

Financial Development and Economic Growth in Poland in Transition: Causality Analysis^{*}

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Abstract

This study examines the causal relationship between economic growth and financial development in Poland on the basis of quarterly data for the period 2000 Q1–2011 Q4. In order to examine the impact of the 2008 financial crisis on the structure of financial sector-GDP links in Poland we performed the empirical research for the full period and the pre-crisis subsample (covering the period 2000 Q1–2008 Q3). The empirical research was performed in two variants: bank- and stock market-oriented approaches. The results obtained for the pre-crisis subsample suggest causality running from stock market development to economic growth and from economic growth to banking sector development. This implies that the direction of the causality strongly depends on which particular area of the financial sector is considered. When the crisis data was also taken into consideration the test results suggested that during the 2008 financial crisis the banking sector had a much more significant impact on economic growth than before the crisis. On the other hand, the positive causal impact of the performance of the WSE on economic growth in Poland was significant before 2008, while during the crisis significant negative shocks occurred. The empirical results for both periods examined were found to be robust to the type of control variable applied and the specification of the testing procedure, which clearly validates the major conclusions of this paper.

1. Introduction

Economists have always been fascinated by the interdependence between financial development and economic growth. In one of the earliest contributions on this subject Bagehot (1873) argued that the financial system played a critical role in starting industrialization in England by supporting the mobilization of capital for growth.

In general, two schools of economic thought justify the importance of financial development for economic growth and their causal relationship. However, these schools have starkly contrasting points of view.

The most prominent representative of the first school is Joseph Schumpeter. Schumpeter (1934) claimed that economic growth is a result of new combinations of resources or innovations in existing resources. He stressed that well-functioning banks are able to identify innovative entrepreneurs, i.e., support the creation of new goods, new markets, and new production processes. These entrepreneurs receive funds from banks, which finance the most promising investment projects. Therefore, such

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credit becomes critical to growth, implying causality running from financial development to economic growth.

Most representative of the second school was Joan Robinson. She thought that economic growth creates demand for more financial services and thereby leads to financial development (Robinson, 1952).

Previous empirical studies have been based either on time series data or on panel data. Time series analyses are usually related to an individual country, thus many country-specific issues are likely to be highlighted and deeply analyzed. Panel-based contributions are believed to provide quite robust empirical findings due to the considerable number of degrees of freedom involved. However, they are often subject to criticism, because heterogeneity bias is in general difficult to control for.

The main objective of our study is to investigate the causal relationship between financial development and economic growth by using time series data for Poland for the period 2000–2011. In order to examine the impact of the financial crisis of 2008 on the causal links between the financial sector and GDP in Poland we performed our research on the basis of the pre-crisis subsample (2000 Q1–2008 Q3) and the full sample (2000 Q1–2011 Q4).¹

The plan of the paper is as follows. Theoretical and empirical contributions concerning the relationship between financial development and economic growth are reviewed in the next section. The main hypotheses are presented in the third section. The data description is given in section 4. The methodology applied is outlined in section 5. The empirical results and a discussion of them are provided in section 6. Brief conclusions and some policy recommendations are given in the last part of the paper.

2. Literature Overview

Contrary to the Schumpeterian tradition of economic thought, Lucas (1988) claimed that finance is not a major determinant of economic growth and its role in economic growth is overstated. In the literature there are also other views on this topic. According to the review by Kemal et al. (2007) previous empirical studies may be assigned to one of four schools of economic thought:

- *Finance supports economic growth*: This point of view is expressed in contributions by Bagehot (1873), Schumpeter (1934), and Hicks (1969), among others.
- *Finance harms growth*: In an extensive review by Beck and Levine (2004) it is stressed that banks and stock markets have done more harm than good to the morality, transparency, and wealth of societies. In consequence, bank activity can even hamper economic growth.
- *Financial development follows economic growth*: According to Robinson (1952) economic growth creates a demand for financial services. The financial sector adjusts to this demand.
- *Financial development does not matter*: According to Lucas (1988) the role of the financial sector in economic growth is neutral.

¹ We analyze the full sample and the pre-crisis one, as the crisis sample (covering the period 2008 Q4–2011 Q4) is too small to be separately evaluated in the causality analysis.

Demetriades and Hussein (1996) found support for causation from economic growth to financial development. On the other hand, empirical results on the relationship between financial development and economic growth in Shan et al. (2001) and Sinha and Macri (2001) were not consistent. Evans et al. (2002) checked the contribution of financial development to economic growth in a panel dataset of 82 countries. The results reported in their paper supported the hypothesis that for economic growth financial development is no less important than human capital. However, Shan and Morris (2002) observed for most of 19 OECD countries that there is no causal relationship in either direction, in the Granger sense, between financial development and economic growth.

Deidda and Fattouh (2002) investigated nonlinear interdependencies and found that in low-income countries there is no significant relationship between financial development and economic growth. However in high-income countries this dependence is positive and strongly significant.

Further evidence on the finance-led-growth hypothesis was documented by Fase and Abma (2003) for several Asian economies. In addition, Lopez-de-Silanes et al. (2004) stressed that the causality direction between financial development and economic growth depends on the institutional environment.

Thangavelu and Ang (2004) provided empirical evidence on the causal impact of the financial market on the economic growth of the Australian economy. Granger causality tests based on error correction models conducted for Greece by Dritsakis and Adamopoulos (2004) and Dritsaki and Dritsaki-Bargiota (2006) showed that there is a causal relationship between financial development and economic growth. Shan (2005) used variance decomposition and impulse response functions for 10 OECD countries and China and found weak support for the hypothesis that financial development “leads” economic growth. In a study of the APEC countries Tang (2006) stressed that only stock market development shows a strong growth-enhancing effect, especially among the developed member countries. A study by Shan and Jianhong (2006) concerning China supported the view that financial development and economic growth exhibit two-way causality and provided evidence against the finance-led-growth hypothesis. The results by Al-Awad and Harb (2005) also indicated that in the long run financial development and economic growth may be related to some extent. In the short run, panel causality tests point to real economic growth as the force that drives changes in financial development, while causality tests for individual countries fail to give clear evidence of the direction of causation. Zang and Kim (2007) with a dataset in the form of a panel of seven time periods and 74 countries covering the period 1961–1995 concluded that the importance of financial development in economic growth might be very badly over-stressed and that Robinson and Lucas may be right. However, in a paper by Abu-Bader and Abu-Qarn (2008) empirical results strongly supported the hypothesis that finance leads to growth in five out of the six countries that were analyzed.

