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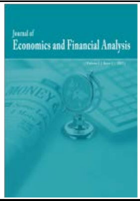

The Impact of Macroeconomic and Institutional Factors on Economic Growth in the CEE-4 Countries

Katarzyna Anna BARAN[*]

Department of Law and Economics, Technical University of Darmstadt, Germany

Abstract

The aim of the study is to examine the main factors driving economic growth in the CEE-4 countries since the transition with the main focus on macroeconomic policies and institutions. The building of a market economy in the region required deep macroeconomic reforms and the creation of a wide range of institutions and business practices needed to support those reforms. Since the collapse of communist regimes, the CEE-4 countries have adopted in the early 1990s a set of policy principles focused on fiscal discipline, interest rate liberalisation, trade and financial liberalisation, privatisation, deregulation and openness to direct foreign investment. Macroeconomic stability by itself, however, does not ensure high rates of GDP growth. In most cases, sustained high rates of growth also depend upon key structural measures, such as regulatory reform, civil service reform, improved governance, and banking sector reform. Institutions of central planning in the CEE-4 region were one of the key barriers to growth prior to the transition. As the development of institutions has been necessary to support the well-functioning market economies in the CEE-4 region, the study also examines deep factors of production – institutions – in addition to the demand-side and the supply-side factors affecting output.

Keywords: *Economic growth; Macroeconomic policies; Institutions; Central and Eastern European countries; Bayesian Model Averaging.*

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[*] Corresponding author. Budziwojowice 1, 55-095 Mirkow, Woj. Dolnoslaskie, Poland
Tel.: +48 579 641 545 | E-Mail: kbaran64@gmail.com

1. Introduction

The aim of the study is to examine the main factors driving economic growth in the CEE-4 countries since the transition with the main focus on macroeconomic policies and institutions. The building of a market economy in the region required deep macroeconomic reforms and the creation of a wide range of institutions and business practices needed to support those reforms. Since the collapse of communist regimes, the CEE-4 countries have adopted in the early 1990s a set of policy principles termed as the so-called Washington Consensus. They focused on fiscal discipline, interest rate liberalisation, trade and financial liberalisation, privatisation, deregulation and openness to direct foreign investment. These policies were perceived to be the key elements of “free markets and sound money” (Rodrik, 2007). The growth literature always stressed the stabilizing role of monetary and fiscal policies for long-term economic growth. They affect both aggregate demand and supply conditions as they influence: the money supply in an economy, which in turn impacts interest rates and inflation rate, investment spending on business capital goods, government spending on public goods and services, taxation, exports and imports. Macroeconomic stability by itself, however, does not ensure high rates of GDP growth. In most cases, sustained high rates of growth also depend upon key structural measures, such as regulatory reform, civil service reform, improved governance, and banking sector reform (Ames et al., 2001). Institutions of central planning in the CEE-4 region were one of the key barriers to growth prior to the transition. Therefore, there was a growing recognition that market-oriented policies in the CEE-4 countries might not be fully sufficient without more serious institutional transformation. Toward the end of the 1990s, the Washington Consensus’ list was thus augmented with a series of so-called second-generation reforms that were more institutional in nature and targeted at problems of “good governance” (Rodrik, 2007). According to Douglass North, institutions are made up of formal constraints (e.g., rules, laws, constitutions), informal constraints (e.g., norms of behavior, conventions, self-imposed codes of conduct), and their enforcement characteristics. Together they define the incentive structure of societies and specifically economies (North, 1994). In essence, institutions set the “rules of the game” that determine the incentives for production, investment, and consumption (Schadler et al., 2006). Generally shared view among economists studying economic growth is that institutional quality is crucial for achieving prosperity. Rich countries are those where investors feel secure about their property rights, the rule of law is upheld, monetary and fiscal policies are anchored in solid macroeconomic institutions and citizens have civil liberties and political representation.[1] As the development of institutions has been necessary to support the well-functioning market economies in the CEE-4 region, the study also examines deep factors of production – institutions – in addition to the demand-side and the supply-side factors affecting output. It is in line with earlier research which provides evidence that policy and institutions affect the level of economic efficiency with which resources are allocated in the economy.[2]

