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Henryk GURGUL*
Łukasz LACH*

INTERNATIONAL TRADE AND ECONOMIC GROWTH IN THE POLISH ECONOMY

The paper presents the results of examinations of linear and nonlinear causalities performed for international trade involving the Polish economy and its economic growth. In order to infer the impact of the world crisis on the Polish economy, two samples have been studied (containing quarterly data) – a full sample (Q1 1996–Q3 2009) and pre-crisis sample (Q1 1996–Q3 2008). The results of linear causality tests support the existence of feedback between the growth rate of exports and growth in gross domestic product (GDP) irrespectively of the time period chosen. For both the samples examined, no direct causal links between the 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 the pre-crisis sample. Some weak evidence of a causal link running from the growth rate of imports to the growth rate of exports was also found for the period that covers the crisis, which may be interpreted as a confirmation of the fact that growth in imports also precedes growth in exports in bullish periods. It results from our computations that, at the time of the financial crisis of 2008, the main factor that caused Polish GDP growth to remain positive was domestic demand. The results of nonlinear causality analysis provided only weak evidence for causality running from GDP to exports, from GDP to imports and from imports to exports.

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

1. Introduction

Many economists try to find the 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 determining

*Department of Applications of Mathematics in Economics, Faculty of Management, University of Science and Technology, Cracow, Poland. e–mail addresses: henryk.gurgul@gmail.com, lukilach1983@o2.pl

economic growth. Considerable attention has been paid for more than two centuries to the impact of foreign trade (exports and imports) on economic growth. The importance of exports for a national economy was underlined in economic literature by mercantilists. They strongly believed that a trade surplus is the most favourable advantage that can be derived from international trade relations. As a consequence, they supported the promotion of exports and the protection of domestic industries.

The profitability of specialization in production and implied profitability of foreign trade was noted and justified by a classical economist David Ricardo within the framework of the well known theory of comparative costs. He proved that there exist prices in foreign trade for two goods produced by two fully specialized countries that profit both countries, i.e. increase their wealth.

In the current economic literature, it is widely accepted that the level of international trade in an economy may be one of the main sources of its growth. In the literature, many reasons are cited for the influence of exports on gross domestic product (the hypothesis of export-led growth). Rising exports support a rise in GDP, because exports (i.e. foreign demand) beside domestic demand are parts of GDP by the definition of the accounts of national income.

The indirect impact of exports on GDP is even more important. Exports constitute a leading factor in determining total growth, since they lead to an increase in investment and thus a rise in labour productivity. Due to the competitiveness of international markets, exports expose countries to the most advanced ideas and methods of production and thus enhance efficiency. Thus a rise in exports is mostly possible due to innovative goods and production processes. Workers employed in exporting sectors enjoy the highest wages and these firms earn the highest profits, since only the most efficient firms can operate in this sector. Because of a lack of mineral resources or modern technology, GDP growth in 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 the most important source of foreign currency necessary for imports, i.e. high exports relax the binding foreign exchange constraint, thus allowing an increase in imports of capital goods and intermediate goods. In long run, exports support the diffusion of modern technology, through advice from foreign buyers and learning by doing. Exports enable a sustainable growth of an economy, prevent price distortion and support efficient allocation of resources through increased competition. A crucial role of exports is reflected in export promotion strategies. Politicians in developing countries, in particular prefer promoting exports to protecting against imports.

We should stress that economic theory also suggests a different relation between exports and output, namely that GDP growth is exogenous with respect to exports and it is a precondition for the growth of exports. According to this theory, a rise in output positively affects exports when such a rise is combined with an increase in productivity and reduction of unit costs. This makes it easier to sell goods abroad. This may be

a result of changes in technology independent of any factor accumulation and trade. It is clear that the comparative cost structure in an economy will tend to adjust in a way that is consistent with growing exports (cf. e.g. [36]). In general, the direction of causation from GDP to exports is based on an *internally generated* mechanism of economic growth that implies the 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 to export growth. By exporting, a country may overcome a small size of its domestic market and minimize costs resulting from increasing returns to scale. VENABLES [53] argues that in the case of non-perfectly competitive industries and vertical integration, growing output may cause fundamental changes in the level of exports through the so called *cumulated causation process*.

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

Balance of trade represents the difference in the value of imports to and exports from a country. There are some major 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 that country, e.g. there are no gas or oil deposits, an agricultural product cannot be produced because the climate is too cold and, in particular, an innovation that has only been introduced in other countries. Secondly, the domestic product might not be of the desired level of quality. Therefore, a country imports better goods than domestic output: note that advertising and/or packaging should be understood as a part of a product. Another reason for importing a good may be that it is just cheaper abroad. The reason for this might be that foreign producers are more efficient. In addition, they might incur lower costs, better exploit economies of scale and/or accept lower profits. Another reason is that at the current domestic price, domestic producers do not supply the amount of a good or service demanded, or because of ex ante coordination problems. Therefore, consumers buy imports due to insufficient domestic production.

