

# Does stock market capitalization cause GDP? A causality study for Central and Eastern European countries

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## Abstract

This paper analyzes the relationship between stock market capitalization to GDP and real GDP in 10 Central and Eastern European countries (CEECs) that joined the European Union in 2004 and 2007, with the objective of determining whether the financial markets played a role as drivers of economic development in these countries or vice versa. The methodology, using a cointegrated Vector Autoregressive (VAR) model, is based on the application of three different measures of causality: Granger causality test, Toda-Yamamoto approach and Frequency Domain approach. The results obtained suggest evidence of a causal relationship in both directions between the variables in a significant number of countries, and especially in those where the variables show to be clearly cointegrated (Bulgaria, Hungary, Latvia, Romania, Slovakia and Slovenia).

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## 1 Introduction

The possibility that the financial sector affects and stimulates the real and productive sector of an economy and its growth generates a wide debate. As Levine (1997) pointed out, economic growth could be affected through the functions of financial markets via the channels of capital accumulation and technological innovation. Therefore, the analysis of the relationship between financial and economic variables arouses great interest in empirical literature (King and Levine, 1993; Levine and Zervos, 1998).

Among the different financial markets, the stock market is very relevant due to three fundamental reasons: the liquidity which it provides to financial assets, the important capital inflows it channels and the fact that it is a very useful source of information for investors (Wachtel, 2003). Therefore, the development of the stock market could potentially contribute to economic growth (Levine and Zervos, 1996; Caporale et al., 2004; Caporale and Spagnolo, 2012) and be, in itself, an economic policy objective. The role played in the financial system by the securities markets (including the stock markets) and by the banks has generated over time an intense debate about which of the two aspects causes greater economic growth. These two currents have led to the analysis of the main determinants on two different fronts: the *market-based* and the *bank-based*. In this paper, we will only focus on aspects related to the importance of stock markets.

“Stock markets are the most developed market segment in emerging Europe” (Iorgova and Ong, 2008, p.8). In this context, the transitioning economies and the Central and Eastern European countries (CEECs) integrated into the European Union (EU) in 2004 (Czechia, Hungary, Poland, Estonia, Latvia, Lithuania, Slovenia and Slovakia) and in 2007 (Bulgaria and Romania), could be an interesting case study. These former communist economies had to develop an important transition process to become market economies. After the fall of the Berlin Wall in 1989 and until the mid-1990s, most CEECs began to open their stock markets and resumed stock market activity interrupted during the communist era. In relation to the stock markets of these countries, the Ljubljana (Slovenia) Stock Exchange was the first to open its market in 1990, followed by Budapest (Hungary); Warsaw (Poland) in 1991; Sofia (Bulgaria) in 1992; Bratislava (Slovakia), Prague (Czechia) and Vilnius (Lithuania) in 1993; Bucharest (Romania) and Riga (Latvia) in 1995; and, finally, Tallinn (Estonia) in 1996.

The three main countries in the Central and Eastern European region –Poland, Hungary and Czechia– “have the most developed stock, bond and derivatives markets, in terms of size, liquidity and instruments” (Iorgova and Ong, 2008, p.6). In addition, it is precisely in these countries where there are significant numbers of shares held by foreigners (Bonin and Wachtel, 2003). In all these countries, the stock market imposes requirements to guarantee a minimum liquidity to the number of shareholders and for the free float criteria (normally 25%) (see Köke and Schröder, 2003).

In general, the emergence of the different stock markets was closely related to the privatization process through which property rights were distributed among citizens. In Bulgaria, Czechia, Lithuania, Slovakia and Romania, the privatization process was especially intense due to the liquidity problems of public companies. In Estonia, Hungary, Latvia, Poland and Slovenia, a limited number of stocks were offered by IPOs (Initial Public Offering) and, as a consequence, were traded more liquidly (Claessens et al., 2000). In precisely those countries

where the privatization process went farthest, the ratio of market capitalization to GDP was the highest (Bonin and Wachtel, 2003).

The evolution of stock market capitalization to GDP, as shown in Annex 1, presents behavior in accordance with the most important events to which the market was subjected. The global stock market crisis, which began in 2000, generated a drop in the behavior of the stock market capitalization to GDP in the economies in transition as well as due to more stringent inclusion requirements and the tendency to concentrate property (Pajuste, 2002). The liberalization process in CEECs economies was subsequently encouraged by the process of European integration, generating a doubly expansive impulse. On the one hand, since the beginning of their transition to market economies, the CEECs have experienced significant rates of economic growth and convergence with the rest of the EU members and, on the other, their stock markets have been transformed. The incorporation of these transitioning economies into the European Union (EU) favored a real improvement in the stock market capitalization to GDP. In contrast, this ratio has been negatively affected by the financial crisis and the Great Recession, which began in 2008.

The purpose of this paper is to analyze the causal relationship between stock market capitalization to GDP (variable denoting stock market development) and real GDP (variable that measures economic activity) using a Vector Autoregressive model (VAR) in ten Central and Eastern European countries (Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia). The analysis was carried out with the highest number of observations available for each country ranging from 1995 to 2017.

The main contribution of this paper is the use of the analysis of three different causality measures (Granger causality test, Frequency Domain approach and Toda-Yamamoto approach) for the study of the relationship between stock market development and the GDP of the CEECs, which has not been previously carried out in the empirical literature for all these countries. Other studies, such as Caporale and Spagnolo (2012) and Pece (2015), used a single method to study causality, making their results less robust. Our results will show whether the stock market played an important role in the economic activity of the CEECs. Logically, the stock market is expected to contribute significantly to the economic activity of these countries. Our results could also be important for policy makers and regulators in facilitating economic growth.

This paper is structured as follows. Section 2 discusses the literature. Section 3 explains the methodology and presents the data. In section 4, the empirical analysis is carried out, and the results of the empirical model are presented. Finally, section 5 concludes the paper.

## 2 Literature review

The relationship between economic activity and financial development is a topic that has been widely researched in economic debate. It is very important for policy makers to understand the possible role of the financial system in economic growth and how the functions of the financial system are linked to economic growth.

Goldsmith (1969) was one of the first authors to empirically demonstrate the connection between financial development and economic growth by using the value of assets intermediated

as a percentage of GDP as a proxy for financial development. Using a sample of 80 countries from 1960 to 1989, King and Levine (1993) found that the development of the financial sector had a strong correlation with economic growth, improvements in the efficiency of capital allocation and the rate of physical capital accumulation. Furthermore, financial development was a good predictor of long-term growth; in countries with high levels of financial development, they found that economic growth tended to be relatively fast, specifically over the next 10 to 30 years.

There is a wide debate in the literature as to whether *bank-based* financial systems stimulate economic growth more than *market-based* financial systems and vice versa (Demirgüç-Kunt and Levine, 2001; Levine, 2002, 2005). There is another group of authors who maintain that the two aspects of the financial system, *bank-based* and *market-based*, are complementary and both contribute to economic growth. Levine and Zervos (1998) suggested that bank development and stock market development were simultaneously good predictors of economic growth, capital accumulation and productivity growth in a sample of 47 countries from 1976 until 1993.

In the context of intervened economies, any of the above disquisitions are useless because of government intervention, including in financial areas. In particular, for financial markets, government intervention implies a restriction on the mobilization of savings, investment and economic growth (McKinnon, 1973; Shaw, 1973). These authors developed the well-known *Hypothesis of Financial Liberalization*, according to which the financial system must be liberalized, and financing must be determined by the free play of the market.<sup>1</sup> This hypothesis was later criticized by the Asymmetric Information Theory (Stiglitz and Weiss, 1981) and fundamentally by King and Levine (1993) who showed the existence of two ways by which causality exists between economic growth and the financial development of a country. On the one hand, a country with financial development of its stock markets can stimulate and promote economic growth and this, in turn, will create greater demand for financial services. If, on the other hand, financial institutions respond effectively to that demand, economic change is assured. From this point of view, both financial development and economic growth are interdependent, and their relationship generates causal feedback.

The relationship between stock market development and GDP has been studied empirically by many authors. By using the data of 41 countries over the period 1976–1993 in a cross-country instrumental variables estimation, Levine and Zervos (1996) demonstrated that stock market development is positively related to long-term economic growth. Economic growth is measured by real per capita growth rate. Stock market development is measured by indicators of size, liquidity and risk diversification. In a later study, Levine and Zervos (1998), using the cross-country data of 47 countries from 1976 to 1993, found that stock market liquidity (turnover and value traded) and banking development (bank credit) were predictors of future economic growth, capital accumulation and productivity growth.

Mauro (2003) found a positive correlation between economic growth (measured by output growth) and stock returns (obtained as the difference between nominal stock returns and consumer price inflation) in ten out of 17 developed countries and five out of eight developing countries, with at least 20 observations and individual-countries regressions. Therefore, the result was stronger in developing countries. From a sample of seven countries (Argentina, Chile,

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<sup>1</sup> For an in-depth review of the Financial Liberalization Theory, see Gomech and Struthers (2003).

