP growth. Therefore we formulate the first (so-called *export-led*) hypothesis in the form:

Conjecture 1. In Polish economy there is a causal relation from exports to economic growth, i.e. exports are exogenous.

In contrast to this conjecture, part of authors think that exports expansion follows the GDP growth. They argue that economic growth is not the result of forces that act from outside but an endogenous outcome of an economic system. So they follow Schumpeter tradition of economic thought. Speed up in economic development will inevitably lead to exports expansion. The implied causation is then from domestic growth and accumulation to trade growth. The focus of endogenous is about the supply side by considering the medium or long-run accumulation of production factors. In short, supply increases faster than domestic demand such that the excess supply is exported. In this view, export expansion is not a necessary condition of growth. Instead, a country's ability to export goods depends on its ability to produce these goods more competitively. This suggests policies that have the potential for helping long-run domestic growth. This view seems to have dominated in some countries after World War II, where countries adopted strong import-substitution policies.

This kind of arguing also may be true in the first phase of transition process e.g. the case of Polish economy. Deep depression in Polish exports due to collapse of Soviet-type economies in Central and Eastern Europe and break of traditional trade connections in the beginning of nineties could be overcame after starting recovery of Polish economy in 1994. Therefore we formulate following contrasting hypothesis:

Conjecture 2 In Polish economy there is a causal relation from economic growth to exports.

As we mentioned in first section in reality the connection between rise of exports and rise in GDP may be closer and deeper than cited one-way options. Both export-led production and production-led exports may coexist in a framework of dynamic relationship. Some economists point out that feedback could give rise to virtuous or vicious cumulative cycles. Therefore we formulate the third conjecture:

Conjecture 3. There is a feedback between exports and economic growth of Polish economy.

A virtuous cycle takes place when export expansion stimulates domestic production and the increased production encourages more exports. A vicious circle would occur if domestic production and exports defeated each other.

In summary, the existing economic theories suggest that three causal relations listed above may be conjectured: export-led production, production-led exports, and feedback (i.e. a reciprocal causation). It is clear that veracity of conjecture 3 implies that conjectures 1 and 2 are also true.

According to overviewed literature imports contribute to all categories of GDP. In developing and in at most a part of emerging economies imports expenditure are rigid i.e. buying some kind of goods is necessary independently of financial situation of a country. Therefore, that is almost surely causation from imports to GDP.

However, as we stressed before imports depend on level and dynamics of domestic income and level and dynamics of each GDP components. Imports just satisfy demand of particular GDP subcategories. Therefore, it seems to be reasonable to claim that causality may also run in the opposite direction. All these remarks seem to justify the need of examining the following hypothesis:

Conjecture 4. There is a feedback between imports and economic growth of Polish economy.

From the presented overview concerning foreign trade one can draw conclusion that exports and imports depend from each other. There is also an important part of imports that first will be processed in domestic plants and then exported abroad. So, imports are preconditions for exports. On the other hand exports are source of foreign currency which determines the size and structure of imports. Therefore, feedback conjecture between exports and imports may be a plausible hypothesis:

Conjecture 5. There is a feedback between real growth rates of imports and exports of Polish economy.

As we had already mentioned, the causation between growth rates of GDP, exports and imports is extremely important. The strength of dynamic links between GDP and growth rates of exports and imports (joint influence) may be interpreted as the most reasonable measure of the level of intensity of relationship between trade openness and economic growth. Taking into account the results of other contributors presented in the literature we formulate the following hypothesis:

Conjecture 6. There is a feedback between rate of growth of GDP and growth rates of exports and imports of Polish economy.

The above conjectures will be proven not only by means of linear Granger causality tests but also by means of impulse response analysis and nonlinear tests. It may be surprising that in general most of previous research was based only on the application of linear tests, especially if we consider all disadvantages of linear approach (see Section 4). We expect that the results of nonlinear tests, especially the most important results concerning causation between exports and GDP, will be in line with results computed by means of linear methods. So, we will prove:

Conjecture 7. The outcomes of nonlinear causality analysis support results computed by means of linear causality.

Before we perform the respective computations, in the next section we will review the dataset and methodology applied.

4. Dataset and methodology

As we had already mentioned most of previous studies concerned with GDP-trade relationships dealt with developed economies. Except for few mentioned papers this problem had not been examined in case of transitional economies. In this context our paper fills the gap in literature, providing results obtained while examining GDP-trade links in case of new EU-member country. In this paragraph we give a short description of our dataset used in further computations. The considered dataset includes quarterly time series of real growth rate of GDP, real growth rate of exports and real growth rate of imports in Poland. All growth rates are calculated in comparison to corresponding quarter of previous year (assuming constant prices of previous year). The investigation covers the period from Q1 1996 to Q3 2009. The full sample contains 55 observations. The quarterly data

describing GDP, exports and imports in Poland in the period under study was obtained from the Central Statistical Office in Poland.