The motivation to analyze the case of the Polish economy is twofold. First, Poland is the largest economy in the CEE region and, to the best of our knowledge, there are no papers dealing with recent data on economic growth and the financial development of this country. Because of a lack of reliable datasets of sufficient size we used recent quarterly data and modern econometric techniques (described in

Table 1 Units, Abbreviations, and a Brief Description of the Variables Examined

Description of variable	Unit	Abbreviation for seasonally adjusted and logarithmically transformed variable
Real quarterly per capita gross domestic product in Poland (at prices of 2000)	PLN	<i>GDP</i>
Ratio of bank claims on private sector to nominal GDP	–	<i>BANK_c</i>
Ratio of bank deposits liability to nominal GDP	–	<i>BANK_d</i>
Ratio of Warsaw Stock Exchange (WSE) turnover to nominal GDP	–	<i>TURNOVER</i>
Reserve bank discount rate	%	<i>R</i>
Interbank offer rate	%	<i>I</i>

section 5). Moreover, since previous empirical studies have not reached a consensus on financial sector-GDP growth links, it seems impossible to simply extrapolate these results to obtain reliable conclusions for the Polish economy. It seems interesting to examine whether the stable economic growth in Poland in the last decade was a cause or a consequence of the rapid development of various components of the financial sector that also took place in Poland in the last decade.

3. Main Research Hypotheses

This section contains the formulation of the main research hypotheses concerning the link between economic growth and financial development in the case of the Polish economy. Hypotheses 1–3 correspond to the pre-crisis period, while Hypothesis 4 refers to the impact of the financial crisis of 2008 on the structure of financial sector-GDP links in Poland. In this paper we use abbreviations for all the variables. *Table 1* contains some initial information.²

At the very beginning of our computations we will check the stationarity of the time series listed in *Table 1*. Stationarity is the main assumption of most statistical causality tests. Preliminary information from the mass media and visual inspection of the dataset encouraged us to formulate the following:

Hypothesis 1: *All the time series under study are nonstationary.*

The lack of stationarity suggests using the concept of cointegration or simply differencing the respective time series. The tests applied allow us to establish the order of nonstationarity, i.e., to determine the order of integration of the individual time series.

From the economic literature it can be seen that the most common questions concerning interdependencies between financial development and economic growth are the following:

- Does the banking sector cause economic growth or does the causality run in the opposite direction?
- Do stock-market-related variables cause economic growth or does economic growth cause stock market development?

² Details on the dataset applied are presented in Section 4.

- Is there a bilateral causal relationship (feedback) between banking sector development and economic growth?
- Is there a bilateral causal relationship (feedback) between stock-market-related variables and economic growth?

These questions concern both short- and long-run linear links as well as nonlinear relationships.

According to the Schumpeterian tradition banks stimulate economic growth. There are a number of empirical contributions whose results support this point of view. However, in the more recent literature the opposite direction of causality, i.e., the impact of economic growth on the development of the banking system, is also reported. This kind of economic thought is based on Robinson's point of view. In the light of the empirical results in the contributions reviewed, it seems that this point of view may be true for highly developed countries. For countries like China and Greece, feedback between economic growth and the development of the banking system was reported. Causality running from banking development to economic growth means that a better developed banking system finances productive projects in a more successful way. An important result that clarifies the theoretical findings is that the causality is more marked in countries with a more developed institutional environment (expressed by the rule of law and regulation). Feedback means that the causality also runs from economic growth to banking, which indicates that a more developed economy has a more developed banking system. This implies, in particular, that credit for the private sector increases and the interest spread diminishes as the economy develops. Both the banking system and economic growth experienced considerable expansion in Poland in the last decade. Therefore, it is not easy to say in advance that "finance leads growth" or that "finance follows growth". Thus we formulate the following hypothesis:

Hypothesis 2: There was feedback between the development of the banking system and economic growth in Poland.

Most theoretical and empirical contributions report a significant causal relationship running from stock market behavior to economic growth. This observation is likely to be true also in the case of the Warsaw Stock Exchange (WSE). Since July 2007 the WSE has experienced drops, although the main macroeconomic indicators did not decline. Market participants were assured that the drops in share prices on the Warsaw stock market were of a temporary nature and did not detract from the good state of the Polish economy. However, in the following year the condition of many Polish companies worsened dramatically.

Large institutional investors (such as banks and investment funds) which operate on the stock market have good information about the financial state of companies and consumer demand. Insiders also play an important role. Confidential information about an upcoming unprofitable event with respect to a company or a whole sector or just fear of crisis encourages the sale of equities. In consequence, the prices of shares decline and a bear phase of the stock market begins. Companies have no incentives to issue shares. Disposable capital is reduced. In consequence investment and employment decrease. Therefore, output (GDP) and demand (consumption) also fall.

A different scenario takes place if the economic situation improves. Share issues start to happen because capital is demanded. This makes the development of companies, a rise in employment, and a rise in GDP possible.

According to the empirical contributions in the literature the more developed the country the stronger the dependence between the stock market and economic growth. Current movements on the stock exchange determine the future economic situation.

In order to check the interdependence between turnover changes on the WSE and economic growth we formulated the following:

Hypothesis 3: Turnover on the WSE Granger-caused economic growth in Poland in both the short and long run.

As already mentioned, Hypotheses 1–3 correspond to the pre-crisis (2000 Q1–2008 Q3) period. The last hypothesis refers to the impact of the financial crisis of 2008 on the structure of financial sector-GDP links in Poland. Since Poland was one of the few countries which managed to avoid serious economic troubles after the bankruptcy of Lehman Brothers, one could formulate the following:

Hypothesis 4: Hypotheses 1–3 also held true for the full sample. In other words, the structure of the causal links between the financial sector and GDP in Poland was robust to the impact of the financial crisis of 2008.

The hypotheses listed above will be checked by some recent causality tests. The details of the testing procedures will be shown in the following sections. The test outcomes depend to some extent on the testing methods applied. Therefore, testing for the robustness of the empirical results is one of our main tasks. Before describing the methodology, in the next section we will give a description of the time series included in our sample.

4. The Dataset and Its Properties

The major problem in most empirical studies is the selection of indicators reflecting the level of financial development. The diversity of services involved makes the construction of financial development indicators extremely difficult. Agents and institutions involved in financial intermediation activities are also highly diversified, which causes additional difficulties. Taking into consideration previous empirical studies (see, for example, Thangavelu and Ang, 2004; Shan and Morris, 2002) we performed an investigation of the causal dependencies between economic growth and financial development in Poland in the last decade using three indicators, namely, the ratio of bank claims in the private sector to nominal GDP, the ratio of bank deposit liability to nominal GDP, and the ratio of Warsaw Stock Exchange turnover to nominal GDP. Therefore, our paper combines bank- and market-based approaches to modeling the dynamic dependencies between GDP and the financial sector.