Greece, Korea, Malaysia, Philippines and Portugal) over the period 1977–1998 and estimating a Vector Autoregressive model (VAR), Caporale et al. (2004) obtained evidence of the relationship between stock market development (measured by capitalization to GDP and the value of listed shares to GDP) and economic development (measured by GDP in levels).

There is also a long list of empirical studies that focuses on the analysis of the relationship between the stock market and economic activity in specific countries. Some examples are: Hondroyiannis et al. (2005) in Greece; Adamopoulos (2010) in Germany; Ndako (2010) in South Africa; Ibrahim (2011) in Thailand; Marques et al. (2013) in Portugal; Pan and Mishra (2018) in China.

The empirical evidence of the relationship between the stock market and economic activity for the CEECs is not entirely clear, perhaps because of the short time horizons of these countries in a market economy system. For example, Caporale and Spagnolo (2012) examined the relationship between economic growth and the volatility of stock returns (stock index differences) in three CEEC countries (Czechia, Hungary and Poland) in a VAR-GARCH framework between 1996 and 2011. The results showed that there was a one-way causality from stock markets to economic growth, especially after joining the EU. Pece (2015) concluded that there was a two-way link between stock market performance (BET Index) and economic growth in Romania in the period 2000–2013. In contrast, by estimating a dynamic panel model, Caporale et al. (2015) suggested that stock market capitalization in the CEE-5 countries (Czechia, Hungary, Poland, Slovakia and Slovenia) had a small positive effect on economic growth; and for Baltic countries, Bulgaria and Romania's stock market capitalization had a positive but irrelevant effect. For 10 CIS (Commonwealth of Independent States) and 15 CEE countries, Cojocaru et al. (2016) concluded that the efficiency of the financial system and competitiveness were more significant than the amount of credits to the private sector provided by banks.

### **3 Methodology and model specification**

#### **3.1 Data**

The variables used are stock market capitalization to GDP as a proxy for stock market development and real GDP (in chain-linked volumes) as a proxy for economic activity. Stock market capitalization is a measure commonly used to quantify stock market size (as in Ake and Ognaligui, 2010; Azam et al., 2016). Real GDP is a main objective for economic and political institutions and an objective in itself within the framework of economic policy, since the concept of GDP growth is often associated with a country's prosperity and well-being and is also used in virtually all empirical research as a fundamental variable in causal relationships.

The countries under study are Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The stock market capitalization to GDP data for the countries have been obtained from the World Bank (*Global Financial Development Database*) except for Latvia, Lithuania and Romania, whose data come from the Federal Reserve Bank of St. Louis (*FRED Economic Data*), which declares the World Bank as its source. Real GDP data

are obtained from Eurostat (*Quarterly National Accounts Database*). The variables are defined in Table 1. Table 2 specifies the frequency of the data in a range from 1995 to 2017, depending on the data available for each country from the sources consulted. A temporal disaggregation of low frequency (annual) to high frequency (quarterly) is performed for the stock market capitalization data through the method of Chow and Lin (1971), which finds the best linear unbiased estimator of the series used. The frequency of data for GDP is quarterly.

*Table 1.* Definition of variables

Variable	Definition
CAP: Stock market capitalization to GDP (% of GDP)	According to World Bank: “stock market capitalization is the value of listed shares to GDP, calculated using the following deflation method: $\{(0.5)*[Ft/P_{et} + Ft - 1/P_{et-1}]\}/[GDPt/P_{at}]$ where F is stock market capitalization, P_e is end-of period CPI, and P_a is average annual CPI (end-of period CPI and average annual CPI is calculated using the monthly CPI values)”. <sup>2</sup> Annual variable. It is transformed to quarterly by the method of Chow and Lin.
GDP: Real GDP	GDP measures the value of total final output of goods and services produced by an economy within a certain period of time. Chain-linked volumes, index 2010=100. <sup>3</sup> According to Eurostat: “quarterly figures of Chain-linked level series (by annual overlap method) are obtained by multiplying the ratio (previous year's price quarterly figure at year T / average quarterly current price figure at year T-1) with average quarterly chain-linked volume figure at year T-1”. <sup>4</sup> Seasonally and calendar adjusted data except for Slovakia (seasonally adjusted data, not calendar adjusted data). Quarterly variable.

*Table 2.* Frequency of data

Country	GDP 2010=100 quarterly	CAP yearly	Range after transformations
Bulgaria	95:1 - 17:4	93 - 12	95:1 - 12:4
Czechia	96:1 - 17:4	93 - 12	96:1 - 12:4
Estonia	95:1 - 17:4	98 - 12	98:4 - 12:4
Hungary	95:1 - 17:4	92 - 17	95:1 - 17:4
Latvia	95:1 - 17:4	96 - 12	96:4 - 12:4
Lithuania	95:1 - 17:4	96 - 12	96:4 - 12:4
Poland	95:1 - 17:4	92 - 17	95:1 - 17:4
Romania	95:1 - 17:4	95 - 11	95:4 - 11:4
Slovenia	95:1 - 17:4	95 - 17	95:4 - 17:4
Slovakia	95:1 - 17:4	93 - 13	95:1 - 13:4

<sup>2</sup> <https://datacatalog.worldbank.org/stock-market-capitalization-gdp>

<sup>3</sup> [http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=namq\\_10\\_gdp&lang=en](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=namq_10_gdp&lang=en)

<sup>4</sup> [https://ec.europa.eu/eurostat/cache/metadata/EN/ei\\_qna\\_esms.htm](https://ec.europa.eu/eurostat/cache/metadata/EN/ei_qna_esms.htm)

### 3.2 Methodology

To analyze the causality relationship between financial and economic variables in the model, we use three different causality measures: Granger, Frequency Domain and Toda-Yamamoto. Specifically, we seek to find evidence of the relationship between stock market capitalization to GDP with real GDP in both directions and for each country. The results of these three measures will be used to demonstrate a causality relationship in a robust manner.

The first causality approach is Granger causality. According to Granger (1969),  $X$  causes  $Y$ , if  $X$ 's past values improve the estimate of  $Y$ , simply by using  $Y$ 's past values. It is therefore a concept that is based on predictability, that is, the ability of one variable to help predict another.

The null hypotheses in Granger causality tests are specified in each direction in the following form:

$$H_a: GDP \not\rightarrow CAP$$

Real GDP does not Granger cause stock market capitalization to GDP

$$H_b: CAP \not\rightarrow GDP$$

Stock market capitalization to GDP does not Granger cause real GDP

The rejection of the null hypothesis leads to the verification of the existence of this relationship between the variables involved.

The model to be specified and estimated is a Vector Autoregressive model VAR, as in Nguyen and Pham (2014). In the application to the variables, the VAR model would have the following form, where the variables are endogenous:

$$GDP_t = \mu_0 + \sum_{i=1}^n \alpha_i GDP_{t-i} + \sum_{i=1}^n \beta_i CAP_{t-i} + \varepsilon_{1t} \quad (1)$$

$$CAP_t = \gamma_0 + \sum_{i=1}^n \lambda_i CAP_{t-i} + \sum_{i=1}^n \delta_i GDP_{t-i} + \varepsilon_{2t} \quad (2)$$

The second causality measure is the Frequency Domain approach. A spectral causality test is proposed (Breitung and Candelon, 2006), whereby causality relationships are broken down into the frequency spectrum that can be attributed to causality relationships in the short, medium and long-terms. Therefore, this approach provides the temporal vision of causality. Tiwari et al. (2015) specifically used this methodology in India. Croux and Reusens (2013) found for the G-7 countries between 1991 and 2010 that slowly fluctuating components of the stock prices (components with a periodicity larger or equal to one year) contained predictive power for future GDP, whereas quickly fluctuating components did not.