Another important fact that distinguishes our paper from previous contributions concerned with similar topics is the application of data that partly covers the period of global economic crisis which started in 2008. Since the methodology of conducting causality analysis does not enable to explore dynamic links between GDP, exports and imports in the period after the bankruptcy of Lehman Brothers Bank (insufficient sample size), we decided to use an alternative approach to examine the impact of economic crisis on the structure of dynamic links between real GDP, real export and real imports in Poland. Namely, we decided to apply two samples – the full sample (Q1 1996 – Q3 2009) and pre-crisis sample (Q1 1996 – Q3 2008). One may expect that this approach may turn out to be helpful in identifying the impact of financial crisis on GDP–trade relationships through the specification of differences in structures of causal links between GDP, exports and imports in Poland for both samples under study. In further parts of this paper we use abbreviations for all examined variables. Table 1 contains suitable information. Additionally, some short description of each variable is also given:

Table 1. Abbreviations and short description of examined variables

Abbreviation	Description
GDP	Real GDP growth rate in Poland
EXPORTS	Real growth rate of exports in Poland
IMPORTS	Real growth rate of imports in Poland

In order to provide basic information about our dataset we present some descriptive statistics of all examined variables. For each time series some typical numbers were calculated. We calculated these values for both considered sub-samples placing pre-crisis (i.e. Q1 1996 – Q3 2008) values in the square brackets. The suitable results are presented in the following table:

Table 2. Descriptive statistics of examined variables

Variable / Quantity	GDP [%]	EXPORTS [%]	IMPORTS [%]
Minimum	0.50 [0.50]	-13.90 [-12.50]	-19.90 [-6.90]
1st quartile	2.40 [3.20]	3.11 [5.30]	1.7 [3.8]
Median	4.80 [5.10]	9.30 [10.10]	11.75 [12.60]
3rd quartile	6.60 [6.60]	19.00 [19.00]	17.41 [17.6]
Maximum	8.10 [8.10]	29.90 [29.90]	42.10 [42.10]
Mean	4.48 [4.70]	9.32 [10.81]	10.22 [12.10]
Std. Deviation	2.18 [2.09]	10.34 [9.47]	12.65 [10.90]
Skewness	-0.28 [-0.41]	-0.32 [-0.17]	0.01 [0.50]
Excess kurtosis	-1.15 [-0.94]	-0.42 [-0.31]	0.32 [0.27]

We can remark some interesting information directly from this table. Firstly, we can see that in the period under study relatively stable development could be observed in Polish economy, since the real GDP growth rate was positive in each quarter. Moreover, periods of rapid development (GDP growth at the level of 8.10%) as well as stages characterized by relatively slow growth rate (at the level of 0.50%) were also perceived. It is worth underlying that after begin of financial crisis in 2008 the real GDP growth rate in Poland did not drop as significantly as GDP growth rates of most countries in Europe. Furthermore, in the period Q4 2008 – Q3 2009 the real GDP growth rate in Poland was positive (which also was a rarity in the whole Europe) with lowest value equal to 0.80% reported in the first quarter of 2009. The lower value of mean and higher value of standard deviation calculated for full sample in comparison to pre-crisis period may also be an evidence of influence of world financial crisis on performance of Polish economy measured by real GDP growth rate.

The analysis of descriptive statistics of time series of real growth rates of exports and imports also provided some essential information. Firstly, we shall note that on average real exports and imports in Poland were in each quarter about 10% greater in comparison to analogous period of previous year. However, we cannot forget that this general tendency was seriously disturbed during the financial crisis as biggest drops of both variables (-13.90% for EXPORTS and -19.90% for IMPORTS) were reported exactly after the September 2008. The influence of shocks caused by global financial crisis on the performance of trade openness of Polish economy is also reflected in the values of standard deviations of EXPORTS and IMPORTS time series. When full sample was considered (i.e. including the period of crisis) values of these quantities were higher in comparison to the case when only pre–crisis period was taken into account.

In this article we use several econometric methods to explore the dynamic relationships between real GDP growth rate, real exports growth rate and real imports growth rate in Poland in two periods under study. The concepts of both linear and nonlinear Granger causality tests, the idea of impulse response analysis based on Cholesky decomposition as well as the method of bootstrap based on leveraged residuals were implemented to provide complex environment for examination of all our main research hypotheses formulated in previous section. As it was already mentioned our main goal was to analyze the results obtained after the application of two quarterly datasets – first one containing all observations and second one with excluded data collected after beginning of global financial crisis in 2008.