Since the development of the financial sector and economic growth can be driven by a common variable (Rajan and Zingales, 1998; Luintel and Khan, 1999; Dritsakis and Adamopoulos, 2004; Thangavelu and Ang, 2004), we applied the interest rate as this common factor. Moreover, to examine the stability of the links we used two types of interest rate—the reserve bank discount rate and the interbank offer rate.

Further parts of this section contain statistical details on the data. Subsection 4.1 provides some initial description of the variables under study, in subsection 4.2 the stationarity properties of all the time series are examined. The identification of the orders of integration of the time series under study is a crucial stage of causality analysis. If the precondition of stationarity is not fulfilled a standard linear Granger causality test is likely to produce spurious results.³

4.1 Description of the Dataset

The dataset applied in this paper includes quarterly data on real per capita GDP (at constant prices of 2000), the ratio of bank claims in the private sector to nominal GDP, the ratio of domestic bank deposit liabilities to nominal GDP, and the ratio of WSE turnover to nominal GDP in the period 2000 Q1–2011 Q4.⁴ Besides *GDP* (a measure of economic growth) and three measures of financial development for bank-based ($BANK_c$, $BANK_d$) and market-based systems (*TURNOVER*), two interest rates (R , I) were applied to avoid the problem of omission of important variables and additionally to test the robustness of the empirical findings. Data on real GDP per capita, $BANK_c$, and $BANK_d$ were obtained from the Central Statistical Office in Poland, and data on *TURNOVER* were gained from WSE Monthly Bulletins. Finally data on R and I were gained from the National Bank of Poland.⁵

Since visual inspection of the unadjusted data provides a basis for claiming that all the variables (except for the two interest rates) are most likely characterized by significant seasonality, and this feature often leads to spurious results in causality analysis, the X-12 ARIMA procedure (which is currently used by the U.S. Census Bureau for seasonal adjustment) in Gretl was applied to adjust the variables. Finally, each seasonally adjusted variable was transformed into logarithmic form, since this Box-Cox transformation can stabilize the variance and therefore improve the statistical properties of the data, which is especially important for parametric tests.

The application of quarterly data is important for two main reasons. First, since the necessary data covered only the last few years, a causality analysis based on annual data could not be carried out due to a lack of degrees of freedom. Moreover, as shown in some papers (Granger et al., 2000) the application of lower frequency data (e.g. annual) may seriously distort the results of Granger causality analysis because some important interactions may stay hidden.

A comprehensive preliminary analysis requires analysis of the charts for all the variables under study. This may also provide some initial idea of the impact of the 2008 financial crisis on the dataset examined. *Figure 1* contains suitable plots of seasonally adjusted and logarithmically transformed variables (as already mentioned, seasonal adjustment was not required for R and I).

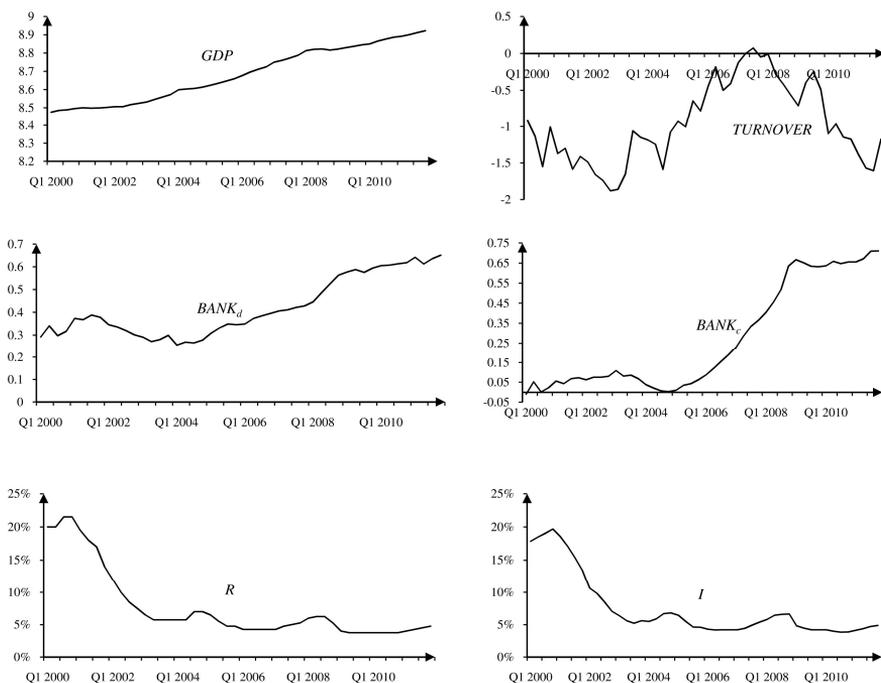
The Polish economy experienced relatively stable growth in the last decade. This is reflected in the graph of *GDP* (with its upward tendency). One should bear in

³ Previous empirical (Granger and Newbold, 1974) and theoretical (Phillips, 1986) deliberations investigated this phenomenon in detail.

⁴ The *dataset* is provided by the authors in a separate file, which is downloadable from the *Journal's* webpage.

⁵ Strictly speaking, R in quarter t is the rediscount rate measured at the end of the period and I is the average of the daily values of the 3-month Warsaw Interbank Offer Rate (WIBOR 3M) for quarter t .

Figure 1 Plots of Time Series Examined



mind that the Polish economy was one of the few that managed to avoid undesirable impacts of the 2008 crisis. However, before 2002 (the 2001 crisis) and after September 2008 one can observe a slight slowdown in the rate of growth of the Polish economy.

Similarly, *Figure 1* provides strong evidence for claiming that the financial sector in Poland also experienced stable development in the recent decade. This is shown by the bank- ($BANK_c$, $BANK_d$) and market-related ($TURNOVER$) variables. In contrast to economic growth, the financial sector in Poland significantly reacted to the economic crises of 2001 and 2008. *Figure 1* provides details about significant drops in $TURNOVER$ before 2002 and especially after September 2008. The negative impact of both economic crises is also demonstrated in the plots of the ratios of bank claims in the private sector and bank deposit liabilities to nominal GDP.