As Gomez-Gonzalez et al. (2015) indicated, the spectral function of each variable is estimated, cycles are extracted by Fourier analysis and the co-movement between cycles is estimated by using the cross-spectral density function and its related measures of coherence. Breitung and Candelon (2006) explained:

Let  $Z_t = [x_t, y_t]'$  be a two-dimensional vector of time series observed as  $t = 1, 2 \dots T$ ,  $Z_t$  represents a finite-order VAR of the following type:

$$\Theta(L)Z_t = \varepsilon_t \quad (3)$$

Where  $\Theta(L) = I - \Theta_1 L - \dots - \Theta_p L^p$  is a  $2 \times 2$  lag polynomial with  $L^k Z_t = Z_{t-k}$ . The error vector  $\varepsilon_t$  is white noise with  $E(\varepsilon_t) = 0$  and  $E(\varepsilon_t \varepsilon_t') = \Sigma$ , where  $\Sigma$  is positive definite. Let  $G$  be the lower triangular matrix of the Cholesky decomposition  $G'G = \Sigma^{-1}$ . The moving average representation of the system (which is assumed to be stationary) is:

$$Z_t = \phi(L)\varepsilon_t = \begin{bmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} = \psi(L)\eta_t \begin{bmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{bmatrix} \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \end{bmatrix} \quad (4)$$

Where  $\phi(L) = \Theta(L)^{-1}$  and  $\psi(L) = \phi(L)G^{-1}$ . The spectral density of  $x_t$  can be expressed as:

$$f_x(\omega) = \frac{1}{2\Pi} \left\{ |\psi_{11}(e^{-i\omega})|^2 + |\psi_{12}(e^{-i\omega})|^2 \right\} \quad (5)$$

Causality is defined as (Geweke, 1982; Hosoya, 1991):

$$M_{y \rightarrow x}(\omega) = \log \left[ 1 + \frac{|\psi_{12}(e^{-i\omega})|^2}{|\psi_{11}(e^{-i\omega})|^2} \right] \quad (6)$$

If  $|\psi_{12}(e^{-i\omega})|^2 = 0$  means that  $y$  does not cause an  $x$  at frequency  $(\omega)$ . Therefore, to test that  $y$  does not cause  $x$  at frequency  $(\omega)$ , within a bivariate framework, the null hypothesis is:

$$H_0: M_{y \rightarrow x}(\omega) = 0 \quad (7)$$

The complete frequency range is from zero to  $\Pi$ . The frequency  $(\omega)$  is equal to  $2\Pi/\text{cycle duration (T)}$ ; therefore, values of  $(\omega)$  near  $\Pi$  correspond to short-term, whereas values of  $(\omega)$  near zero correspond to long-term (Gomez-Gonzalez et al., 2015).

And finally, we analyze the Toda-Yamamoto approach (Toda and Yamamoto, 1995). These authors step forward with the Granger causality approach and use the modified Wald test (MWALD), based on a VAR( $k + d_{\max}$ ) model where  $k$  is the optimal order of system lags, and  $d_{\max}$  is the maximum order of model integration (Saafi et al., 2016). This approach includes additional lags to consider the non-stationarity of the series, and the number of additional lags is based on the order of integration of the series. The VAR can be used in non-stationary series (Andersson et al., 2016). Saafi et al. (2016) used this approach to analyze causality between financial integration and economic growth for a group of 19 developing and developed countries. Andersson et al. (2016) analyzed causality between the banking sector and Chinese economic growth with the Toda-Yamamoto approach. Caporale et al. (2004) also used this approach when studying the relationship between stock market development and economic growth for Argentina, Chile, Greece, Korea, Malaysia, Philippines and Portugal during the period 1977–1998 and estimating a Vector Autoregressive model (VAR).

In the application to the variables and in accordance with the approach of Toda and Yamamoto, the VAR model would have the following form:

$$GDP_t = \mu_0 + \sum_{i=1}^k \alpha_{1i} GDP_{t-i} + \sum_{j=k+1}^{k+d_{\max}} \alpha_{2j} GDP_{t-j} + \sum_{i=1}^k \beta_{1i} CAP_{t-i} + \sum_{j=k+1}^{k+d_{\max}} \beta_{2j} CAP_{t-j} + \varepsilon_{2t} \quad (8)$$

$$CAP_t = \gamma_0 + \sum_{i=1}^k \lambda_{1i} CAP_{t-i} + \sum_{j=k+1}^{k+d_{\max}} \lambda_{2j} CAP_{t-j} + \sum_{i=1}^k \delta_{1i} GDP_{t-i} + \sum_{j=k+1}^{k+d_{\max}} \delta_{2j} GDP_{t-j} + \varepsilon_{1t} \quad (9)$$

## 4 Empirical analysis and results

The first step for empirical study involves testing for unit root in time series. The series should not have a unit root for both Granger causality, i.e., they should be I(0) or stationary, whereas in the Toda-Yamamoto approach and Frequency Domain causality (if the series cointegrate), it is not a necessary condition.

First, we transform the time series into logarithms due to its exponential behavior. Then, the presence of unit roots is analyzed by means of the Phillips-Perron test (Phillips and Perron, 1988) whereby the null hypothesis is the existence of a unit root, or I(1). The results indicate (see Annex 2) that LCAP and LGDP are I(1) in all countries. For Poland and Hungary, the stationarity of LCAP is also tested with the KPSS test (Kwiatkowski et al., 1992). For these countries, LCAP does not have a linear trend, so the results could be confusing when applying a trend. The graph shows for these countries that LCAP could be I(1). The KPSS test results show that LCAP is not stationary, which is why another test is used. Consequently, the series are differentiated to correct the presence of a unit root, as well as in first differences to verify that the order of integration is 1.

Secondly, the presence of cointegration is studied between LCAP and LGDP (see results in Annex 3). Cointegration indicates the existence of long-term relationships between the different variables of the model. Cointegration exists when given two (or more) non-stationary series (they must be I(d) of order d in the variables), there is a linear combination between them that is stationary. The Johansen method has been used to verify cointegration between the non-stationary series LCAP and LGDP at levels (Johansen; 1991, 1995). The results show the evidence of a cointegration vector (1, -1) between the two variables for Bulgaria, Hungary, Latvia, Romania, Slovakia and Slovenia, whereas it does not exist in Czechia, Estonia, Lithuania and Poland.

The third step, once the stationarity and cointegration of the series have been analyzed, is studying causality from the different approaches.

For Granger causality, the models established in equations (1) and (2) are estimated with an unrestricted VAR if the series do not cointegrate. If they cointegrate, it is estimated with an Error Correction Model (ECM). We have to take into account that if the series cointegrate the variables are used at levels (LCAP and LGDP) and if they do not cointegrate, LCAP and LGDP

are used in first differences.<sup>5</sup> Once the model has been estimated, the Granger causality test is carried out from them. Granger causality is sensitive to the number of lags included, and they have been selected by using Akaike Information Criteria (AIC) and Schwarz Information Criteria (SC). The selected VAR models are summarized in Table 3. For Granger causality, the optimum lag is obtained with the series in differences, and for the Toda-Yamamoto approach, it is not necessary.

Granger causality results are shown in Table 4. The results reveal Granger causality from LGDP (real GDP) to LCAP (stock market capitalization to GDP) in Bulgaria, Estonia and Slovenia. In the opposite direction, the results reveal Granger causality from LCAP to LGDP in six countries: Bulgaria, Czechia, Latvia, Lithuania, Poland and Slovakia.

The causality from the Frequency Domain approach<sup>6</sup> is represented in Table 5, where the countries shown are those where the angular frequency ( $\omega$ ) is significant (at a significance level of 5%) and the corresponding time range (Poland is not shown because the angular frequency ( $\omega$ ) is not significant). Annex 4 shows the results in graphical form, where in the abscissa axis the frequency ( $\omega$ ) is represented, which is equal to  $2\pi/cycle\ duration\ (T)$ . The probability is shown on the ordinate axis. Transforming the previous function with respect to time would remain:

$$Cycle\ duration\ (T) = \frac{2\pi}{\omega} \quad (10)$$

For the interpretation of results, short-term is considered less than two years; medium-term between two and five years; and long-term five years or more.

For the causal relationship of LGDP to LCAP, the evidence is in the long-term for Bulgaria, Hungary, Lithuania, Romania and Slovenia, and in the medium and long-term for Estonia. For the causal relationship of LCAP to LGDP, the evidence is in the long-term for Czechia, Hungary, Latvia, Lithuania and Romania, and in the medium and long-term for Bulgaria, Slovakia and Slovenia. Comparing with Granger causality, these results are similar in Bulgaria (LGDP to LCAP, and LCAP to LGDP); Estonia and Slovenia (LGDP to LCAP); and Czechia, Latvia, Lithuania and Slovakia (LCAP to LGDP).

Table 3. Optimum VAR lag

Country	For Granger causality	For Toda-Yamamoto approach	Country	For Granger causality	For Toda-Yamamoto approach
Bulgaria	6	6	Lithuania	1	2
Czechia	5	6	Poland	1	2
Estonia	5	5	Romania	2	2
Hungary	2	2	Slovakia	2	2
Latvia	3	3	Slovenia	2	2

<sup>5</sup> First differences of log-level variables are equivalent to their growth rates. Therefore, instead of calling them by their original names, it is appropriate to refer to them in terms of economic growth and the variations of the stock market capitalization to GDP ratio.

<sup>6</sup> If the series do not cointegrate, LCAP and LGDP are used in first differences. If the series cointegrate, LCAP and LGDP are used at levels.