In order to finance imports, an economy must rely on exports, foreign credit, foreign direct investment and foreign aid. Countries with an internationally accepted currency (such as the US dollar or the Euro) may pay with it. Imports are usually classified according to economic destination and the classification of a product. Imports contribute to domestic consumption, to domestic investment (increasing production capabilities using newly installed equipment) and to current domestic production (e.g. raw materials and spare parts). There is also an important stream of imports that will first be processed and then exported. Imports can also result from government expenditure (e.g. medical or military equipment). To summarize, imports contribute to all the components of GDP, but they are usually described by central statistical offices separately as a stand–alone aggregate. The level of imports is usually thought to be

determined by the level and dynamics of domestic income, the level and dynamics of each component of GDP (investment, private consumption, government consumption, exports) as differentiated drivers of imports, the price competitiveness of domestic production (normally influenced by the exchange rate and its fluctuations, as well as by differences between the inflation rate in a country and foreign nations), the non-price competitiveness of domestic production (for example, quality, technological innovativeness, design, promotion), the national attitude toward foreign goods, shifts in domestic patterns of demand and supply, historical links with certain countries, structural trends toward economic integration with other countries.

According to economic theory, imports should grow when consumers' disposable income increases. This especially concerns *luxury goods*, i.e. their demand grow more than proportionally when income increases. According to economic theory, when gross domestic product (GDP) increases, then an elasticity of 1 is assumed. However, from empirical results it follows that the growth rates of imports are systematically different from GDP growth rates, which contradicts this hypothesis. Suppose private consumption, investment, exports and government consumption rise and the elasticity of imports with respect to GDP differs from one. In this case, the national currency strengthens and the inflation rate tends to increase compared to other countries. Hence, foreign products become cheaper and cheaper, leading to a widening technological and quality distance between domestic and foreign production. Also, the increase in the level of imports depends on a general perception of foreign goods by domestic buyers (e.g. "foreign is better"). The level of imports depends on integration with other countries, e.g. on national production specializing, which implies that the world is becoming systematically more 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 quite a general observation.

Another feature is that imports are pro-cyclical. Moreover, it is a well known fact that in a deep recession, a phenomenon called *inversion* takes place. At such times, imports fall at a faster rate than GDP as whole. Consequently, the trade balance improves significantly and this may turn out to be decisive in the recovery process.

Economies with a high ratio of international trade to GDP are called *open economies*. All economies are open to some extent, with the degree of international trade varying substantially from one country to another. How the level of international trade is defined depends on the objective of empirical analysis and the country under study. In this respect, at least three measures can be found in the literature. The former one identifies international trade with imports, another with exports (*narrow definitions*) and the latter (*broad definition*) with imports plus exports, all expressed as a proportion of GDP. In developing countries, these three definitions have been used in studies of public finance mostly in connection with government income. The general premise

of these studies was that, for reasons of administrative efficiency, there was a preference for indirect taxes in these countries. Most of them were imposed on internationally traded goods that passed through a limited number of well guarded points of entry [39], [11].

In order to prove a bidirectional relationship between export growth and GDP growth, we use a specific modification of the broad definition of international trade. Namely, we do not consider simply the sum of exports and imports, but we examine a linear function of the growth rates of imports and exports. Therefore, we enable the possibility of testing whether the relationship between GDP and international trade is based (mostly) on a strong influence of only one component – exports or imports (obviously, this is not testable when the sum of exports and imports is considered). Furthermore, for reasons of analytical completeness, the bidirectional causal relationship between export growth and import growth is proven, in order to find out which one of these 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 is to indicate dynamic relationships between the real growth rates of GDP, exports and imports in the case of the Polish economy, which is still in a transitory phase. All the causality tests were performed on these growth rates, not on the original macroeconomic values.

The rest of the paper is organized as follows. Section 2 contains an overview of the literature. In part 3, we describe the 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. Overview of the literature