Since the transition from centrally planned systems to market economies, the CEE-4 countries have pursued a distinctive model of development based on economic and political integration and institutional anchoring to the EU. The prospect of membership in the EU and the adoption of its acquis communautaire significantly differentiated the CEE-4 countries from other emerging market economies (Becker et al., 2010). Economic policies and institutions of central planning were the key constraints on growth in the CEE-4 region before the transition. To examine significant changes which have occurred in the last two decades in the region, a wide range of macroeconomic and demographic variables as well as key institutional indicators have been analysed within the Bayesian Model Averaging (BMA) framework to avoid model uncertainty problem. Another contribution of this comprehensive study has been an empirical analysis of growth determinants in the CEE-4 region in comparison to the Euro area-12 group as well as within the EU-28 block.

The rest of the paper consists of five sections. Section 2 provides the literature overview while sections 3 and 4 describe the data and methodology. The main findings of the study are presented in section 5 and section 6 then concludes.

2. Literature overview

The early studies of economic growth determinants focused on the impact of macroeconomic policies such as low inflation, reduced budget deficits and exchange rate stability.[3] Only later, the literature on growth factors de-

[1] It should be noted, however, that causality can run in both directions as strong institutions can be as much a result of economic prosperity as they are its cause. See Rodrik (2007), p. 184.

[2] See i.a.Bassanini and Scarpetta (2001), IMF (2003), Acemoglu et al. (2004), Schadler et al. (2006) and Rodrik (2007).

[3] For the literature overview see Temple (1999), Ahn and Hemmings (2000).

emphasized macroeconomic policies in favor of the role of institutions as drivers of economic performance (Fatás and Mihov, 2005). The main advocates of the view that economic and political institutions were the major source of economic growth included, among others, North (1981, 1990), Jones (1981), Bardhan (1984), Hall and Jones (1999), Rodrik (1999), Acemoglu and Robinson (2000, 2002), Acemoglu at al. (2001, 2002). Those studies focused on the effect of institutions on economic growth, investment or the level of development (Acemoglu et al., 2003). The simultaneous impact of policy settings and institutions on economic growth was also examined empirically, for example, by Bassanini and Scarpetta (2001), Acemoglu et al. (2003), Rodrik (2003), Easterly (2004) and Fatás and Mihov (2005). Acemoglu et al. (2003) and Easterly (2004) provided evidence that macroeconomic policies (monetary, fiscal, trade) have an explanatory power for the cross-country variation in growth rates and income per capita only because they serve as proxies for institutions. Both poor macroeconomic performance and distortionarymacroeconomic policies are more likely to be symptoms of underlying institutional problems rather than the main causes of economic instability. Under various specifications, policy variables turn insignificant once institutions are included in the regressions, which imply that bad policies are simply a reflection of bad institutions. This does not mean, however, that macroeconomic policies do not matter for macroeconomic outcomes. Certainly, overvalued exchange rates or high inflation would discourage certain investments, and unsustainable policies will necessarily lead to some sort of crisis (Acemoglu et al., 2003).The results presented by Fatás and Mihov (2005) indicated, however, that policy volatility had a significant negative effect on economic growth and that this was a direct effect, not simply a spurious correlation due to the fact that both variables were caused by bad institutions. In their analysis, institutions had an effect on growth but only through the effects they had on macroeconomic policies. Therefore, institutions mattered to a large extent because they affected policy and, in particular, policy volatility.