The plots of the last two time series examined describe some key aspects of the monetary policy of the National Bank of Poland in the last decade. Both rates dropped from a level of about 20% in 2000 to around 5% in 2004. In general, starting from 2004 both rates were oscillating around 4.5%, reaching values of 4.75% (R) and 4.86% (I) in the last quarter of 2011. It seems very likely that such large fluctuations in both types of interest rate should have an effect (individual and mutual) on economic growth and on the performance of the financial sector in Poland in the period 2000–2011. Thus, we included these variables as additional (common) factors.

In the next subsection the preliminary analysis of the time series included in our dataset will be extended by stationarity testing.

4.2 Stationarity Properties of the Dataset

Augmented Dickey-Fuller, Kwiatkowski-Phillips-Schmidt-Shin, and Phillips-Perron tests were applied to analyze the stationarity properties of the time series under study. For each test we examined two types of deterministic term (the first one restricted to a constant and the other one containing a constant and a linear trend). For the pre-crisis period all the time series examined were found to be nonstationary at the 5% significance level regardless of the type of deterministic term, which clearly supports Hypothesis 1.⁶ Some further calculations (conducted for first differences) confirmed that all the variables under study are integrated of order one.⁷ Finally, it should be noted that all the variables under study were found to be I(1) also for the full sample (covering the period 2000 Q1–2011 Q4).

5. Methodology

In this paper several econometric tools were applied to test for both linear and nonlinear Granger causality between GDP and financial development in the Polish economy. The main part of our research was conducted in three variants, each of which involved *GDP* and one variable related to the financial sector (*BANK_c*, *BANK_d*, and *TURNOVER*). As already mentioned, for the sake of correctness of the computations (allowing for control variables) and robustness of the empirical results, two types of interest rate were also applied. Therefore, our analysis was based on six modeling schemes. Each model was evaluated on the basis of pre-crisis data and the full sample.

5.1 Linear Short- and Long-Run Granger Causality Tests

In this study we applied three econometric methods suitable for testing for linear short- and long-run Granger causality for nonstationary variables integrated in the same order, namely, analysis of the unrestricted vector error correction model (VECM), sequential elimination of insignificant variables in the VECM, and the Toda-Yamamoto procedure. Moreover, besides the asymptotic variant, each procedure was additionally performed in a bootstrap framework. The application of such a variety of methods is believed to ensure verification of the robustness and validation of the empirical findings.

Since for both periods all the variables under study were found to be I(1), the idea of cointegration and analysis of the unrestricted VEC model allowed for examination of both short- and long-run causal dependencies. The finding that the variables are cointegrated implies the existence of long-run Granger causality in at least one direction (Granger, 1988). The simplest way to establish the direction of this type of causality is based on checking (using a *t*-test) the statistical significance of the error correction terms in the VECM. The test of joint significance (*F*-test) of lagged differences allows for short-run causality investigations.

The application of an unrestricted VEC model has one serious drawback, however. In order to avoid the consequences of the autocorrelation of residuals it is

⁶ For *TURNOVER* time series trend-stationarity was confirmed by the KPSS test, although the ADF and PP tests clearly rejected this possibility.

⁷ The results of all computations that are not presented directly in the text in detailed form (usually to save space) are available from the authors upon request.

often necessary to use a relatively large number of lags, which may simultaneously reduce the number of degrees of freedom. This in turn may have an undesirable impact on test performance, especially for small samples. Another problem related to testing for linear causality using a traditional Granger test is multicollinearity, which is especially significant for dimensions higher than two. For these reasons, sequential elimination of insignificant variables was additionally applied for each VECM equation separately. This procedure sequentially omits the variable with the highest p -value (t -test) until all remaining variables have a p -value no greater than a fixed value (in this paper it was 0.10).⁸

An alternative method for testing for linear Granger causality was formulated by Toda and Yamamoto (1995). The prevalence of this method is due to the fact that it is relatively simple to perform and free of complicated pretesting procedures, which may bias the test results, especially when dealing with nonstationary variables (Gurgul and Lach, 2011). However, the key advantage is the fact that this procedure is applicable even if the variables under study are characterized by different orders of integration.⁹ On the other hand, the Toda-Yamamoto (TY) approach does not allow us to distinguish between short- and long-run causal effects.¹⁰

All the aforementioned parametric methods have a few serious drawbacks. First of all, the application of asymptotic theory requires specific modeling assumptions to hold true. Otherwise, spurious results may occur. Second, for extremely small samples the distribution of the test statistic may be significantly different from an asymptotic pattern even if all the modeling assumptions hold true. One possible way of overcoming these difficulties is to apply the bootstrap method. By and large, this procedure is used for estimating the distribution of a test statistic by resampling data. Since the estimated distribution depends only on the available dataset, bootstrapping does not require such strong assumptions as parametric methods. However, in some specific cases this concept is also likely to fail, so it should not be treated as a perfect tool for solving all possible model specification problems (Horowitz, 1995).

The bootstrap test applied in this paper was based on resampling leveraged residuals, because such an approach can minimize the undesirable influence of heteroskedasticity. In recent years the problem of establishing the number of bootstrap replications has attracted considerable attention (Horowitz, 1995). The procedure for establishing the number of bootstrap replications recently developed by Andrews and Buchinsky (2000) was applied in this paper. In all cases our goal was to choose the number of replications which ensures that the relative error of establishing the 10%-critical value does not exceed 0.05 with a probability equal to 0.95.¹¹ All the aforementioned procedures were implemented using Gretl.

⁸ More technical details of this approach can be found in Gurgul and Lach (2010).

⁹ In such cases a standard linear causality analysis cannot be performed by the direct application of a basic VAR or VEC model. On the other hand, differencing or calculating the growth rates of some variables allows the use of the traditional approach, but it can also cause a loss of some information and lead to problems with interpretation of the results.

¹⁰ The long-run dependencies between GDP and the financial sector are especially important, as short-run causal links may be related to business cycle or multiplier effects and die out without having lasting effects.

¹¹ A detailed description of the resampling procedure applied in this paper can be found in Hacker and Hatemi (2006).

Table 2 Specification of Models Applied in Empirical Study

Model structure	Variables used	Description
1	$GDP, BANK_c, R$	
2	$GDP, BANK_c, I$	Bank-based approach:
3	$GDP, BANK_d, R$	focusing on interrelations between
4	$GDP, BANK_d, I$	banking sector and economic growth.
5	$GDP, TURNOVER, R$	Market-based approach:
6	$GDP, TURNOVER, I$	focusing on interrelations between
		stock market and economic growth.