The concept of causality used in this paper was originally formulated by Granger [28]. Further empirical (e.g. Granger and Newbold [27]) and theoretical (e.g Phillips [43]) deliberations proved that if time series under study are indeed nonstationary then the results of typical linear causality tests may lead to spurious conclusions. Thus, the initial part of each standard causality analysis is testing time series for stationarity and identification of their order of integration. For this purpose we conducted augmented Dickey–Fuller (ADF) unit root test. Table 3 contains results of ADF test with deterministic term including only constant as well as constant and linear time trend. Before conducting the test we had set up the maximal lag length equal to 6 and then we used AIC and BIC information criteria to choose the optimal lag length from the set {0, 1, …, 6}. We performed this analysis for both samples, i.e. the full sample as well as pre–crisis sample. Suitable results obtained for reduced sample are once again cited in square brackets:

Variable	ADF (only constant)		ADF (linear trend)		KPSS (only constant) *	KPSS (constant and linear trend) **
	Test statistic (*p*-value)	Optimal lag	Test statistic (*p*-value)	Optimal lag	Test statistic	Test statistic
GDP	-2.85 (0.04) [-2,56 (0.09)]	1 [1]	-2,80 (0.19) [-2.53 (0.50)]	1 [1]	0.16 [0.23]	0.15 [0.22]
EXPORTS	-4.45 (0.00) [–5.46 (0.00)]	1 [4]	-4.61 (0.00) [-5.04 (0.00)]	1 [4]	0.22 [0.05]	0.08 [0.03]
IMPORTS	-3.08 (0.03) [-3.31 (0.02)]	0 [1]	-2.92 (0.15) [-3.83 (0.02)]	1 [0]	0.41 [0.32]	0.15 [0.23]

* *critical values*: 0.347 (10%), 0.463 (5%), 0.739 (1%)
** *critical values*: 0.119 (10%), 0.146 (5%), 0.216 (1%)

Directly from table 3 one can easily see that all time series were found to be stationary around constant (at 10% significance level). In addition, in order to confirm these findings Kwiatkowski, Phillips, Schmidt and Shin [37] (KPSS) test was also conducted. The results of the KPSS test are presented in two last columns of table 3. Numbers in square brackets have the same meaning like in case of results of ADF test.

To summarise, analysis of the results presented in table 3 provided solid evidence for the claim that all the time series are stationary around constant. This final conclusion will be crucial for our further analysis as it allows us to apply standard linear Granger causality tests.

In order to test for linear Granger causality we applied simple vector autoregression (VAR) methodology. In this paper we have decided to use a trivariate VAR model constructed for GDP, EXPORTS and IMPORTS:

$$Y_t = c + \sum_{i=1}^{m} A_i Y_{t-i} + \varepsilon_t , \tag{1}$$

where $Y_t = [GDP_t, EXPORTS_t, IMPORTS_t]^{tr}$, $c = [c_1, c_2, c_3]^{tr}$ is the vector of constants, m is the lag length and $t = m+1, \ldots, T$ (tr denotes transpose operator). As we had already mentioned we considered the full sample and the pre–crisis sample (i.e. two values of parameter T). The initial step of this procedure is related to establishment of lag length. For this purpose we set up a maximal lag length equal to 6 and then we used AIC and BIC information criteria to choose this parameter (m) from the set $\{0, 1, \ldots, 6\}$. For both VAR models this value was found to be equal to two. For each VAR model some standard test for autocorrelations were conducted providing no evidence of autocorrelation of error term, which may somehow prove that setting the value of m at the level of two was indeed a proper choice. The idea of testing for linear Granger causality by a VAR approach is based on application of simple Wald test with standard asymptotic chi-square distribution. At this place we shall stress two important facts. Firstly, the proper application of asymptotic theory requires some specific modelling assumptions to be fulfilled (e.g. whiteness of error term resulting from VAR model, for more details see Lütkepohl [40]). If mentioned assumptions do not hold the application of asymptotic theory may lead to spurious results. Secondly, even if modelling assumptions are generally fulfilled the distribution of Wald test statistic may still be significantly different from chi-square while dealing with relatively small samples.

As a cure for these problems we have decided to use bootstrap technique additionally. This method is used for estimating the distribution of test statistic by resampling data. At this point we shall also underline some important facts. Firstly, the estimated distribution depends only on available dataset, therefore it may be reasonable to expect that none of the assumptions required for parametric methods has to be fulfilled for proper application of bootstrap technique. Secondly, the size and power properties of causality test based on bootstrap techniques remain relatively good even in cases of nonstationarity and various schemes of error term structure including heteroscedasticity etc. (for more details see Dolado and Lütkepohl [21], Mantalos [41], Hacker and Hatemi [30] and Lach [38]).

However, we cannot forget that bootstrap methods have some drawbacks too and hence they cannot be treated as perfect tools for solving all possible model specification problems. The bootstrap approach is likely to fail in some specific cases and therefore should not be used without second thought (see e.g. Horowitz [34], Chou and Zhou [13]).