Table 4. Granger Causality Test

Country		LGDP does not cause LCAP	LCAP does not cause LGDP
Bulgaria	Chi-sq	71.54587	32.67190
	Lags	6	6
	Prob	0.0000*	0.0000*
Czechia	Chi-sq	2.214748	25.55086
	Lags	5	5
	Prob	0.8187	0.0001*
Estonia	Chi-sq	13.50423	2.799691
	Lags	5	5
	Prob	0.0191**	0.7308
Hungary	Chi-sq	0.093006	4.429123
	Lags	2	2
	Prob	0.9546	0.1092
Latvia	Chi-sq	1.173336	8.990155
	Lags	3	3
	Prob	0.7594	0.0294**
Lithuania	Chi-sq	0.031587	10.11122
	Lags	1	1
	Prob	0.8589	0.0015*
Poland	Chi-sq	0.152508	6.843598
	Lags	1	1
	Prob	0.6962	0.0089*
Romania	Chi-sq	0.831612	0.049580
	Lags	2	2
	Prob	0.6598	0.9755
Slovakia	Chi-sq	0.380414	10.84742
	Lags	2	2
	Prob	0.8268	0.0044*
Slovenia	Chi-sq	7.481536	1.439342
	Lags	2	2
	Prob	0.0237**	0.4869

Notes: \*, \*\*, \*\*\* show that the null hypothesis is rejected with a significance level of 1%, 5%, 10% respectively.

For Czechia, Estonia, Lithuania and Poland, LCAP and LGDP are used in first differences (they do not cointegrate).

For Bulgaria, Hungary, Latvia, Romania, Slovakia and Slovenia, LCAP and LGDP are used at levels (they cointegrate).

For causality from the Toda-Yamamoto approach, we estimate the VAR models established in equations (8) and (9), and causality tests are performed from them. We employ Akaike Information Criteria (AIC) and Schwarz Information Criteria (SC) to find the optimal number of lags, shown in Table 3.

The results of causality from the Toda-Yamamoto approach<sup>7</sup> are shown in Table 6. The results reveal causality from LGDP to LCAP in Bulgaria, Estonia and Slovenia. In the opposite direction, LCAP to LGDP in five countries: Bulgaria, Czechia, Lithuania, Poland and Slovakia.

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<sup>7</sup> LCAP and LGDP are used at levels, since stationarity and cointegration are not relevant.

Table 5. Causality from the Frequency Domain approach

LGDP does not cause LCAP		LCAP does not cause LGDP		
Country	Angular frequency ( $\omega$ )	Time range (years)	Angular frequency ( $\omega$ )	Time range (years)
Bulgaria	0.0816 to 0.3264	76.9998 - 19.2500	0.0816 to 0.2448	76.9998 - 25.6667
	0.5712 to 1.1424	11.0000 - 5.5000	0.4896 to 0.7344	12.8333 - 8.5556
			1.1424 to 1.4688	5.5000 - 4.2778
			1.7952 to 1.8768	3.5000 - 3.3478
			2.2848 to 2.4480	2.7500 - 2.5667
			2.8560 to 3.0192	2.2000 - 2.0811
Czechia			0.6614 to 0.9094	9.4998 - 6.9092
Estonia	0.5610 to 2.1318 3.0294	11.2000 - 2.9474 2.0741		
Hungary	0.1366 to 0.6830	46.0000 - 9.2000	0.1366 to 0.8878	46.0000 - 7.0769
Latvia			0.0967 to 0.3867	65.0003 - 16.2500
Lithuania	0.7854 to 0.9817	8.0000 - 6.4000	0.0982	63.9999
Romania	0.0966	65.0003	0.0966 to 0.2899	65.0003 - 21.6667
Slovakia			0.0776 to 0.6206 1.9393 to 3.0252	81.0002 - 10.1250 3.2400 - 2.0769
Slovenia	0.0706 0.5648 to 0.9178	88.9995 11.1250 - 6.8462	0.4236 to 1.4825 2.8945 to 3.0357	14.8333 - 4.2381 2.1707 - 2.0698

Notes: For Czechia, Estonia and Lithuania LCAP and LGDP are used in first differences (they do not cointegrate). For Bulgaria, Hungary, Latvia, Romania, Slovakia and Slovenia, LCAP and LGDP are used at levels (they cointegrate).

According to the results, there is evidence of bi-directional causality in all three approaches and in both directions in a considerable number of countries (Table 7). There is empirical evidence of causality in all the countries that joined the European Union in 2004 and 2007. In the three most developed countries, the results point to the existence of causal relationships from stock market capitalization to real GDP in this way: in Czechia from Granger causality, the Toda-Yamamoto approach and the Frequency Domain approach; in Hungary from the Frequency Domain approach; in Poland from Granger causality and Toda-Yamamoto approach.

Also noteworthy are the cases of Estonia, Lithuania and Latvia, which are countries with a common pattern (they comprise the Baltic Republics). In Lithuania and Latvia, Granger causality is from LCAP to LGDP, whereas in Estonia, Granger causality is from LGDP to LCAP. For these countries, causality from the Toda-Yamamoto approach exists from LCAP to LGDP in Lithuania and from LGDP to LCAP in Estonia. Causality from the Frequency Domain approach exists from LCAP to LGDP in Latvia and Lithuania and from LGDP to LCAP in Estonia and Lithuania.

In Bulgaria, causality exists in all directions and approaches, whereas in Romania, causality exists from the Frequency Domain approach.

Table 6. Causality from the Toda-Yamamoto approach

Country		LGDP does not cause LCAP	LCAP does not cause LGDP
Bulgaria	Chi-sq	72.07504	31.20633
	Lags	6	6
	Prob	0.0000*	0.0000*
Czechia	Chi-sq	2.934159	26.74237
	Lags	6	6
	Prob	0.8171	0.0002*
Estonia	Chi-sq	11.29194	5.126207
	Lags	5	5
	Prob	0.0459**	0.4007
Hungary	Chi-sq	0.075906	3.343927
	Lags	2	2
	Prob	0.9628	0.1879
Latvia	Chi-sq	2.044722	0.506075
	Lags	3	3
	Prob	0.5632	0.9176
Lithuania	Chi-sq	0.195098	6.241992
	Lags	2	2
	Prob	0.9071	0.0441**
Poland	Chi-sq	0.462088	6.507404
	Lags	2	2
	Prob	0.7937	0.0386**
Romania	Chi-sq	0.921528	1.059475
	Lags	2	2
	Prob	0.6308	0.5888
Slovakia	Chi-sq	1.164178	10.27040
	Lags	2	2
	Prob	0.5587	0.0059*
Slovenia	Chi-sq	6.392230	1.337711
	Lags	2	2
	Prob	0.0409**	0.5123

Notes: \*, \*\*, \*\*\* show that the null hypothesis is rejected with a significance level of 1%, 5% and 10% respectively.  
LCAP and LGDP are used at levels for all the countries.

Especially in those countries where there is cointegration, i.e., a long-term relationship between the variables –Bulgaria, Hungary, Latvia, Romania, Slovakia and Slovenia–, the causality analysis from the Frequency Domain approach shows the significance in a time horizon (medium- and long-term). This long-term equilibrium relationship should be exploited in terms of the contribution of the stock market capitalization to GDP to real GDP particularly in those countries with less developed markets – Bulgaria, Latvia, Romania, Slovakia and Slovenia.

Table 7. Summary of results

Country		Granger	Toda- Yamamoto	Frequency Domain	Cointegration
Bulgaria	LCAP to LGDP	*	*	Medium and long-term Long-term	*
	LGDP to LCAP	*	*		
Czechia	LCAP to LGDP	*	*	Long-term	
	LGDP to LCAP				
Estonia	LCAP to LGDP			Medium and long-term	
	LGDP to LCAP	*	*		
Hungary	LCAP to LGDP			Long-term Long-term	*
	LGDP to LCAP				
Latvia	LCAP to LGDP	*		Long-term	*
	LGDP to LCAP				
Lithuania	LCAP to LGDP	*	*	Long-term Long-term	
	LGDP to LCAP				
Poland	LCAP to LGDP	*	*	Long-term Long-term	
	LGDP to LCAP				
Romania	LCAP to LGDP			Long-term Long-term	*
	LGDP to LCAP				
Slovakia	LCAP to LGDP	*	*	Medium and long-term	*
	LGDP to LCAP				
Slovenia	LCAP to LGDP			Medium and long-term Long-term	*
	LGDP to LCAP	*	*		

Therefore, the importance of stock market size in the early stages of the transition for these emerging countries (CEECs) and how stock market development could catalyze economic development should be considered by the policy makers after proving that there is a link between stock market capitalization and GDP, which is also in accordance with Caporale and Spagnolo (2012).

Consequently, measures should be taken to promote the better functioning of these stock markets, given their importance. For example, Draženović and Kusanović (2016) emphasized the importance of continuing with investment liberalization for institutional investors and implementing measures for stimulation of savings and investments, thus strengthening property rights, among others. The authors showed in a sample of six CEE countries (Croatia, Czechia, Hungary, Poland, Slovakia and Slovenia), over the period 1995–2010, that saving is a good predictor of stock market development (measured as stock market capitalization to GDP) as a high level of macroeconomic stability (lower inflation rate), as well as the complementary development of capital markets and banks.