5.2. Nonlinear Granger Causality Test

The motivation to use nonlinear methods in testing for Granger causality is twofold. First, the traditional linear Granger causality test was found to have very low power in detecting certain kinds of nonlinear causal interrelations.¹² Second, since linear tests are mainly based on checking the statistical significance of suitable parameters only in a mean equation, testing for causality in any higher-order structure (e.g. variance) is impossible (Diks and DeGoede, 2001).

The nonlinear causality testing procedure proposed by Diks and Panchenko (2006) was used in this paper. We set up a common lag parameter (denoted as l_{DP}) at a level of 1 and 2, while the bandwidth (denoted as b_{DP}) was set at an order of 0.5, 1, and 1.5.¹³ A nonlinear causality is significant if it was found for at least one combination of b_{DP} and l_{DP} . A detailed description of the role of these technical parameters and the form of the test statistic can be found in Diks and Panchenko (2006).

6. Empirical Results

This section contains the results of the short- and long-run linear Granger causality analysis as well as the outcomes of the nonlinear causality tests. The main goal of our empirical study was to examine the research hypotheses presented in section 3. The outcomes presented in subsections 6.1–6.3 correspond to the pre-crisis period, while subsection 6.4 also discusses the results obtained for the full sample. As already mentioned, for both periods examined, the research was performed on the basis of six schemes. *Table 2* contains some initial details.

The empirical results presented in the following subsections are related in most cases only to the examination of the causal links between economic growth and financial development. The results of testing for causality between interest rates and economic growth, as well as interest rates and financial development, are not the main focus of this study and hence they are not presented explicitly in the text. However, some short remarks about the analysis of these links (less important for the subject of the paper) in both periods under study are also made.

¹² See, for example, Brock (1991).

¹³ These values have been commonly used in previous papers (see, for example, Diks and Panchenko, 2006; Gurgul and Lach, 2010). Moreover, we applied the discussed nonlinear procedure using all the practical suggestions presented in Gurgul and Lach (2010).

Table 3 Analysis of Causal Links for Model Structures 1 and 2 (VEC-Based Approach) Based on Pre-Crisis Data

Model structure	Null hypothesis	Short run		Long run	
		<i>p</i> -value ^a		<i>p</i> -value of error correction component ^a	
		Unrestricted	Sequential	Unrestricted	Sequential
1	$BANK_c \nrightarrow GDP$	0.92 [0.83]	NCL [NCL]	0.59 [0.34]	NCL [NCL]
	$GDP \nrightarrow BANK_c$	0.32 [0.23]	NCL [NCL]	0.00 [0.01]	0.00 [0.00]
2	$BANK_c \nrightarrow GDP$	0.89 [0.76]	NCL [NCL]	0.81 [0.68]	NCL [NCL]
	$GDP \nrightarrow BANK_c$	0.49 [0.51]	NCL [NCL]	0.01 [0.00]	0.00 [0.00]

Note: ^a Number of bootstrap replications established by the Andrews and Buchinsky (2000) method varied between 2889 and 3739.

6.1 Results Obtained for Bank-Related Models Based on Pre-Crisis Data

The examination of causal dependencies between economic growth and financial development was first performed for the bank-related models. Since all the variables examined in this part of the research (GDP , $BANK_c$, $BANK_d$, R , I) were found to be I(1), a cointegration analysis was first performed.

6.1.1 Bank Claims and Economic Growth

Before conducting cointegration tests the type of deterministic trend was first specified using the five possibilities listed in Johansen (1995). The results presented in subsection 4.2 (no trend-stationarity) provided a basis for assuming Johansen's third case, that is, the presence of a constant in both the cointegrating equation and the test VAR. Next, we set the maximum lag length (for levels) at six and then we established the appropriate number of lags using the information criteria (AIC, BIC, HQ).

The results of both variants of Johansen's test provided solid evidence for claiming that GDP , each bank-related variable, and the interest rate are indeed cointegrated. All the tests supported the hypothesis that the dimension of the cointegration space is equal to one at the 5% significance level.¹⁴ After performing an analysis of the cointegration properties, we estimated suitable VEC models assuming two lags (for levels) and one cointegrating vector in each case. *Table 3* contains the *p*-values obtained when testing for linear short- and long-run Granger causality using an unrestricted VEC model and the sequential elimination of insignificant variables. Testing for causality in each direction was based on asymptotic- and bootstrap-based critical values (bootstrap *p*-values are presented in square brackets).¹⁵

An analysis of the results presented in *Table 3* leads to the conclusion that in the short run no causality was detected. This result was found to be robust when exposed to VEC-based analysis as well as the type of interest rate used. Similarly, the long-run impact of GDP on $BANK_c$ was also found to be robust to changes of

¹⁴ In all testing variants the hypothesis that the smallest eigenvalue is equal to 0 was clearly accepted, which additionally validated the results of the previously performed unit root tests (Lütkepohl, 1993).

¹⁵ Throughout this paper the notation " $x \nrightarrow y$ " is equivalent to " x does not Granger cause y ". Moreover, the symbol "NCL" is short for "no coefficients left". Finally, bold face always indicates finding a causal link in a particular direction at the 10% significance level.

Table 4 Analysis of Causal Links for Model Structures 1 and 2 (TY Approach) Based on Pre-Crisis Data

Model structure	Parameters for TY procedure ^b	Null hypothesis	p-value	
			Asymptotic	Bootstrap ^a
1	$p_1 = 2, p_2 = 1$	$BANK_c \neg \rightarrow GDP$	0.57	0.65 (N = 3139)
		$GDP \neg \rightarrow BANK_c$	0.36	0.42 (N = 3099)
2	$p_1 = 2, p_2 = 1$	$BANK_c \neg \rightarrow GDP$	0.44	0.51 (N = 3479)
		$GDP \neg \rightarrow BANK_c$	0.62	0.54 (N = 2759)

Notes: ^a Parameter *N* denotes the number of bootstrap replications established according to the Andrews and Buchinsky (2000) procedure.

^b Parameter p_1 denotes order of the VAR model while parameter p_2 stand for the highest order of integration of all examined variables (Toda and Yamamoto, 1995).

testing procedure and the choice of control variable. On the other hand, evidence of long-run causality from $BANK_c$ to GDP was supported neither by the results of an analysis of the unrestricted VEC models nor by any sequential variant.

For the sake of comprehensiveness the Toda-Yamamoto approach for testing for causal effects between bank claims and economic growth was additionally applied. The outcomes of this procedure are presented in *Table 4*.