Every bootstrap simulation conducted for the use of this article is based on resampling leveraged residuals. We have decided to use leverages as this is just a simple modification of regression raw residuals which supports stabilization of their variance (more details on leverages may be found in Davison and Hinkley [16]). For each examined sample we estimated trivariate VAR model through OLS methodology with specific null hypothesis assumed. In fact this means that some elements of coefficient matrices were restricted to zero. In the next step we used leverages to transform regression raw residuals (set of vectors of residuals modified by this transformation will be denoted as $\{\hat{\varepsilon}_i^m\}_{i=3,\ldots,T}$, T stands for sample size, initial value of i is equal to VAR lag length plus one). Finally, the following algorithm was conducted:

- Drawing randomly with replacement (each point has the same probability $\frac{1}{T-2}$) from the set $\{\hat{\varepsilon}_i^m\}_{i=3,\ldots,T}$ (as a result we get the set $\{\hat{\varepsilon}_i^{**}\}_{i=3,\ldots,T}$);
- Subtracting the mean in order to guarantee the mean of bootstrap residuals is zero (this way we create the set $\{\hat{\varepsilon}_i^*\}_{i=3,\ldots,T}$, such that $\hat{\varepsilon}_{k,i}^*=\hat{\varepsilon}_{k,i}^{**}-\frac{\sum_{j=3}^{T}\hat{\varepsilon}_{k,j}^{**}}{T-2}$, $i=3,\ldots,T$, $k=1,2,3$);
- Generating the simulated data through the use of original data, coefficient estimates from the regression of restricted VAR model and the bootstrap residuals $\{\hat{\varepsilon}_i^*\}_{i=3,\ldots,T}$;
- Calculate the Wald statistic (for simulated data).

After repeating this procedure N times it was possible to create the empirical distribution of TY test statistic and get empirical critical values (bootstrap critical values) next. The academic discussion on how the number of bootstrap replications (parameter N) may affect performance of bootstrap techniques has gained a considerable attention in recent years (see e.g. Horowitz [34], Lach [38]). In this paper we applied recently developed procedure of establishing the number of bootstrap replications presented by Andrews and Buchinsky [2]. In each case we aimed to apply such value of the parameter N which would ensure that the relative error of establishing the critical value (for 5% significance level) would not exceed 5% with probability equal to 0.95. The latter may be expressed in the following formula:

$$P^*\left(\frac{|c_b-c|}{c}\leq 0.05\right)=0.95\,, \tag{2}$$

where P^* denotes probability with respect to the randomness in the bootstrap samples, c_b stands for bootstrap critical value (for 5% significance level) and c denotes the *ideal* (i.e. gained after infinitive number of replications) bootstrap critical value (for 5% significance level). The suitable procedure

(including Andrews and Buchinsky method) written in Gretl is available from the authors upon request.

Beside the standard linear Granger causality tests we applied impulse response (IR) analysis additionally. The motivation to use this method is as follows. The standard Granger causality analysis is helpful in establishing only the direction of causal links between variables of interest, while signs of these relationships are not examined. In order to capture these details we applied impulse response function based on orthogonal residuals. We used Cholesky decomposition to transform residuals from both tridimensional VAR models. In order to save the space we do not present all technical details (like definition and properties of Wold decomposition etc.) and results of suitable preliminary analysis (like analysis of Wold instantaneous causality, establishment of Cholesky ordering etc.) which should be performed before applying orthogonal IR functions. The theoretical background of this method may be found in Lütkepohl [40] and Hamilton [31].

In order to perform the comprehensive examination of dynamic links between GDP and trade openness in Poland in two periods under study we also applied nonlinear test for Granger causality. The motivation to use this technique is twofold. Firstly, detecting certain kinds of nonlinear relationships by means of standard linear Granger causality may lead to relatively poor results due to low power of the linear test in this specific case (see e.g. Brock [9], Gurgul and Lach [29]). Secondly, the causality in higher-order structure (for example causality in variance etc.) cannot be explored by the means of traditional linear approach since the latter is based on testing the statistical significance of suitable parameters only in the mean equation (Diks and DeGoede [17]). This problem may be solved by the application of nonlinear approach as it allows exploring complex dynamic links between variables of interest.

In this article we use nonlinear causality test proposed by Diks and Panchenko [19]. In our research we decided to use some typical values of technical parameters of this method. We set up the bandwidth parameter (denoted as ε) at the level of 0.5, 1 and 1.5 for all conducted tests as these values were commonly used in previous papers (see e.g. Hiemstra and Jones [33], Diks and Panchenko [18], [19]). Furthermore, we have also decided to use the same lags for every pair of time series being analyzed establishing this lag (denoted as l) at the order of 1 and 2. Detailed information about meaning of technical parameters and the form of applied test statistic may be found in [19].