In relation to the functioning of the market as well, the quality of information and the strength of legal system are essential to the financial development, in the same sense as the financial development for economic growth (Claessens et al., 2000). With respect to the quality of information in terms of efficiency,<sup>8</sup> there is a margin for improvement in these economies as the following authors have shown. By testing the martingale hypothesis (from 2000–2009),

<sup>8</sup> “In weak-form efficient markets, current prices are the best predictors of the next period’s prices. Since historical information is already embedded in current prices, past prices have no role in predicting future prices” (Smith, 2012, p. 689).

Smith (2012) demonstrated that Hungarian and Polish markets are among the most efficient markets, and Estonia is among the least. Dragotă and Țilică (2014) showed that for stocks of 20 East European formerly communist countries, there were severe doubts concerning stock market efficiency for these countries in the analyzed period (January 2008–December 2010). Therefore, due to the evidence, the efficiency of the markets should be improved.

## 5 Conclusions

The aim of this paper was to study the link between stock market capitalization to GDP and real GDP in ten Central and Eastern European countries (CEECs) which joined the European Union in 2004 (Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) and 2007 (Bulgaria and Romania) in the framework of a cointegrated VAR. We investigate this relationship through the study of three different approaches to causality: Granger, Frequency Domain and Toda-Yamamoto.

These former communist economies developed important transition processes to become market economies. Therefore, we analyzed the direction of causality and we tried to find out whether stock markets could be catalysts for real GDP in these countries. We studied empirically whether stock market capitalization to GDP caused real GDP and vice versa. The results from the different causality approaches show support for the relationship between stock market capitalization to GDP and real GDP, with a two-way causality link. This stronger relationship exists in those countries where we found evidence of a long-term relationship (cointegration): Bulgaria, Hungary, Latvia, Romania, Slovakia and Slovenia.

Therefore, the potential contribution of stock market development to economic activity must be taken into consideration in these countries. In this context, policy makers should encourage stock market development as a potential way to increase economic growth where there is a transfer of resources from the financial to the productive sector; policy makers should also undertake legal reforms to increase transparency and efficiency and to ensure better performance in these markets. In this context, the Federation of European Securities Exchanges (2014) proposed an *Action Plan for European Capital Markets*. It suggested “more financing through capital markets helps achieve not just greater amounts of financing but also higher levels of innovation, risk management, savings mobilisation, wealth distribution and job creation” (Federation of European Securities Exchanges, 2014, p.3). The *Action Plan for European Capital Markets*, “well implemented and driven by policy makers and regulators together with stock markets, it would reduce the cost of financing and to be able to provide more capital and profitability to all companies especially those most affected by the crisis: SMEs” (Bolsas y Mercados Españoles, 2014, p.33).

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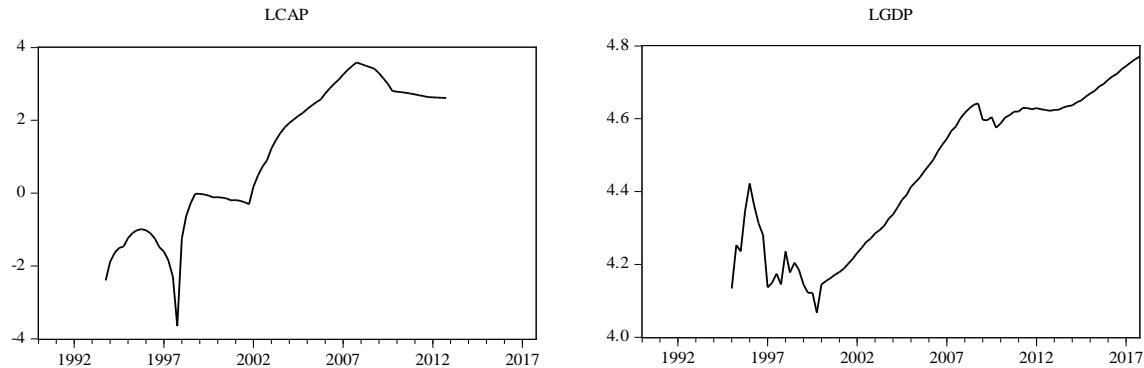
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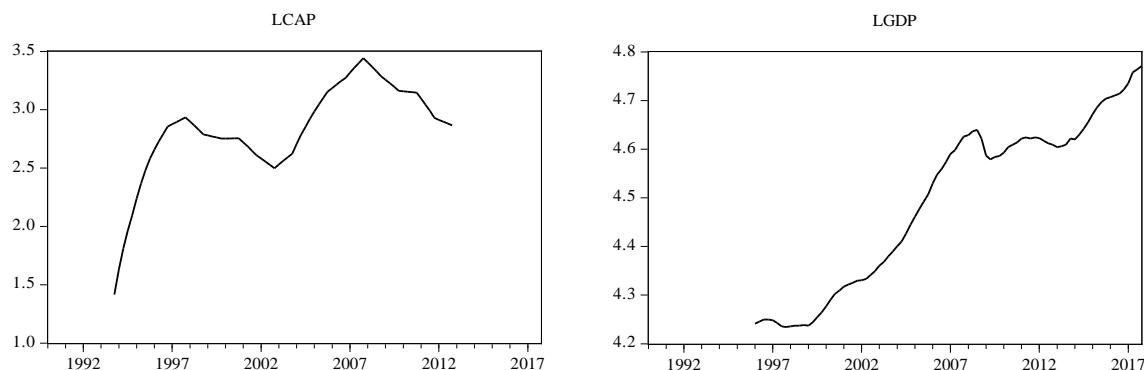
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## Annex 1: Country graphs

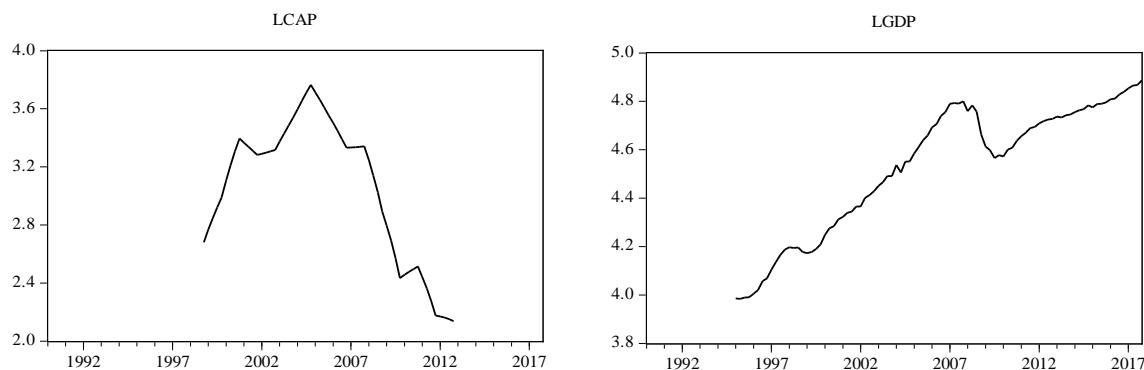
### 1.1 Bulgaria



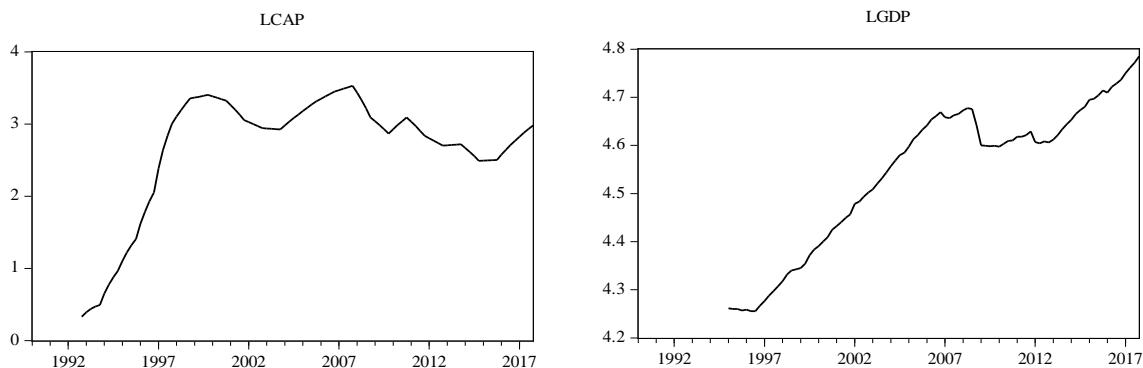
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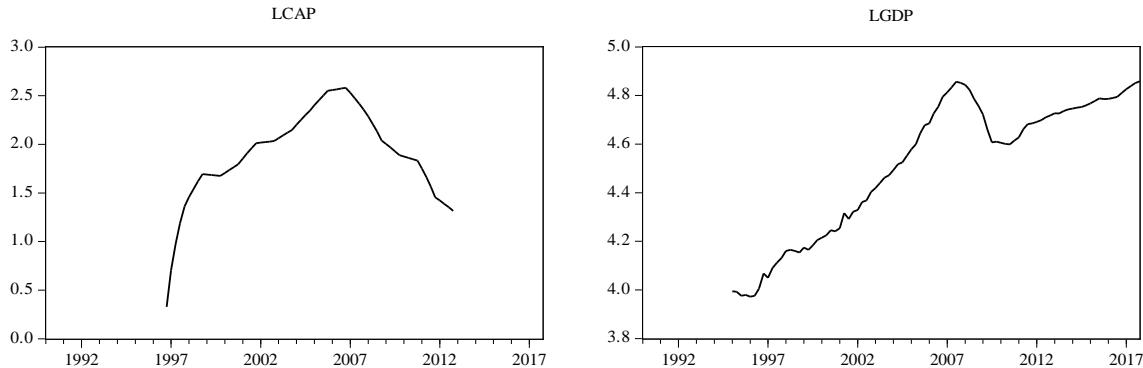
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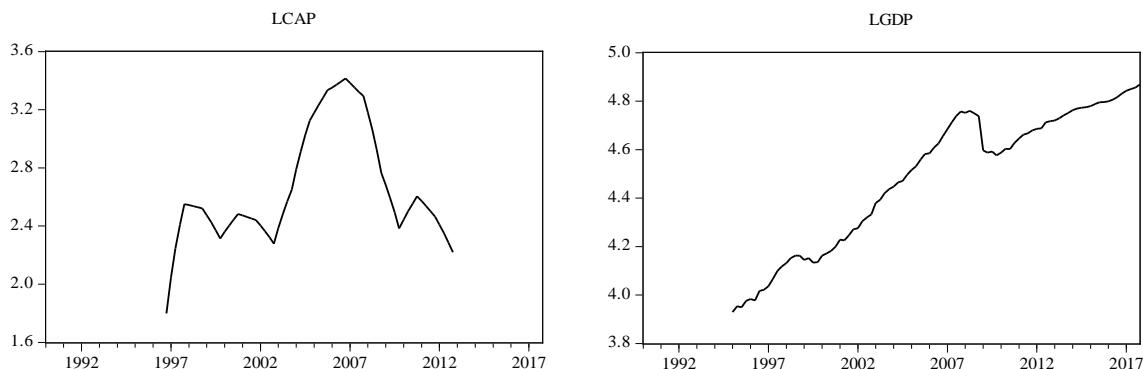
#### 1.4 Hungary