In general, the results presented in *Table 4* are in line with the outcomes contained in *Table 3*. Short-run causality was not reported in any direction regardless of the type of critical values used.

In the last step of the causality analysis we performed nonlinear tests for three sets of residuals resulting from linear models, that is, the residuals of the unrestricted VECM, the residuals resulting from the individually (sequentially) restricted equations, and the residuals resulting from the augmented VAR model applied in the Toda-Yamamoto method.¹⁶ For each combination of b_{DP} and l_{DP} three *p*-values are presented: in the upper row the *p*-value for the residuals of the unrestricted VEC model (left) and the *p*-value for the residuals of the sequentially restricted equations (right) are presented. In the lower row the *p*-value obtained after analysis of the residuals of the TY procedure is shown. *Table 5* presents the *p*-values obtained when testing for nonlinear Granger causality between $BANK_c$ and economic growth. In all the cases examined, no filtering was used, since no significant evidence of heteroskedasticity was found.¹⁷

As one can see, nonlinear causality running from GDP to the ratio of bank claims in the private sector to nominal GDP was found for the residuals resulting from the post-TY residuals of both model structures. On the other hand, nonlinear causality in the opposite direction was not reported in any research variant.

To summarize, we found strong support for claiming that GDP causes $BANK_c$ in both the long and short run. On the other hand, we found no evidence of causality running in the opposite direction. It is important to note that in general both these

¹⁶ The residuals are believed to reflect strict nonlinear dependencies, as the structure of linear connections was filtered out after an analysis of linear models (Baek and Brock, 1992).

¹⁷ As stated in Diks and Panchenko (2006) the filtration of (conditional) heteroskedasticity may simply affect the dependence structure and consequently reduce the power of the test. Moreover, without knowing the true functional form of the process, a simple heteroskedasticity filter (such as an ARCH or GARCH model) may not entirely remove the conditional heteroskedasticity in the residuals.

Table 5 Analysis of Nonlinear Causal Links for $BANK_c$ and GDP Based on Pre-Crisis Data

Model structure	Null hypothesis	p-value											
		$b_{DP}=0.5, l_{DP}=1$		$b_{DP}=1, l_{DP}=1$		$b_{DP}=1.5, l_{DP}=1$		$b_{DP}=0.5, l_{DP}=2$		$b_{DP}=1, l_{DP}=2$		$b_{DP}=1.5, l_{DP}=2$	
1	$BANK_c \nrightarrow GDP$	0.62	0.82	0.61	0.59	0.72	0.88	0.32	0.61	0.48	0.72	0.68	0.91
		0.63		0.65		0.61		0.79		0.35		0.29	
	$GDP \nrightarrow BANK_c$	0.83	0.69	0.42	0.54	0.76	0.62	0.58	0.39	0.41	0.62	0.61	0.69
		0.09		0.79		0.05		0.64		0.78		0.08	
2	$BANK_c \nrightarrow GDP$	0.58	0.79	0.69	0.62	0.71	0.59	0.61	0.58	0.32	0.69	0.31	0.72
		0.19		0.53		0.82		0.71		0.74		0.59	
	$GDP \nrightarrow BANK_c$	0.32	0.23	0.41	0.32	0.38	0.81	0.45	0.61	0.57	0.29	0.39	0.78
		0.16		0.27		0.45		0.42		0.59		0.07	

Table 6 Results of Causality Analysis for Model Structures 3 and 4 Based on Pre-Crisis Data

Model structure	Null hypothesis	VEC-based approach (unrestricted) ^{a,b}	VEC-based approach (sequential) ^{a,b}	TY-based approach ^{a,c}	Nonlinear test (after unrestricted VEC)	Nonlinear test (after sequential elimination)	Nonlinear test (after TY procedure)
3	$BANK_d \nrightarrow GDP$	x [x]	x [x]	x [x]	x	x	x
	$GDP \nrightarrow BANK_d$	✓ [✓]	✓ [✓]	x [x]	x	x	✓
4	$BANK_d \nrightarrow GDP$	x [x]	x [x]	x [x]	x	x	x
	$GDP \nrightarrow BANK_d$	✓ [✓]	✓ [✓]	x [x]	x	x	✓

Notes: ^a Number of bootstrap replications established using the Andrews and Buchinsky (2000) method varied between 2829 and 3839.

^b One lag (in levels) was found as optimal, thus short-run causality could not be examined within a VECM framework.

^c Parameters for TY procedure: $p_1 = 1, p_2 = 1$.

findings were supported by the results of different econometric methods (linear VEC-based and TY-based procedures supplemented by Diks and Panchenko's nonlinear test) and different choices of control variable. The stability of these results is especially important in terms of the robustness and validation of the empirical findings.

6.1.2 Bank Deposit Liability and Economic Growth

This subsection contains results obtained from an analysis of the causal dependencies between real per capita GDP and the ratio of bank deposit liability to nominal GDP. At the 5% significance level both variants of Johansen's test provided solid evidence for claiming that for model structures 3 and 4 the dimension of the cointegration space is equal to two. As in the previous case (subsection 6.1.1) nonstationarity of all the variables was confirmed once again. Next, we estimated a suitable VEC model assuming one lag (for levels) and two cointegrating vectors to test for causality. As in previous subsection, a TY procedure was additionally applied. Finally, a nonlinear test was applied to the residuals resulting from all the linear models. *Table 6* contains a summary of the results. Causality (non-causality) at

Table 7 Results of Causality Analysis for Model Structures 5 and 6 Based on Pre-Crisis Data

Model structure	Null hypothesis	VEC-based approach (unrestricted) ^a		VEC-based approach (sequential) ^a		TY-based approach ^{a,b}	Nonlinear test (after unrestricted VEC)	Nonlinear test (after sequential elimination)	Nonlinear test (after TY procedure)
		Short run	Long run	Short run	Long run				
5	<i>TURNOVER</i> \rightarrow \rightarrow <i>GDP</i>	*[x]	✓ [✓]	*[x]	✓ [✓]	✓ [✓]	x	x	x
	<i>GDP</i> \rightarrow \rightarrow <i>TURNOVER</i>	*[x]	*[x]	*[x]	*[x]	*[x]	✓	x	✓
	<i>TURNOVER</i> \rightarrow \rightarrow <i>GDP</i>	*[x]	✓ [✓]	*[x]	✓ [✓]	✓ [✓]	x	x	x
6	<i>GDP</i> \rightarrow \rightarrow <i>TURNOVER</i>	*[x]	*[x]	*[x]	*[x]	*[x]	✓	x	✓

Notes: ^a Bootstrap-based results are presented in square brackets. Number of bootstrap replications established using the Andrews and Buchinsky (2000) method varied between 2669 and 3479.