Because of the importance of the relation between exports and GDP, in the overview the most important results have been cited concerning these two categories in particular. The known empirical evidence of the relationship between international trade and GDP is mostly based on testing for causality between exports and output. The results are mostly mixed and frequently contradictory at first glance. Some studies support the export led growth hypothesis (e.g. papers by 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, empirical results from causality tests reported in other studies do not supply evidence in favour of a positive causal relation running from exports to economic growth (e.g. papers by 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 hypothesis of export led growth can be classified into three groups. Authors in the former group apply cross country correla-

tion coefficients to test this hypothesis. Another group of studies, which typically uses the OLS method, also uses cross country data. A recent group of articles applies various time series techniques to examine the relationship between exports and growth. Typical problems with methods using cross–country data are widely described in the literature. First of all, a number of previous studies (e.g. MICHAELY [42], BALASSA [6], FEDER [23]), 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 they also react differently to external shocks. Therefore, the estimates computed using cross-sectional regressions are misleading. Within the framework of this approach, it is not possible to take country specific features into account. Neither are empirical studies [8], [25], [26], [50] based on time series free from some problems arising from the causality methodology applied, e.g. 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 the hypothesis of *export led growth* if time series are integrated [51], [55] and causality tests are sensitive to model selection [26]. This paper attempts to explore the causal link between exports and output by examining unit root properties and Granger's non-causality tests. In particular, the procedure developed by TODA and YAMAMOTO [51] is expected to improve using the standard *F* statistic in a causality test.

The relationship between foreign trade and GDP is especially important for transitional economies. However, the majority of previous contributions were related to the analysis of advanced markets. There are few papers that contain an examination of the relationship between GDP and international trade for less developed countries. RAMOS [45] performed an analysis of the dynamic links between GDP and international trade for Portugal over the period 1865–1998. His findings confirmed that during the period considered there was feedback between growth in exports and output, as well as between growth in imports and output. Furthermore, no kind of significant causality between the growth of imports and exports 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. CETINTAS and BARISIK [10] examined the relationship between GDP and international trade 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 hypothesis of growth led exports is valid in these countries and growth is rather shaped by an increase in demand for imports. It is also worth mentioning that in all these papers imports was believed to be an important variable that should not be omitted, in order to conduct the analysis of the links between GDP and foreign trade properly. Moreover, the authors mentioned above claimed that indirect causal links between GDP and exports may exist, due to the impact of imports.

This paper fills this perceived gap in the literature, as it contains the results of an analysis of the dynamic links between economic growth and international trade in the case of a new EU member country. Furthermore, we aim to provide some description of the influence of the global financial crisis (which began in September 2008) on the structure of relationship between GDP and foreign trade in Poland.

3. Main conjectures

The main attention, in the context of pair wise causation between GDP and foreign trade (exports and imports), is paid to the relation between exports and economic growth. According to the literature cited above, the last causation is the 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 increasing exports stimulates economic growth by augmenting domestic production. Such causality between exports and growth has been widely reported in the literature. This may be justified by David Ricardo's model of comparative advantage. By opening to the world market, a country can increase its income by producing those goods that it can produce most cheaply. The literature on economic development is based on Ricardo's model. Increasing exports generates foreign exchange earnings, finances capital goods and intermediate imports and hence induces more production. Because potential markets offer greater economies of scale, an exporting economy enhances its productivity by better resource allocation and technological innovation. The contributors point out that production of non-export goods can also be enhanced through various channels such as technological spillover, learning-by-doing and externalities. As a result, increasing exports contributes to growth in GDP. This view seems to be supported by the success of East Asian economies where, between the 1960's and 1980's, rapid GDP growth followed aggressive trade policies. Also, in the case of emerging economies like Poland, foreign direct investment (FDI), lower production costs, foreign aid and the advantages of EU accession significantly supported export growth and nowadays it has become an important factor of GDP growth. Therefore, we formulate the first (so called *export led*) hypothesis in the form:

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

In contrast to this conjecture, some authors think that increasing exports follows 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's tradition of economic thought. Acceleration in economic development will inevitably lead to increasing exports. The implied causation is thus from domestic growth and accumulation to growth in trade. The focus of endogenous growth is on the supply side, considering the medium or long run accumulation of production factors. In short, supply increases faster than domestic demand, so that excess supply is exported. According to this view, increasing exports is not a necessary condition for 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 argument may also be true in the first phase of a transition process e.g. the case of the Polish economy. A deep depression in Polish exports, due to the collapse of the Soviet type economies in Central and Eastern Europe and the breaking of traditional trade links at the beginning of the nineties was overcome after the start of the recovery in the Polish economy in 1994. Therefore, we formulate the following contrasting hypothesis:

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

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

Conjecture 3. There is feedback between export and economic growth in the Polish economy.

A virtuous cycle takes place when increasing exports stimulates domestic production and this increased production encourages more exports. A vicious circle would occur if decreasing domestic production leads to decreased exports, which leads to further decreases in production.

In summary, current economic theories suggest that the 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 the veracity of conjecture 3 implies that conjectures 1 and 2 are also true.

According to the literature cited above, imports contribute to all categories of GDP. In developing and some emerging economies expenditure on imports is rigid,

i.e. buying some kinds of goods is necessary, independently of the financial situation of a country. Therefore, there is almost surely causation from imports to GDP.

However, as we stressed before, imports depend on the level and dynamics of domestic income and the level and dynamics of each component of GDP. Also, imports satisfy the demand from particular subcategories of GDP. 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 to examine the following hypothesis:

Conjecture 4. There is feedback between import and economic growth in the Polish economy.