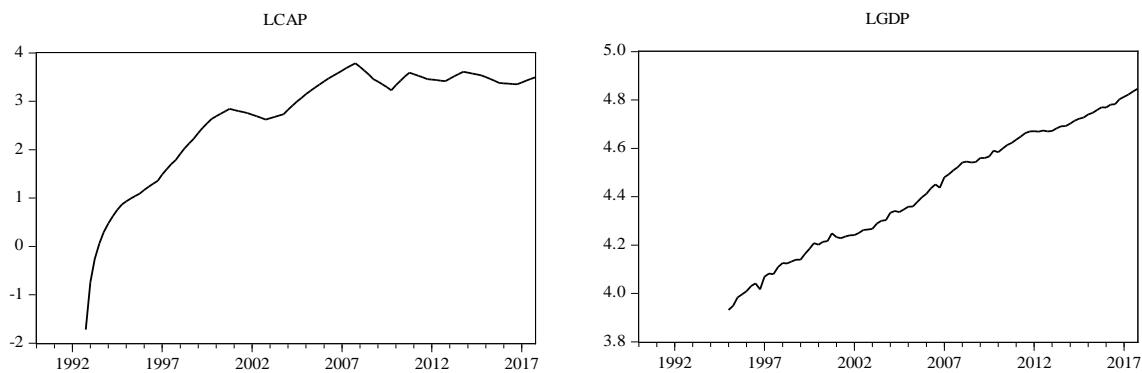
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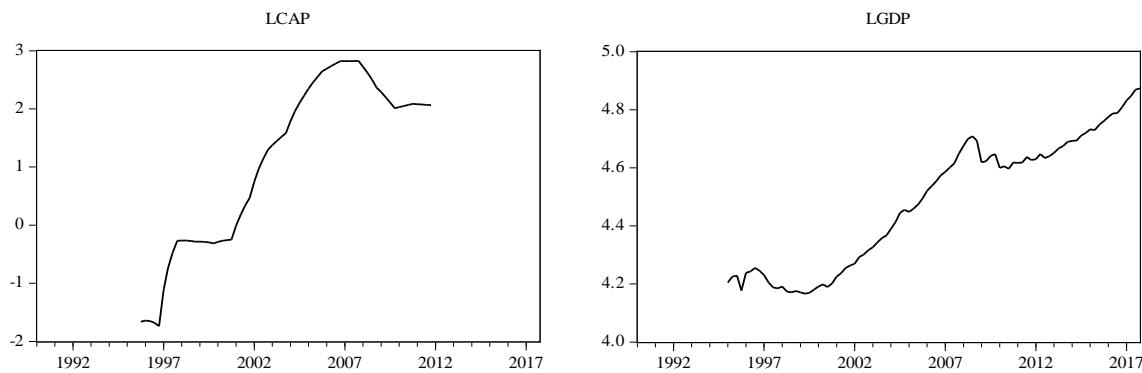
#### 1.6 Lithuania



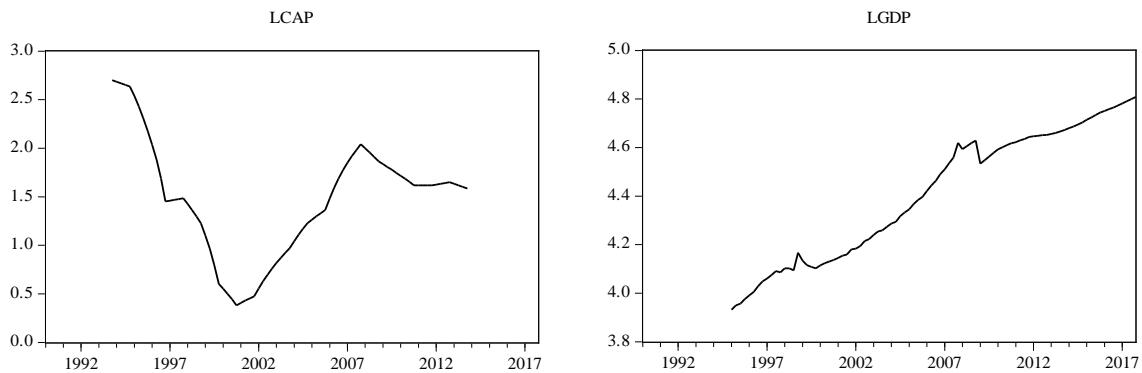
1.7 Poland



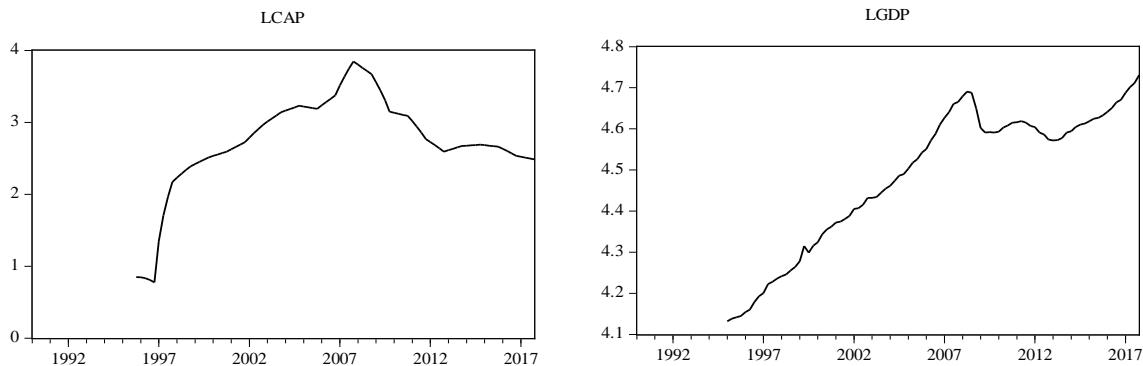
1.8 Romania



1.9 Slovakia



### 1.10 Slovenia



## Annex 2: Unit root test (Phillips-Perron test) and KPSS test

### 2.1 Phillips-Perron test

Country	Variable	t-Stat	Prob.	Data	Unit root
Bulgaria	LGDP	-2.150155	0.5110	Trend	
	LCAP	-1.755856	0.7163	Trend	LGDP: I(1)
	ΔLGDP	-9.827242	0.0000*	0 mean	LCAP: I(1)
	ΔLCAP	-8.436299	0.0000*	0 mean	
Czechia	LGDP	-1.729401	0.7298	Trend	
	LCAP	-3.195202	0.0932	Trend	LGDP: I(1)
	ΔLGDP	-2.948487	0.0036*	0 mean	LCAP: I(1)
	ΔLCAP	-3.906734	0.0002*	0 mean	
Estonia	LGDP	-1.695813	0.7453	Trend	
	LCAP	-0.216773	0.9298	Constant	LGDP: I(1)
	ΔLGDP	-6.447840	0.0000*	0 mean	LCAP: I(1)
	ΔLCAP	-2.578064	0.0108**	0 mean	
Hungary	LGDP	-1.308612	0.8796	Trend	
	LCAP	-2.391948	0.3815	Trend	LGDP: I(1)
	ΔLGDP	-4.112357	0.0001*	0 mean	LCAP: I(1)
	ΔLCAP	-2.464738	0.0140**	0 mean	
Latvia	LGDP	-1.410266	0.8516	Trend	
	LCAP	-2.792841	0.2053	Trend	LGDP: I(1)
	ΔLGDP	-5.717847	0.0000*	0 mean	LCAP: I(1)
	ΔLCAP	-5.660983	0.0000*	0 mean	
Lithuania	LGDP	-1.631983	0.7726	Trend	
	LCAP	-2.184319	0.2139	Constant	LGDP: I(1)
	ΔLGDP	-6.618819	0.0000*	0 mean	LCAP: I(1)
	ΔLCAP	-3.470282	0.0008*	0 mean	
Poland	LGDP	-2.947297	0.1530	Trend	
	LCAP	-5.504325	0.0001*	Trend	LGDP: I(1)
	ΔLGDP	-7.807336	0.0000*	0 mean	LCAP: I(0)
	ΔLCAP	-10.23882	0.0000*	0 mean	