The analysis of nonlinear Granger causality was not performed for initial data but it was based on residual time series resulting from the appropriate trivariate VAR model. Residual time series reflect strict nonlinear dependencies since the structure of linear dependences had been filtered out with application of suitable VAR models and (see e.g. Baek and Brock [4], Chen and Lin [12]). In this paper we used one-side test rejecting whenever calculated test statistic was significantly large. The motivation of this approach is twofold. Firstly, in practice one-sided test is often found to have larger power than a two-sided one (see e.g. Skaug and Tjøstheim [48]). Secondly, despite the fact that significant negative values of test statistic also provide basis for rejection of the null hypothesis of

Granger non-causality, they additionally convince us to claim that the knowledge of past values of one time series may aggravate the prediction of another one. In contrast, the causality analysis is usually conducted to judge whether this knowledge is helpful (not aggravating) for prediction issues or not.

Since some former research (e.g. [19]) provided solid basis for claiming that examined nonlinear causality test tends to over-reject in cases of presence of heteroscedastic structures in analyzed time series, we have also decided to test all residual time series for the presence of GARCH structures. Since we found significant proof of the presence of conditional heterocedasticity in residuals of both VAR models, we decided to re-run nonlinear causality test for filtered series of residuals. However, we shall also note that GARCH filtering may also lead to loss of power of the test, which derives from possible misspecification of conditional heterocedasticity model. This of course may simply lead to spurious results of the test (see [19]).

5. Empirical results

This section contains the outcomes of short-run linear and nonlinear Granger causality tests as well as the results of impulse response analysis. One may expect these outcomes to provide basis for judging which of hypotheses presented in section 3 holds true. It may also be reasonable to expect that the application of the full as well as the reduced sample may help to describe the impact of global financial crisis started in September 2008 on the structure of causal links between GDP and trade openness in Poland. The presentation of the results of our research shall start with the outcomes obtained from analysis of linear Granger causality. Following table contains *p*-values obtained while testing for linear Granger causality through the application of bootstrap-based Wald procedure for both samples. Numbers in round brackets denote corresponding *p*-values obtained by means of standard (chi-square) distribution of Wald test statistic. In each case the value of *N* parameter denotes number of bootstrap replications established though the application of the method proposed in [2]. Whenever the results of bootstrap-based indicated the existence of causal link in certain direction (at 5% significance level) the shading was used to mark this finding:

Table 1. Results of tests for linear Granger causality between GDP, EXPORTS and IMPORTS

Null hypothesis	Full sample	Pre–crisis sample
GDP does not Granger cause EXPORTS	0.009 (0.011) *N*=3359	0.007 (0.009) *N*=3259
EXPORTS does not Granger cause GDP	0.044 (0.021) *N*=3259	0.031 (0.033) *N*=3379
GDP does not Granger cause IMPORTS	0.277 (0.032) *N*=3359	0.232 (0.009) *N*=3559
IMPORTS does not Granger cause GDP	0.256 (0.097) *N*=3259	0.213 (0.122) *N*=3439
EXPORTS does not Granger cause IMPORTS	0.151 (0.189) *N*=3259	0.042 (0.094) *N*=3379
IMPORTS does not Granger cause EXPORTS	0.071 (0.101) *N*=3259	0.007 (0.009) *N*=3239
GDP does not Granger cause EXPORTS and IMPORTS	0.182 (0.006) *N*=2059	0.154 (0.013) *N*=2199
EXPORTS and IMPORTS do not Granger cause GDP	0.125 (0.054) *N*=1919	0.049 (0.034) *N*=1979

After analyzing outcomes presented in table 1 one can easily see that for the real growth rate of GDP and real growth rate of EXPORTS the feedback relationship existed. It is worth mentioning that this phenomenon was reported not only for the pre–crisis data but also for the case of full sample. This may somehow prove that conjecture 3 is true (this way conjectures 1 and 2 are also true).

Although for both examined samples no direct causal links between GDP and IMPORTS were found out, we shall stress one basic difference. Since for the pre–crisis data the feedback relationship between real growth rates of exports and imports was established this may be interpreted as a proof of the existence of indirect bidirectional causal relationship between IMPORTS and GDP (through indirect impact of EXPORTS). This may provide some basis to claim that before beginning of financial crisis of 2008 conjecture 4 was true.

As we had already mentioned the structure of dynamic links between EXPORTS and IMPORTS was found to differ significantly for both considered samples. Before September 2008 one could observe feedback relationship between these two variables and therefore conjecture 5 was true in that period. The fluctuation of import growth rate causes change in export growth rate. This may be implied by the fact that production process often requires some specific half–products which have to be imported. On the other hand, changes of exports may simply cause fluctuations in the imports (especially in the case of consumer goods). For example, the increase of exports shall lead to increase of foreign currency supplies which in turn may easily lead to appreciation of domestic currency and drop of prices of imported goods. This simply leads to increase of imports. Taking into consideration the data collected from time period covering crisis period one could observe the radical change in EXPORTS–IMPORTS relations. For this time period no causality was reported in any direction (at 5% significance level), which may prove that global financial shock had a significant influence on performance of trade openness in Poland after September 2008. However, some weak evidence of causal link running from IMPORTS to EXPORTS was found even for data that covered crisis period (p-value at the level of 0.071), which may somehow be interpreted as a confirmation of the fact that import growth precedes export growth also in economically unstable periods. Anyway, the analysis of additional data from crisis period caused rejection of conjecture 5, which was accepted after analysis of pre-crisis sample (period of stable development).