From the above overview concerning foreign trade, one can draw the conclusion that exports and imports depend on each other. There is also a significant fraction of imports that will first be processed in domestic plants and then exported abroad. Thus imports are preconditions for exports. On the other hand, exports are a source of foreign currency, which determines the level and structure of imports. Therefore, the conjecture regarding feedback between exports and imports may be a plausible hypothesis:

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

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

Conjecture 6. There is feedback between the rate of growth of GDP and the growth rates of exports and imports in the 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 previous research was based only on the application of linear tests, especially if we consider all the disadvantages of the 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 the results computed by means of linear methods. Thus, we will prove:

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

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

4. Dataset and methodology

As has been already mentioned, most previous studies concerned with the relationship between GDP and trade dealt with developed economies. Except for a few papers mentioned above, this problem had not been examined in the case of transitional economies. In this context, our paper fills a gap in the literature, providing results obtained in examining the relationship between GDP and trade in the case of a new EU member country. In this section, we give a short description of the dataset used in further computations. The dataset considered includes quarterly time series of the 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 the corresponding quarter of the previous year (assuming constant prices from the previous year). The study 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 for the period under study was obtained from the Central Statistical Office in Poland.

Another important fact that distinguishes the present paper from previous contributions concerned with similar topics is the application of data that partly covers the period of the global economic crisis which started in 2008. Since the methodology of causality analysis does not enable exploring dynamic links between GDP, exports and imports in the period after the bankruptcy of Lehman Brothers Bank (insufficient sample size), an alternative approach has been used to examine the impact of the economic crisis on the structure of dynamic links between real GDP, real export and real imports in Poland. Namely, two samples have been analyzed – 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 the financial crisis on the relationship between GDP and trade through the specification of differences in the structures of causal links between GDP, exports and imports in Poland for both samples studied. Henceforth, we use abbreviations for all the variables examined. Table 1 contains the relevant abbreviations. Additionally, a short description of each variable is also given:

Table 1. Abbreviations and short descriptions of the variables examined

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 for all the variables examined. For each time series, some typical statistics were calculated. We calculated these values for both the subsamples considered placing those corresponding to the pre-crisis period (i.e. Q1 1996–Q3 2008) in square brackets. The appropriate results are presented in Table 2:

Table 2. Descriptive statistics for the variables examined

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]

Some interesting information is visible directly from this table. Firstly, we can see that in the period under study, relatively stable development could be observed in the 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 a relatively slow growth rate (at the level of 0.50%) can also be seen. It is worth underlining that after the beginning of the financial crisis in 2008, the real GDP growth rate in Poland did not drop as significantly as the 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 was a rarity in Europe) with the lowest value, equal to 0.80%, reported in the first quarter of 2009. The lower value of the mean and the higher value of the standard deviation calculated for the full sample in comparison to the pre-crisis period may also be evidence of the influence of the world financial crisis on the performance of the Polish economy measured by the real GDP growth rate.

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

In the paper, several econometric methods have been used to explore the dynamic relationships between the real GDP growth rate, real growth rate of exports and real growth rate of imports in Poland for the two periods under study. The concepts of both linear and nonlinear Granger causality tests, the idea of impulse response analysis based on Cholesky decomposition and the method of bootstrap based on leveraged residuals were used to provide a complex environment for the examination of all our main research hypotheses formulated in the previous section. As was previously mentioned, authors' main goal was to analyze the results obtained using two time series with quarterly data – the former one containing all the observations and latter one with the data collected after the beginning of the global financial crisis in 2008 being excluded.

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

Directly from Table 3, one can easily see that all the time series were found to be stationary around a constant (at the 10% significance level). In addition, in order to confirm these findings the test of KWIATKOWSKI, PHILLIPS, SCHMIDT and SHIN [37] (KPSS) was also conducted. The results of the KPSS test are presented in the two last columns of Table 3. The numbers in square brackets have the same meaning as in the case of the results of the ADF test.

Table 3. Results of the tests for stationarity

Variable	ADF (no trend)		ADF (linear trend)		KPSS (no trend)*	KPSS (linear trend)**
	Test statistics (*p*-value)	Optimum lag	Test statistics (*p*-value)	Optimum lag	Test statistics	Test statistics
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%).