Romania	LGDP	-1.806563	0.6936	Trend	
	LCAP	-0.436846	0.9841	Trend	LGDP: I(1) LCAP: I(1)
	ΔLGDP	-7.313172	0.0000*	0 mean	
	ΔLCAP	-3.235762	0.0016*	0 mean	
	LGDP	-1.627917	0.7743	Trend	
Slovakia	LCAP	-2.086407	0.2507	Constant	LGDP: I(1) LCAP: I(1)
	ΔLGDP	-8.348053	0.0000*	0 mean	
	ΔLCAP	-2.490002	0.0132**	0 mean	
	LGDP	-1.534536	0.8104	Trend	
Slovenia	LCAP	-2.222784	0.4710	Trend	LGDP: I(1) LCAP: I(1)
	ΔLGDP	-4.420164	0.0000*	0 mean	
	ΔLCAP	-4.082828	0.0001*	0 mean	

Notes:

\*, \*\*, \*\*\* shows that the null hypothesis is rejected with a significance level of 1%, 5%, 10%.

Critical values from MacKinnon (1996).

## 2.2 KPSS test

	LCAP Hungary	Stationary	LCAP Poland	Stationary
LM-Stat.	0.242277	No	0.288845	No
1% level	0.216		0.216	
5% level	0.146		0.146	
10% level	0.119		0.119	

### Annex 3: Johansen cointegration test

Country	Hypothesized No. of CE(s)	Prob. Unrestricted Cointegration Rank Test (Trace)	Prob. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)	Cointegration
Bulgaria	None <sup>(i)(ii)</sup>	0.0000	0.0000	(A), (C)
	At most 1	0.0585	0.0585	
Czechia	None	0.1727	0.3832	(B), (D)
	At most 1	0.0535	0.0535	
Estonia	None	0.0805	0.0737	(B), (D)
	At most 1	0.4658	0.4658	
Hungary	None <sup>(i)(ii)</sup>	0.0373	0.0250	(A), (C)
	At most 1	0.6584	0.6584	
Latvia	None <sup>(i)(ii)</sup>	0.0143	0.0088	(A), (C)
	At most 1	0.4972	0.4972	
Lithuania	None	0.8425	0.7271	(B), (D)
	At most 1	0.9235	0.9235	
Poland	None	0.3190	0.2453	(B), (D)
	At most 1	0.9477	0.9477	
Romania	None <sup>(i)(ii)</sup>	0.0182	0.0369	(A), (C)
	At most 1	0.0722	0.0722	
Slovakia	None <sup>(ii)</sup>	0.0617	0.0326	(C)
	At most 1	0.6730	0.6730	
Slovenia	None <sup>(i)(ii)</sup>	0.0348	0.0225	(A), (C)
	At most 1	0.7299	0.7299	

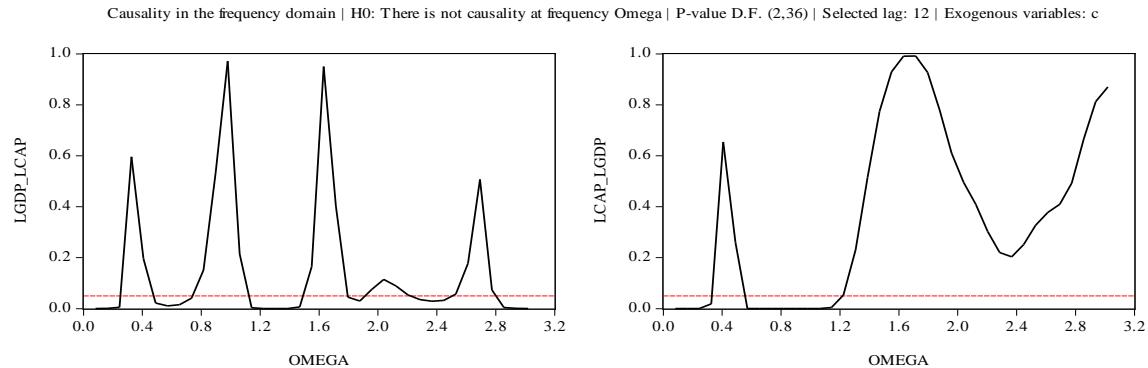
Notes:

- (i) Denotes rejection of the hypothesis at the 0.05 level (Trace test).
- (ii) Denotes rejection of the hypothesis at the 0.05 level (Max-Eigenvalue test).
- (A) Trace test indicates 1 cointegrating eqn(s) at the 0.05 level.
- (B) Trace test indicates no cointegration at the 0.05 level.
- (C) Max-Eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.
- (D) Max-Eigenvalue test indicates no cointegration at the 0.05 level.

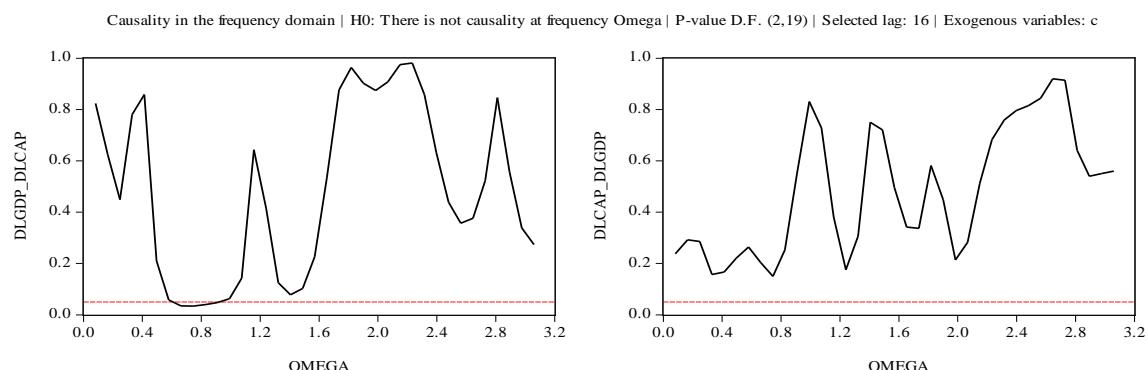
Critical values from MacKinnon-Haug-Michelis (1999).