The outcomes presented in last two rows of table 1 also provide some interesting information. Namely, before the bankruptcy of Lehman Brothers Bank the joint hypothesis that EXPORTS and IMPORTS do not Granger cause GDP was rejected at 5% significance level. Furthermore, no evidence of causality running in opposite direction was reported. On the other hand, the analysis of full sample provided relatively strong basis to claim that both joint hypotheses should not be rejected (at 5% significance level). It seems to be reasonable to treat this finding as a basis to claim that during financial crisis of 2008 the main factor that caused Polish GDP to stay positive was the domestic demand. It is worth mentioning that these outcomes provided some additional evidence in favour of

hypothesis 4. They also provided basis to claim that before September 2008 conjecture 6 was partly true, but when full sample was considered this conjecture was clearly rejected.

The analysis of linear Granger causality in terms of bootstrap-based procedure may not provide the complete information about the dynamic interactions between the variables of interest. Therefore, the impulse response analysis was performed additionally. Every IR function illustrates the response of one variable (found as a caused variable through application of linear causality analysis performed at 5% significance level) to one s.d. (i.e. standard deviation) shock in time series of other variable (found as a causal factor in linear causality analysis) for eight quarters. As we have already mentioned the complete results of preliminary tests are available from authors upon request. The following figure contains illustration of all responses obtained after analysis of the full sample:

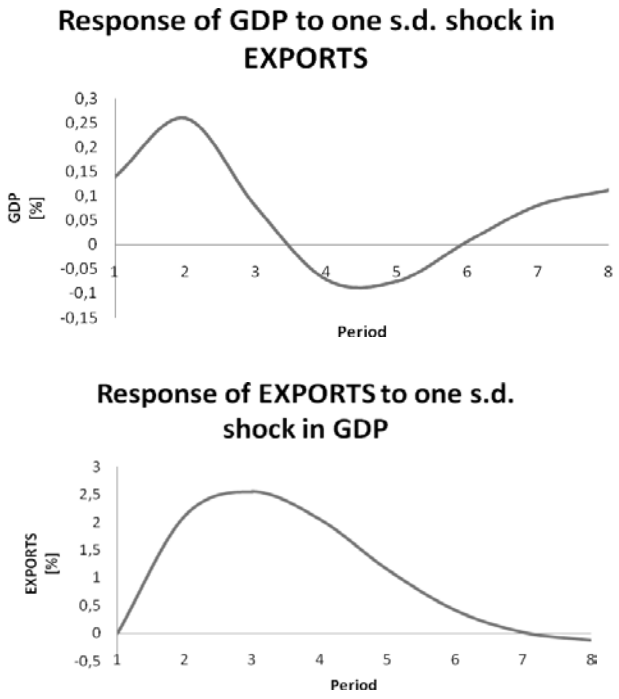

Figure 1. Impulse responses of caused variables to one s.d. shocks in time series of causal factors (full sample)

The one s.d. (10.34%) shock from EXPORTS causes positive responses of GDP in the first three quarters. However, the negative responses were reported in quarters 4 and 5. The highest positive response was reported for the second period and reached the value of 0.26%. The biggest drop in GDP was found for quarter 5 and it reached the value of -0.075%. On the other hand, the one s.d. (2.18%) shock from GDP causes positive responses of EXPORTS in first seven quarters. The highest positive response was reported for third period and reached the value of 2.55%. However, in eight quarter the slight negative (-0.11%) response was reported.

The following figure contains illustration of all responses obtained after analysis of the reduced sample:

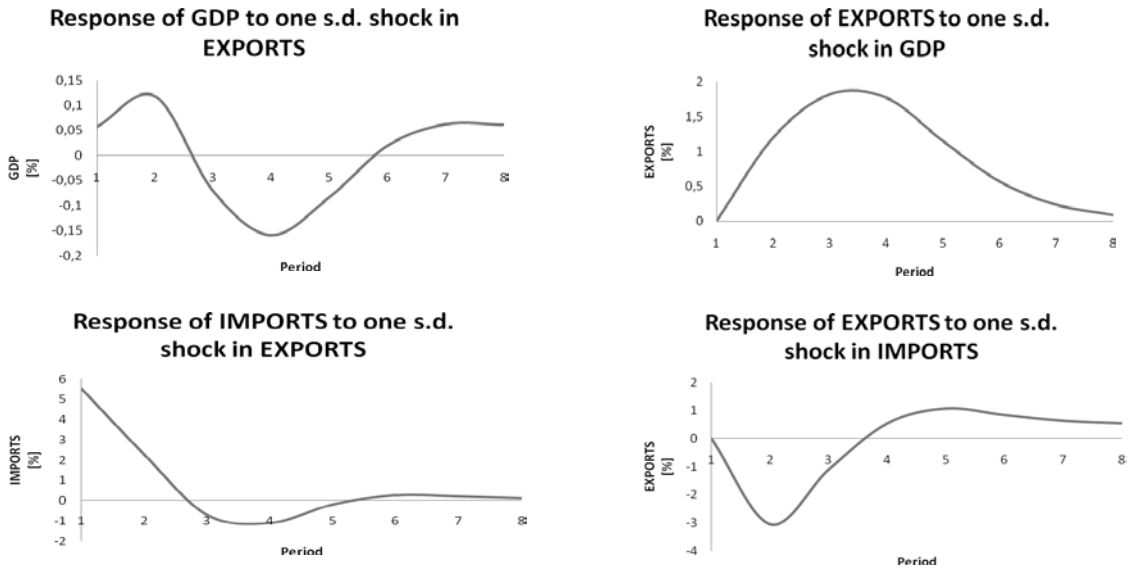

Figure 2. Impulse responses of caused variables to one s.d. shocks in time series of causal factors (pre-crisis sample)

The one s.d. (9.47%) shock from EXPORTS causes positive responses of GDP in the first two quarters with the highest positive value reported for second quarter (0.11%).The negative responses were reported in quarters 3, 4 and 5 with the lowest value occurring in fourth quarter and equal to -0.13%. On the other hand the one s.d. (2.09%) shock from GDP causes positive responses of EXPORTS in all eight quarters. The highest positive response was reported for third period and reached the value of 1.82%. The one s.d. (9.47%) shock from EXPORTS causes positive responses of IMPORTS in the first two quarters with the highest positive value reported for first quarter (5.22%).The negative responses were reported in quarters 3, 4 and 5 with the lowest value occurring in fifth quarter and equal to -1.09%. In quarters 6 to 8 positive responses were once again reported. On contrary, the one s.d. (10.90%) shock from IMPORTS causes negative responses of EXPORTS in the first three quarters with the lowest value reported for second quarter (-3.01%).The positive responses were reported in quarters 4 to 8 with the highest value occurring in sixth quarter and equal to 1.06%.

One may be interested in identifying sources of differences in shapes of IR functions calculated for full sample and pre–crisis data. Beside technical aspects of estimation details we cannot forget that in both cases values of one s.d. shocks were different. Another important issue is the fact that after September 2008 the structure of causal links between variables of interest has changed, which surely must have influenced impulse responses (especially in terms of IMPORTS-EXPORTS links).

In addition to linear causality tests and impulse response analysis the nonlinear Granger causality tests were conducted as well. Results obtained after analysis of full sample and unfiltered residual time series are presented in the table 2. Similarly to the case of previous table, numbers in square brackets refer to analogous nonlinear analysis performed for pre–crisis data. This time shading was used to indicate the test results supporting rejection of null hypothesis at 10% significance level:

Table 2. Results of tests for nonlinear Granger causality between examined variables (unfiltered data)

Null hypothesis	*p*-value			
	ε=0.5	ε=1	ε=1.5	
GDP does not Granger cause EXPORTS	0.42 [0.45]	0.28 [0.23]	0.39 [0.31]	l=1
	0.32 [0.41]	0.44 [0.08]	0.65 [0.42]	l=2
	0.54 [0.32]	0.92 [0.09]	0.62 [0.24]	l=4
EXPORT does not Granger cause GDP	0.58 [0.80]	0.74 [0.71]	0.46 [0.52]	l=1
	0.21 [0.81]	0.76 [0.70]	0.72 [0.73]	l=2
	0.45 [0.64]	0.43 [0.70]	0.31 [0.21]	l =4
GDP does not Granger cause IMPORTS	0.34 [0.42]	0.39 [0.40]	0.61 [0.10]	l =1
	0.22 [0.28]	0.64 [0.09]	0.53 [0.32]	l =2
	0.27 [0.31]	0.35 [0.23]	0.47 [0.39]	l =4
IMPORTS does not Granger cause GDP	0.69 [0.48]	0.63 [0.70]	0.92 [0.95]	l =1
	0.19 [0.13]	0.80 [0.74]	0.91 [0.96]	l =2
	0.51 [0.43]	0.82 [0.78]	0.61 [0.46]	l =4
EXPORT does not Granger cause IMPORTS	0.25 [0.14]	0.23 [0.20]	0.15 [0.42]	l =1
	0.18 [0.15]	0.56 [0.20]	0.30 [0.21]	l =2
	0.23 [0.24]	0.19 [0.31]	0.34 [0.27]	l =4
IMPORTS does not Granger cause EXPORTS	0.48 [0.34]	0.12 [0.05]	0.08 [0.18]	l =1
	0.18 [0.19]	0.30 [0.05]	0.28 [0.14]	l =2
	0.22 [0.23]	0.27 [0.08]	0.09 [0.05]	l =4