To summarise, analysis of the results presented in Table 3 provided solid evidence for the claim that all the time series are stationary around a 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, the basic methodology of vector autoregression (VAR) has been applied. For this paper, a trivariate VAR model constructed for GDP, EXPORTS and IMPORTS has been used:

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

where $Y_t = [\mathrm{GDP}_t, \mathrm{EXPORTS}_t, \mathrm{IMPORTS}_t]^{\mathrm{tr}}$, $c = [c_1, c_2, c_3]^{\mathrm{tr}}$ is a vector of constants, m is the lag length and $t = m + 1, \ldots, T$ (tr denotes the transpose operator). As previously mentioned, a full sample was considered and the pre-crisis sample (i.e. two values of the parameter T). The initial step of this procedure is related to the establishment of the lag length. For this purpose, the maximum lag length equal to 6 was set and then the AIC and BIC information criteria were used 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 tests for autocorrelations were conducted which provided no evidence of autocorrelations between the error terms, indicating that setting the value of m equal to 2 was indeed a suitable choice. The idea of testing for linear Granger causality using a VAR approach is based on the application of the basic Wald test with a standard asymptotic chi square distribution. At this point, two important facts should be stressed. Firstly, the appropriate application of asymptotic theory requires some specific modelling assumptions to be fulfilled (e.g. whiteness of the error term resulting from the VAR model, for more details cf. [40]). If these assumptions do not hold, the application of asymptotic theory

may lead to spurious results. Secondly, even if the assumptions of a model are generally fulfilled, the distribution of the Wald test statistics may still be significantly different from chi-square when dealing with relatively small samples.

As a cure for these problems, the bootstrap technique was additionally used. This method is used for estimating the distribution of a test statistic by resampling data. At this point, we should also underline some important facts. Firstly, the estimated distribution only depends on the dataset available; therefore it may be reasonable to expect that none of the assumptions required for parametric methods to be valid have to be fulfilled for the application of the bootstrap technique to be appropriate. Secondly, the size and power properties of a causality test based on bootstrap techniques remain relatively good for small samples (for more details cf. e.g. [21], [41], [30] and [38]).

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

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

- Draw randomly from the set $\{\hat{\varepsilon}_i^m\}_{i=3,\ldots,T} = \begin{bmatrix} \hat{\varepsilon}_{1,i}^m \\ \hat{\varepsilon}_{2,i}^m \\ \hat{\varepsilon}_{3,i}^m \end{bmatrix}_{i=3,\ldots,T}$ with replacement (each point has the same probability $1/(T-2)$). As a result we get the set $\{\hat{\varepsilon}_i^{**}\}_{i=3,\ldots,T}$.
- Subtract the mean in order to guarantee that the mean of the bootstrap residuals is zero. In this way, we create a set $\{\hat{\varepsilon}_i^*\}_{i=3,\ldots,T}$, such that

$$\hat{\varepsilon}_{k,i}^* = \hat{\varepsilon}_{k,i}^{**} - \frac{\sum_{j=3}^{T} \hat{\varepsilon}_{k,j}^{**}}{T-2}, \quad i=3,\ldots,T, \quad k=1,2,3$$

- Generate the simulated data using the original data, the estimates of coefficients from the regression of the restricted VAR model and the bootstrap residuals $\{\hat{\varepsilon}_i^*\}_{i=3,\ldots,T}$.

• Calculate the Wald statistic (for the data simulated).

After repeating the procedure N times, it is possible to derive the empirical distribution of the TY test statistic and then obtain empirical critical values (bootstrap critical values). The academic discussion on how the number of bootstrap replications (the parameter N) may affect the performance of bootstrap techniques gained considerable attention in recent years (see e.g. [34], [38]). In this paper, we applied the recently developed procedure of establishing the number of bootstrap replications presented by ANDREWS and BUCHINSKY [2]. In each case, we aimed to apply such a value of the parameter N which would ensure that the relative error of the estimated critical value (for the 5% significance level) would not exceed 5% with probability equal to 0.95. This 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 the bootstrap critical value (for the 5% significance level) and c denotes the *ideal* (i.e. gained after an infinite number of replications) bootstrap critical value (for the 5% significance level). A suitable procedure (including the Andrews and Buchinsky method) written in Gretl is available from the authors upon request.

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

In order to perform a comprehensive examination of the dynamic links between GDP and international trade in Poland for the two periods under study, we also applied the nonlinear test for Granger causality. The motivation to use this technique is twofold. Firstly, detecting certain kinds of nonlinear relationships by means of the standard linear Granger causality may lead to relatively poor results, due to the low power of the linear test in such cases (see e.g. [9], [29]). Secondly, causality in a higher order structure (e.g. causality in variance, etc.) cannot be explored by means of the traditional linear approach, since the latter is based on testing the statistical significance of the appropriate parameters only in the equation for the mean [17]. This

problem may be solved by the application of a nonlinear approach, as it allows exploring complex dynamic links between the variables of interest.