## Annex 4: Causality graphs from the Frequency Domain approach

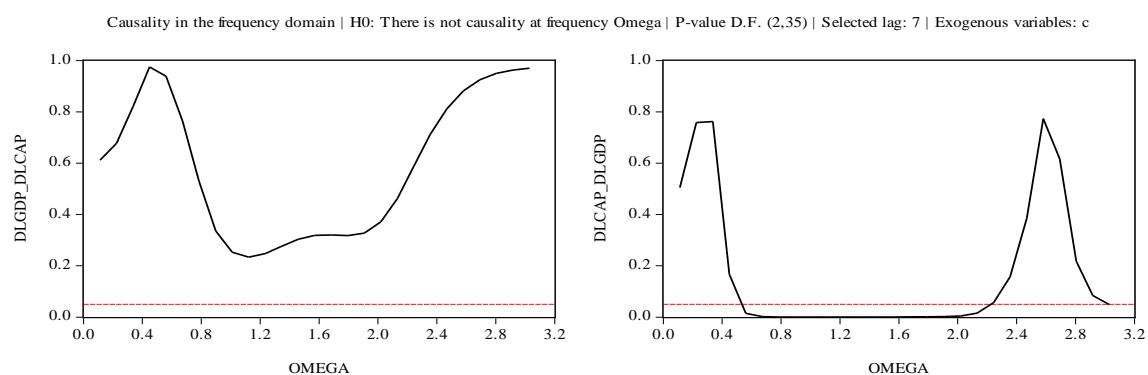
### 4.1 Bulgaria



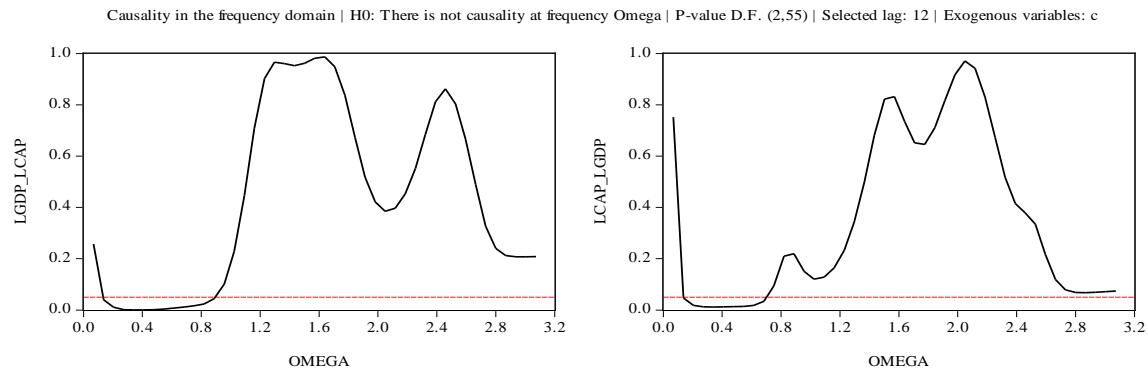
### 4.2 Czechia



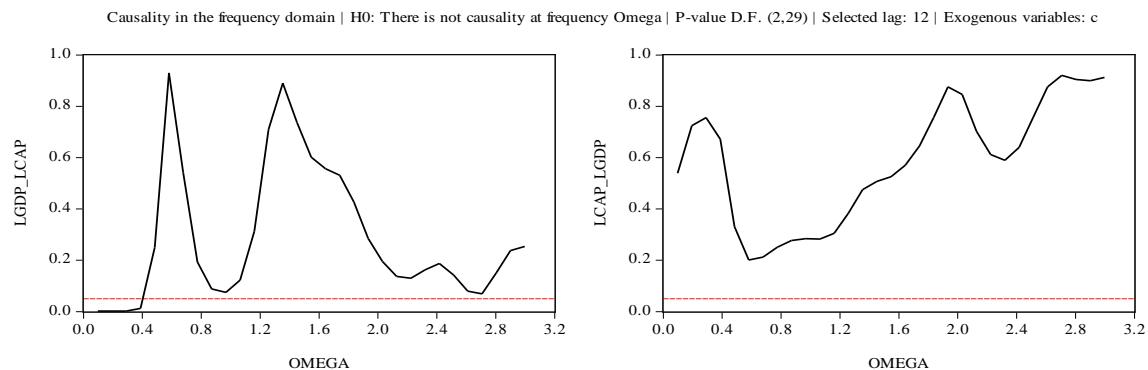
### 4.3 Estonia



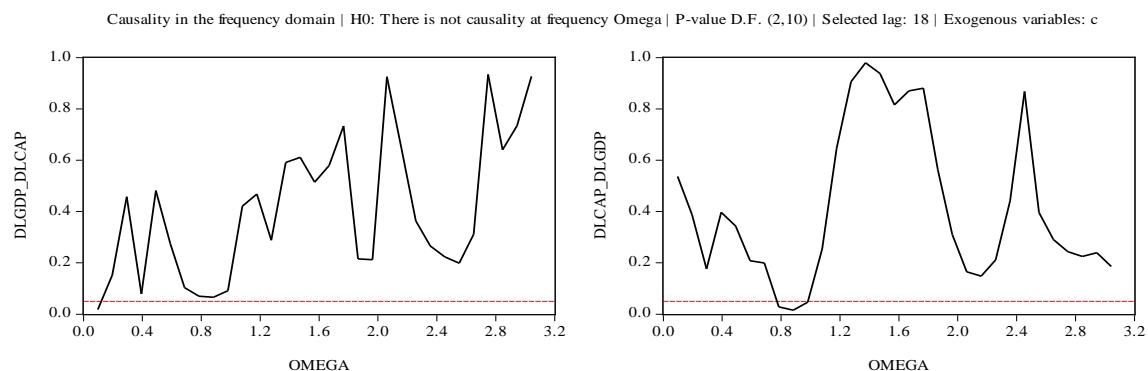
#### 4.4 Hungary



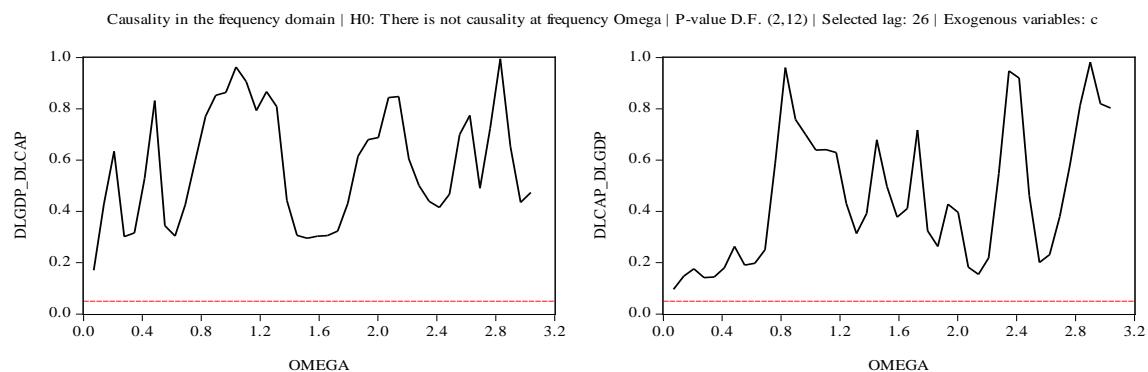
#### 4.5 Latvia



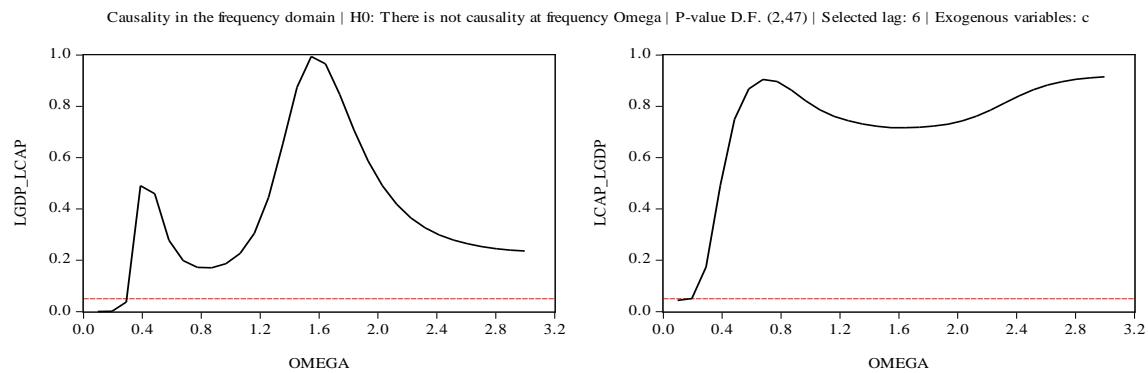
#### 4.6 Lithuania



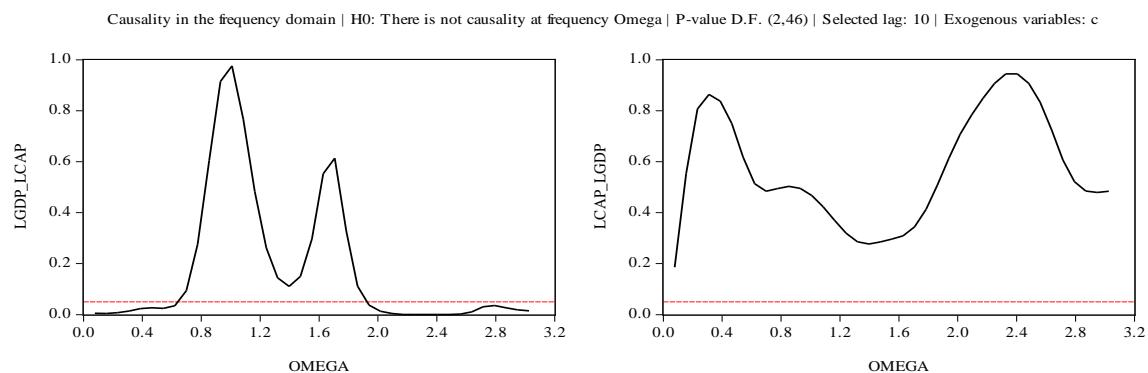
#### 4.7 Poland



#### 4.8 Romania



#### 4.9 Slovakia



#### 4.10 Slovenia

Causality in the frequency domain | H0: There is not causality at frequency Omega | P-value D.F. (2,52) | Selected lag: 12 | Exogenous variables: c