As we can see in all but two cases the established causal links were found only for pre–crisis data. The results of nonlinear tests provided basis to claim that before September 2008 nonlinear causality was running from real growth rate of GDP to real growth rate of exports. As we additionally take into account results of linear causality analysis then this outcome may justify the fact that in pre–crisis period causality running from GDP to EXPORTS was extremely strong. The nonlinear causality analysis also leads to the conclusion that before crisis GDP was a causal factor for IMPORTS. Before the September 2008 the strongest nonlinear link was reported for causality running from IMPORTS to EXPORTS. This link was also found to be significant when full sample was considered. To summarize, results of nonlinear causality analysis conducted for unfiltered data are supporting the outcomes of linear causality tests only to some extent. This finding provides only some weak evidence in favour of conjecture 7.

Since we had found significant evidence of presence of GARCH structures in residual time series resulting from both considered VAR models, we decided to re-run nonlinear causality analysis for GARCH(1,1)-filtered data (for both samples the GARCH(1,1) model was found to be most

appropriate for modelling conditional heterocsedasticity in the residual time series). The results of causality tests conducted for filtered data provided no evidence of existence of nonlinear Granger causality in any direction regardless sample size (at 10 % significance level). Therefore, after the GARCH(1,1) filtration of residual time series it turned out that conjecture 7 should clearly be rejected. Additionally, this phenomenon may somehow prove that nonlinear causality analysis is indeed sensitive to the presence of heteroscedastic structures in examined data which is in line with the outcomes presented in previous papers (e.g. [19]). However, one cannot forget that possible misspecification of heteroscedasticity model could be the reason for relatively different indications of tests conducted for unfiltered and filtered data. In conclusion, results of nonlinear Granger causality conducted for unfiltered and filtered data provided relatively convincing arguments to claim that conjecture 7 is false.

6. Final remarks

The main goal of this paper was to examine the dynamic relationships between real growth rates of GDP, exports and imports in Poland. We used two quarterly datasets for the period Q1 1996 to Q3 2008 (pre–crisis data) as well as for the period Q1 1996 to Q3 2009 (full sample). We ran linear Granger causality tests with critical values established through the application of bootstrap based on leveraged residuals. In order to provide satisfying accuracy of our research the number of bootstrap replications was chosen according to recently developed procedure. Finally, the application of impulse response functions as well as tests for nonlinear Granger causality provided basis to investigate the dynamic links between variables of interest in most comprehensive way.

The results of linear Granger causality analysis led us to the conclusion that regardless of considered sample size there was a feedback relationship between GDP and EXPORTS. On the other hand, the strong support for the existence of feedback between EXPORTS and IMPORTS was found for pre–crisis sample, while for full sample only some weak evidence of causality running from IMPORTS to EXPORTS was reported. Furthermore, before September 2008 the EXPORTS and IMPORTS were found to jointly cause fluctuations of real GDP in Poland. When the crisis data was also taken into consideration, this causal link was not found to be significant. In general, all these facts seem to prove that the global financial crisis had seriously disturbed the structure of dynamic interactions between GDP and trade openness of Polish economy. One may wonder whether these outcomes provide solid basis to claim that the good shape of Polish economy during financial crisis of 2008 was rather the consequence of high domestic demand than the impact of foreign trade.

The results of impulse response analysis had also provided some interesting conclusions. Firstly, irrespectively the chosen sample one could observe positive responses of EXPORTS to one s.d. shocks from GDP. Furthermore, in both cases responses of GDP to one s.d. shocks from EXPORTS were relatively similar. However, we cannot forget that for the pre–crisis sample impulse responses

calculated for GDP and EXPORTS were significantly influenced by EXPORTS-IMPORTS dynamic interactions.

Nonlinear causality analysis provided evidence of existence of dynamic links mostly for pre–crisis sample. However, the filtration of autoregressive heteroscedasticity caused that these links were not statistically significant. To summarize, the nonlinear causality running from GDP to EXPORTS, from GDP to IMPORTS and from IMPORTS to EXPORTS is rather weak.

We believe that this research will be helpful in analyzing the nature of dynamic relationships between economic growth and trade openness in case of transitional economies. The application of time series with included and excluded data from the global economic crisis provided the opportunity to examine the influence of worldwide economic shocks on the structure of dynamic links between GDP and trade openness of Polish economy.

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