In the paper, a nonlinear causality test was used proposed by DIKS and PANCHENKO [19]. In the research, some typical values for the technical parameters applied in this method were used. The bandwidth parameter (denoted as ε) was set to be one of the following values: 0.5, 1.0 and 1.5, as these values were commonly used in previous papers (see e.g. [33], [18], [19]). Furthermore, the same lag for each pair of time series analyzed was used, (denoted as l) being of the order of 1 or 2. Detailed information about the meaning of these technical parameters and the form of the test statistic applied may be found in [19].

The analysis of nonlinear Granger causality was not performed for the initial data, but it was based on the time series of residuals resulting from the appropriate trivariate VAR model. Time series of residuals reflect strictly nonlinear dependences, since the structure of linear dependences has been filtered out by the application of a suitable VAR model (see e.g. [4], [12]). In this paper, a one sided test was used, rejecting whenever the realization of the test statistic was significantly large. The motivation of this approach is twofold. Firstly, in practice a one sided test is often found to have a larger power than a two sided one (see e.g. [48]). Secondly, despite the fact that significant negative values of the test statistic also provide a basis for rejecting the null hypothesis of Granger non-causality, they additionally lead us to claim that the knowledge of past values of one time series may make the prediction of another one more difficult. In contrast, the analysis of causality is usually conducted to judge whether such knowledge is helpful in prediction or not.

Since some past research (e.g. [19]) has provided a solid basis for claiming that such nonlinear causality tests tend to reject the null hypothesis more often than they should when there are heteroscedastic structures in the time series analyzed, we also decided to test all the time series of residuals for the presence of GARCH structures. Since we found significant evidence of the presence of conditional heteroscedasticity in the residuals for both VAR models, we decided to re–run the nonlinear causality test on the filtered series of residuals. However, we should also note that GARCH filtering may also lead to a loss in the power of a test, which derives from the possible misspecification of the model for conditional heteroscedasticity. 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 a basis for judging which of hypotheses presented in section 3 holds true. It may also be reasonable to expect that a comparison of the two samples may help to describe the impact of the global financial crisis, which started in September 2008, on the structure of the causal links between GDP and international trade in Poland. The presentation of the results of our research start with the results obtained from the analysis of the linear Granger causality. Table 4 contains the *p*-values obtained when testing for linear Granger causality using the bootstrap based Wald procedure for both samples. The numbers in round brackets denote the corresponding *p*-values obtained by means of the standard (chi–square) distribution of the Wald test statistic. In each case, the value of the parameter *N* denotes the number of bootstrap replications established by applying the method proposed in [2].

Whenever the results of bootstrap based testing indicated the existence of a causal link in a certain direction (at the 5% significance level), shading was used to highlight this finding:

Table 4. Results of tests for the 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 do 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 do not Granger cause GDP	0.256 (0.097) *N* = 3259	0.213 (0.122) *N* = 3439
EXPORTS do not Granger cause IMPORTS	0.151 (0.189) *N* = 3259	0.042 (0.094) *N* = 3379
IMPORTS do not Granger cause EXPORTS	0.071 (0.101) *N* = 3259	0.007 (0.009) *N* = 3239
GDP does not Granger cause EXPORTS or 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 the results presented in the table, one can easily see that feedback exists between the real growth rate of GDP and the real growth rate of EXPORTS. It is worth mentioning that this phenomenon was reported not only for the pre-crisis data, but also for the case of the full sample. This may indicate that conjecture 3 is true (hence, conjectures 1 and 2 are also true).

Although no direct causal links between GDP and IMPORTS were found for either of the samples examined, one basic difference should be stressed. Since feedback between the real growth rates of exports and imports has been established based on the

pre-crisis data, this may be interpreted as evidence for the existence of an indirect bidirectional causal relationship between IMPORTS and GDP (through the impact of EXPORTS). This may provide some basis to claim that before the beginning of the financial crisis of 2008, conjecture 4 was true.

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

The results presented in the last two rows of Table 4 also provide some interesting information. Namely, before the bankruptcy of Lehman Brothers Bank, the composite hypothesis that EXPORTS and IMPORTS do not Granger cause GDP was rejected at the 5% significance level. Furthermore, no evidence of causality running in the opposite direction was reported. On the other hand, the analysis of the full sample provided a relatively strong basis to claim that both composite hypotheses should not be rejected (at the 5% significance level). It seems to be reasonable to treat this finding as a basis to claim that the main factor that caused Polish GDP growth to stay positive during the financial crisis of 2008 was domestic demand. It is worth mentioning that these results provide some additional evidence in favour of hypothesis 4. They also provide some evidence to claim that before September 2008 conjecture 6 was true, but when the full sample is considered, this conjecture is clearly rejected.