^b Parameters for TY procedure: $p_1 = 2$, $p_2 = 1$.

the 10% significance level is marked in *Table 6* by ✓ (✗). Symbols in square brackets refer to the results of bootstrap-based procedures.

In general, the results contained in *Table 6* are in line with those presented in the previous subsection. Swapping *BANK_c* with *BANK_d* did not change the conclusion that real per capita GDP in Poland caused bank sector development in the short and long run in the last decade. On the other hand, we found no evidence supporting causality running in the opposite direction. This way, only weak evidence supporting Hypothesis 2 was found. As in the previous subsection, all these empirical findings were supported by the results of different econometric methods and different choices of control variable, which surely validates our empirical findings.

6.2 Results Obtained for Stock Market-Related Models Based on Pre-Crisis Data

This subsection contains the results of the examination of causal dependencies between real per capita GDP in Poland and the ratio of WSE turnover to nominal GDP. In other words, the dynamic links between the financial development and economic growth of Poland in the period 2000 Q1–2008 Q3 were examined within a stock market-based framework.

As in subsection 6.1, to begin with a cointegration analysis was performed. First, we followed the previously described preliminary procedure (selection of the lag and the type of deterministic term). The testing procedure was based on two lags (in levels) and the assumption of Johansen's third case. At the 5% significance level both variants of Johansen's test provided solid evidence for claiming that for model structures 5 and 6 the dimension of the cointegration space is equal to one. After the cointegration analysis, linear and nonlinear causality tests were also conducted. To ensure ease of interpretation and to save space the results are briefly presented in *Table 7*.

As one can see, the results presented in this table lead to a different conclusion from the one drawn in subsection 6.1. Real per capita GDP was found to be positively (compare the plots of the examined variables) caused by *TURNOVER* both

in the short and long run. This phenomenon was indicated regardless of the choice of control variable and type of linear test applied, which provides clear evidence of robustness. On the other hand, causality in the opposite direction was found to be much less likely and possible only in the short-run nonlinear sense. To summarize, Hypothesis 3 was clearly supported.

6.3 Supplementary Results for Pre-Crisis Period

As already mentioned, the results of testing for causality between interest rates and economic growth, as well as interest rates and financial development, are not the main focus of this study and hence they are not presented in detail. Moreover, a number of the results obtained for the pairs *GDP* vs interest rate and financial development vs interest rate were found to depend on the type of testing procedure applied and the type of interest rate used. However, there is a group of results which was found to be stable and robust. We will briefly report these major observations.

For model structures 1–4 the interest rate was found to have a short- and long-run impact on $BANK_c$ and $BANK_d$. Evidence of causality running in the opposite direction was markedly weaker and reported only in the nonlinear test. In general, a similar long-run causal pattern was also found for real per capita GDP and the interest rate within model structures 1–4. Moreover, solid support for claiming that *GDP* caused both interest rates in the short run was also found, indicating an indirect short-run impact from *GDP* to both bank-related variables. It is worth noting that these indirect links were confirmed by testing for direct causality between *GDP* and $BANK_c$ as well as between *GDP* and $BANK_d$ (see subsection 6.1).

On the other hand, no causal links were found between the ratio of WSE turnover to nominal GDP or to either interest rate in both the short and long run. This lack of causality in any direction implies that fluctuations in WSE turnover were not affected directly by the monetary policy of the National Bank of Poland and vice versa. Moreover, it proves that in the period 2000 Q1–2008 Q3 the dynamic relations between GDP, interest rates, and financial development were not consistent for different variables related to the financial sector in Poland.¹⁸

6.4 The Impact of the 2008 Financial Crisis

In this subsection we focus on comparing between the outcomes obtained for the pre-crisis-based models (presented in subsections 6.1–6.3) and the full-sample-based ones. Using the all the available data (covering the period 2000 Q1–2011 Q4) we repeated all the steps of the empirical procedure, including unit root testing, cointegration analysis, and short- and long-run linear and nonlinear causality tests.

As already mentioned, the results of the unit root tests confirmed that all the variables were $I(1)$ also in the period 2000–2011. In the next step we re-examined the cointegration properties of all six models and came to the conclusion that at

¹⁸ The results presented in subsections 6.1 and 6.2 lead to the conclusion that stock market development was an indirect causal factor for banking sector development in Poland in the last decade. Since this causal link is of great importance for a number of social groups in Poland (investors, bankers, policy makers, savers) we additionally performed an analysis of the causal dependencies between both bank-related variables and *TURNOVER* within a two-dimensional framework. The results confirmed that *TURNOVER* causes $BANK_c$ and $BANK_d$ in both the short- and long-run. Evidence of causality in the opposite direction was markedly weaker (indicated only by the nonlinear test).

Table 8 Comparison of Results of Causality Analysis Based on Pre-Crisis and Full Sample

Pre-crisis subsample								
Null hypothesis	VEC-based approach (unrestricted) ^a		VEC-based approach (sequential) ^a		TY-based approach ^{a,b}	Nonlinear test (after unrestricted VEC)	Nonlinear test (after sequential elimination)	Non-linear test (after TY procedure)
	Short run	Long run	Short run	Long run				
$BANK_c \nrightarrow GDP$	x[x]	x[x]	x[x]	x[x]	x[x]	x	x	x
$GDP \nrightarrow BANK_c$	x[x]	✓[✓]	x[x]	✓[✓]	x[x]	x	x	✓
$BANK_d \nrightarrow GDP$	Untest-able	x[x]	Untest-able	x[x]	x[x]	x	x	x
$GDP \nrightarrow BANK_d$	Untest-able	✓[✓]	Untest-able	✓[✓]	x[x]	x	x	✓
$TURNOVER \nrightarrow GDP$	x[x]	✓[✓]	x[x]	✓[✓]	✓[✓]	x	x	x
$GDP \nrightarrow TURNOVER$	x[x]	x[x]	x[x]	x[x]	x[x]	✓	x	✓

Full sample								
Null hypothesis	VEC-based approach (unrestricted) ^a		VEC-based approach (sequential) ^a		TY-based approach ^{a,b}	Nonlinear test (after unrestricted VEC)	Nonlinear test (after sequential elimination)	Nonlinear test (after TY procedure)
	Short run	Long run	Short run	Long run				
$BANK_c \nrightarrow GDP$	x[x]	✓[✓]	x[x]	✓[✓]	x[x]	x	x	x
$GDP \nrightarrow BANK_c$	x[x]	✓[✓]	x[x]	✓[✓]	x[x]	x	x	✓
$BANK_d \nrightarrow GDP$	Untest-able	✓[✓]	Untest-able	✓[✓]	x[x]	x	x	x
$GDP \nrightarrow BANK_d$	Untest-able	✓[✓]	Untest-able	✓[✓]	x[x]	x	x	✓
$TURNOVER \nrightarrow GDP$	x[x]	x[x]	x[x]	x[x]	x[x]	x	x	x
$GDP \nrightarrow TURNOVER$	x[x]	x[x]	x[x]	x[x]	x[x]	x	x	x

Notes: ^a Bootstrap-based results are presented in square brackets. Number of bootstrap replications established using the Andrews and Buchinsky (2000) method varied between 2949 and 3879.