The analysis of linear Granger causality using the bootstrap based procedure may not provide a full picture of the dynamic interactions between the variables of interest. Therefore, in addition, impulse response analysis was performed. Each IR function

illustrates the response of one variable (defined to be the response variable in the application of linear causality analysis at the 5% significance level) to a one s.d. (i.e. standard deviation) shock in the time series of the other variable (defined to be the causal factor in the linear causality analysis) for eight quarters. As previously mentioned, the complete results of the preliminary tests are available from the authors upon request. Figure 1 illustrates the responses obtained from the analysis of the full sample:

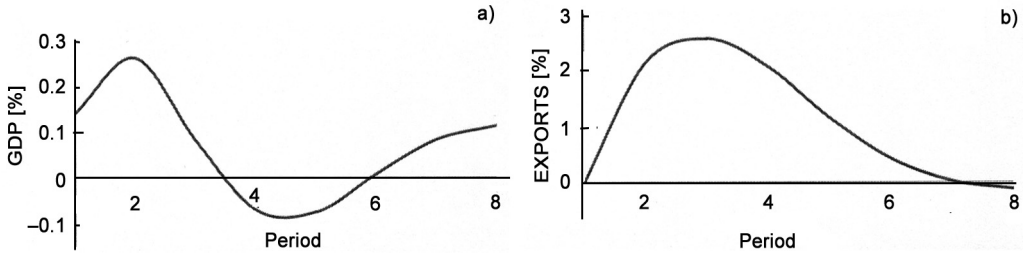

Fig. 1. Impulse responses of response variables to a one s.d. shock in the time series of causal factors (full sample): a) response of GDP to a one s.d. shock in EXPORTS, b) response of EXPORTS to a one s.d. shock in GDP

A one s.d. (10.34%) shock from EXPORTS causes a positive response in GDP over the next three quarters. However, 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 highest drop in GDP was found for quarter 5 and reached the value of –0.075%. On the other hand, a one s.d. (2.18%) shock from GDP causes a positive response in EXPORTS over the next seven quarters. The highest positive response was reported for the third period and reached the value of 2.55%. However, in the eighth quarter a slightly negative (–0.11%) response was reported.

Figure 2 illustrates all the responses obtained from the analysis of the reduced sample. A one s.d. (9.47%) shock in EXPORTS causes a positive response in GDP for the first two quarters with the highest positive value reported for the second quarter (0.11%). Negative responses were reported in quarters 3, 4 and 5 with the lowest value occurring in the fourth quarter and being equal to –0.13%. On the other hand, a one s.d. (2.09%) shock in GDP causes a positive response in EXPORTS in all eight quarters. The highest positive response was reported for the third period and reached the value of 1.82%. A one s.d. (9.47%) shock in EXPORTS causes a positive response in IMPORTS for the first two quarters with the highest positive value reported for first quarter (5.22%). Negative responses were reported in quarters 3, 4 and 5 with the lowest value occurring in the fifth quarter and being equal to –1.09%. Positive responses were once again reported in quarters 6 to 8. On the contrary, a one s.d. (10.90%) shock in IMPORTS causes a negative response in EXPORTS in the first three quarters with the lowest value reported for the second quarter (–3.01%). Positive responses were

reported in quarters 4–8 with the highest value occurring in the sixth quarter and being equal to 1.06%.

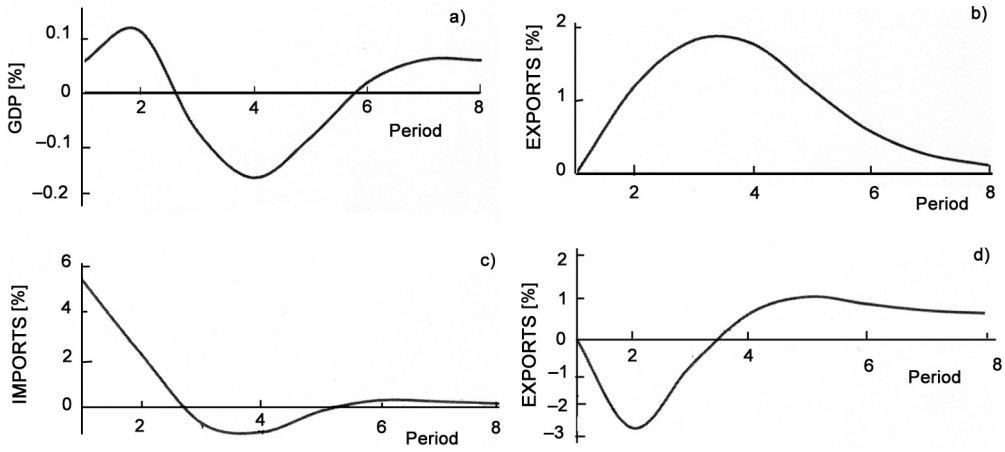

Fig. 2. Impulse responses of response variables to a one s.d. shock in the time series of causal factors (pre-crisis sample) a) response of GDP to a one s.d. shock in EXPORTS, b) response of EXPORTS to a one s.d. shock in GDP, c) response of IMPORTS to a one s.d. shock in EXPORTS, d) response of EXPORTS to a one s.d. shock in IMPORTS

One may be interested in identifying the sources of the differences in the shapes of IR functions calculated based on the full sample and pre-crisis data. Besides the technical aspects of such estimation, we should not forget that the values of one s.d. shocks are different for these two cases. Another important issue is the fact that after September 2008, the structure of the causal links between the variables of interest changed, which surely must have influenced the impulse responses (especially in terms of the relation between IMPORTS and EXPORTS).

In addition to linear causality tests and impulse response analysis, nonlinear Granger causality tests were conducted as well. The results obtained on the basis of the full sample and the unfiltered time series of residuals are presented in Table 5. Similarly as in the previous table, the numbers in square brackets refer to the analysis performed on the pre-crisis data. Shading is used to highlight test results supporting the rejection of the null hypothesis at the 10% significance level:

As we can see, in all but two cases the established causal links were found based only on the pre-crisis data. The results of these nonlinear tests provide a basis to claim that before September 2008 nonlinear causality ran from the real growth rate of GDP to the real growth rate of exports. Additionally taking into account the results of linear causality analysis, these results give strong evidence that in the pre-crisis period there was causality running from GDP to EXPORTS. The nonlinear causality analysis also leads to the conclusion that before the crisis, GDP was a causal factor for IMPORTS.

Before September 2008, the strongest nonlinear link was reported for causality running from IMPORTS to EXPORTS. This link was also found to be significant when the full sample was considered. To summarize, the results of the nonlinear causality analysis conducted on the unfiltered data support the outcomes of the linear causality tests only to a limited extent. This finding only provides weak evidence in favour of conjecture 7.

Table 5. Results of tests for nonlinear Granger causality between the study variables (unfiltered data)

Null hypothesis	*p*-value			
	$\varepsilon = 0.5$	$\varepsilon = 1$	$\varepsilon = 1.5$	
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]	$l = 4$
EXPORTS do 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 do 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]	$l = 4$
EXPORTS do 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 do 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]	$l = 4$

Since we have found significant evidence for the presence of GARCH structures in the time series of residuals resulting from both the VAR models considered, we decided to re-run the nonlinear causality analysis based on GARCH(1,1) filtered data (in both cases a GARCH(1,1) model was found to be the most appropriate for modelling the conditional heteroscedasticity in the time series of residuals). The results of the causality tests conducted on these filtered data provided no evidence of the existence of nonlinear Granger causality in any direction regardless of the sample used (at the 10% significance level). Therefore, after GARCH(1,1) filtration of the time series of residuals, it turned out that conjecture 7 should clearly be rejected. Additionally,

this phenomenon indicates that nonlinear causality analysis is indeed sensitive to the presence of heteroscedastic structures in the data examined, which is in line with results presented in previous papers (e.g. [19]). However, one cannot forget that possible misspecification of the model for heteroscedasticity could be a reason for the different conclusions of tests conducted on the basis of unfiltered and filtered data. In conclusion, the results of the nonlinear analysis of Granger causality conducted on both unfiltered and filtered data provide 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 from Q1 1996 to Q3 2008 (pre-crisis data), as well as for the period from Q1 1996 to Q3 2009 (full sample). We carried out linear Granger causality tests with critical values being estimated using a bootstrap procedure based on leveraged residuals. In order to provide satisfactory accuracy in estimating these critical values, the number of bootstrap replications was chosen according to a recently developed procedure. Finally, the application of impulse response functions, as well as tests for nonlinear Granger causality provided a basis for investigating the dynamic links between the variables of interest in the most comprehensive way.

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

The results from impulse response analysis also provided some interesting conclusions. Firstly, irrespectively the sample chosen, one can observe a positive response of EXPORTS to a one s.d. shocks in GDP. Furthermore, in both cases, responses of

GDP to a one s.d. shock in EXPORTS were relatively similar. However, we cannot forget that for the pre-crisis sample the impulse responses calculated for GDP and EXPORTS were significantly influenced by the dynamic interactions between EXPORTS and IMPORTS.

Nonlinear causality analysis provided evidence for the existence of dynamic links mostly on the basis of the pre-crisis sample. However, the filtration of autoregressive heteroscedasticity led to these links becoming not statistically significant. To summarize, the nonlinear causalities running from GDP to EXPORTS, from GDP to IMPORTS and from IMPORTS to EXPORTS are rather weak.

We believe that this research will be helpful in analyzing the nature of dynamic relationships between economic growth and international trade in the case of transitional economies. The application of time series analysis to two data sets, one including and one excluding the period of the global economic crisis, provided an opportunity to examine the influence of worldwide economic shocks on the structure of the dynamic links between GDP and international trade in the Polish economy.

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