^b Parameters for TY procedure: $p_1 = 2$, $p_2 = 1$ (except for the pair GDP and $BANK_d$ —in this case: $p_1 = p_2 = 1$).

the 5% significance level the dimensions of the cointegration spaces were exactly the same for both periods. Finally, we reran all the causality tests for the period 2000 Q1–2011 Q4. In order to save space, and also simultaneously to highlight the main differences between the empirical results obtained for the two periods, we present a brief comparison of the outcomes of both research scenarios in *Table 8*.¹⁹

¹⁹ Since for all six models estimated on the basis of the pre-crisis and full samples the results of the causality tests between the financial sector and GDP were the same for the R and I control variables in *Table 8* we do not specify the type of control variable used. Causality (non-causality) at the 10% significance level is marked in *Table 8* by ✓ (✗).

The summary of the empirical results presented in *Table 8* leads to several important conclusions. First of all, we should mention that before the 2008 crisis there was unidirectional long-run causality from GDP to both bank-related variables, while in the full period under study (also covering the crisis period) long-run causality from $BANK_c$ and $BANK_d$ to GDP was also reported. On the other hand, the long-run causality from $TURNOVER$ to GDP was not statistically significant for the full sample. Both these findings provided evidence that Hypothesis 4 should clearly be rejected. To summarize, the data presented in *Table 8* provide a basis for claiming that during the 2008 financial crisis the banking sector had a much more significant impact on economic growth than before the crisis. On the other hand, the causal impact of the performance of the WSE on economic growth in Poland was significant mostly for the pre-crisis subsample. Finally, it is worth noting that in general the outcomes of the analysis of the indirect links between financial-sector-related variables and GDP in the period 2000 Q1–2011 Q4 (through an analysis of causal links with R and J) were in line with the results of testing for the direct causal links between $BANK_c$, $BANK_d$, $TURNOVER$, and GDP.

7. Concluding Remarks

Most contributors have stressed that economic growth does not seem, as a rule, to depend on “prior” changes in the financial system. Further deregulation of financial systems and financial institutions in developed economies should improve and extend financial services. But this liberalization of policy will not necessarily cause (in the Granger sense) a subsequent speeding up of economic growth. Moreover, some economists think that financial crises might be caused by too intensive liberalization of the financial sector, far in excess of the growth of the real sector. Other studies, however, are in line with the conviction that financial development promotes economic growth, thus supporting the old Schumpeterian hypothesis. The literature overview suggests that the link between financial development and economic growth may be country-specific and probably depends on differences in the industrial structures and cultures of societies.

In general, the results of the causality analysis performed for the pre-crisis subsample indicated the existence of a significant unidirectional short- and long-run impact of real per capita GDP on both bank-related proxies for financial development in Poland. These results were found to be robust to the econometric method applied and the type of control variable used. Causality running from economic growth to the banking sector may indicate that a more developed economy has a more developed banking system. On the other hand, we found no evidence of causality running in the opposite direction.

By contrast, causality tests performed for market-based models on the basis of the pre-crisis subsample supported the existence of significant short- and long-run causality from financial development to economic growth in Poland in the last decade. The robustness of this major finding was also confirmed. In general, causality from real per capita GDP to the ratio of WSE turnover to nominal GDP could not be confirmed by most of the tests applied, which led to serious doubts about its existence.

To summarize, the empirical results provided evidence for claiming that before the 2008 crisis the causal links between economic growth and the financial

development of the Polish economy strongly depended on the segment of the financial sector. In general, we found that development of the Warsaw Stock Exchange caused real per capita GDP growth and that economic growth caused development of the banking sector in Poland. These findings lead to the conclusion that stock market development was a causal factor for banking sector development in Poland in the last decade. This was confirmed by direct causality tests performed within a two-dimensional framework.

Research on the direction of the causality between financial development and economic growth is important because it has essential policy implications on the best economic strategy for enhancing the growth, in particular, of economies in transition. Financial development in Poland seems to stimulate the economic growth of the country to some extent. Moreover, we can conclude (on the basis of the dataset for Poland) that a better developed stock market leads to higher economic growth. This occurs because the development of stock markets can imply risk diversification and better resource allocation. Financial deregulation conducted in the period of transition improved competition and allowed greater access to financial products. Therefore, we can take it for granted that financial deregulation in Poland in transition had a positive impact on economic growth.

In order to examine the impact of the 2008 financial crisis on financial sector-GDP causal links in Poland we compared the results of the research performed for the full sample (covering the period 2000 Q1–2011 Q4) and the pre-crisis subsample (2000 Q1–2008 Q3). This comparison provided a basis for claiming that during the 2008 financial crisis the banking sector had a much more significant impact on economic growth than before the crisis. On the other hand, the causal impact of the performance of the WSE on economic growth in Poland was significant mostly for the pre-crisis subsample. The fact that the positive causality running from *TURNOVER* to *GDP* was significant only before the crisis means that during the crisis this causal impact could be significantly negative. This important conclusion arises from the fact that the positive impact (reported for the pre-crisis period) was most likely cancelled out by negative shocks (observed in the crisis period), which in consequence led to a lack of significant causalities in the full period.

We recognize, however, that our study might have inherent limitations. For example, our tests could suffer from the omission of some variables. Nevertheless, these probable drawbacks are likely to exist in most, if not all, time series analyses of this kind. The reason for this is the lack of a sufficient dataset. In our opinion, future time series analyses should examine whether banking and stock markets are related to certain components of GDP, such as investment, or to certain intensive sectors on the supply side of the economy, such as the manufacturing industry.

Finally, we believe that our study provides a basis for further quantitative time series investigations of the historical and contemporary role of banking and the stock market in the economic development of Poland and other countries in transition.

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