Due to model uncertainty which prevents researchers to reach consensus on the key determinants of economic growth, a number of studies adopted more recently Bayesian-inspired frameworks to examine the impact of economic policies and institutions. Fernández, Ley and Steel (2001) applied the Bayesian Model Averaging approach to determine which of 41 regressors should be included in cross-country growth regressions. Their results for 140 countries over the period 1960-1992 differed somewhat from the findings obtained by Sala-i-Martin (1997). The authors did not advocate selecting a subset of the regressors, but they used BMA, where all inference was averaged over models, using the corresponding posterior model probabilities as weights. Among the most important regressors for explaining cross-country growth patterns identified by Fernández, Ley and Steel (2001) were GDP level in 1960, life expectancy, investment in equipment, rule of law, number of years an economy was 'open', degree of capitalism as well as geographical and religious variables. Sala-i-Martin et al. (2004) examined the robustness of explanatory variables in cross-country economic growth regressions employing a novel approach, Bayesian Averaging of Classical Estimates (BACE), which constructs estimates by averaging OLS coefficients across models. The weights given to individual regressions have a Bayesian justification similar to the Schwarz model selection criterion. Of 67 explanatory variables collected for 88 countries over the years 1960-1996, the authors found 18 to be significantly and robustly correlated with long-term growth, and another three variables to be marginally related. Those variables included, among others, primary schooling, investment price, initial level of GDP per capita, geographical and religious variables, life expectancy in 1960, number of years an economy was 'open' and government consumption share in GDP. Moral-Benito (2005) extended the Bayesian Model Averaging approach to panel data models with country-specific fixed effects. The dataset covered 34 explanatory variables for 73 countries over the period 1960-2000. The empirical results pointed to economic, institutional, geographic and demographic factors affecting growth. The most robust growth determinants were investment price, air distance to big cities and political rights. Among other variables which could be considered as robust were demographic factors (population growth, urban population and population), geographical dummies (such as the dummy for landlocked countries), measures of openness and civil liberties, as well as macroeconomic indicators such as investment share and government share.

Two studies by Bergh and Karlsson (2010) and Próchniak and Witkowski (2014) examined the relationship between economic freedom and growth. Bergh and Karlsson (2010) focused on one out of five dimension of the economic freedom (EF) index developed by the Fraser Institute, namely on government size.The authors constructed a measure of economic freedom based on the remaining four dimensions of the EF: legal structure and security of property rights, access to sound money, freedom to exchange with foreigners, and regulation of credit, labor and business.They analysed the impact of government size on economic growth while controlling for economic freedom and globalization, and using Bayesian Averaging over Classical Estimates in a panel of 29 rich countries. The study included the set of 21 control variables and covered the 1970–1995 and 1970–2005 periods. The results pointed to the negative effect of government size on economic growth. The authors also found some evidence that countries with big government could use economic openness and sound economic policies to mitigate negative effects of big government. Próchniak and Witkowski (2014) also examined the impact of regulations – measured by the Fraser Institute index ofeconomic freedom – on economic growth. Their study covered 111 countries of the world as well as the EU-27 and 14 post-socialist countries from Central and Eastern Europe over the years 1970–2010. The authors used Bayesian Model Averaging method applied to Blundell and Bond's generalized method of moments (GMM) system estimator.The method of the analysis was based on growth regressions where economicfreedom was included in the set of explanatory variables, along with other 12 macroeconomic and demographic controlfactors.Their results showed that the level of and the change in economic freedom both had a positiveand nonlinear relationship with economic growth.

3. Data

For the purpose of an empirical analysis, 21 macroeconomic and institutional variables have been examined as growth factors for the CEE-4 countries, Euro area-12and EU-28 member states.[4]The list of variables and their sources is presented in Table 1. Annual data cover the period of 23 years: from 1995 till 2018. For the purpose of the analysis, three BMS models were estimated, which differ in terms of the sample of countries: for the CEE-4 group, Euro area-12 and EU-28. The dependent variable - economic growth - is measured by GDP per capita at purchasing power parity (PPP) in constant prices. Among the explanatory variables collected for a study of the regulatory framework were: economic freedom, democracy index and financial development. The economic freedom index published by the Heritage Foundation is based on 12 quantitative and qualitative factors, grouped into four broad pillars: rule of law (property rights, government integrity, judicial effectiveness), government size (government spending, tax burden, fiscal health), regulatory efficiency (business freedom, labor freedom, monetary freedom) and open markets (trade freedom, investment freedom, financial freedom). Each of those 12 components of economic freedom is graded on a scale from 0 to 100, with higher outcome representing greater

[4] The Euro area-12 group consists of Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. The EU-28 encompass Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.

scope of economic freedom.They are equally weighted and averaged to produce an overall economic freedom score for each economy.[5]Since the regulatory environment in which an economy operates is very important, more economic freedom is viewed as detrimental to economic growth.Another qualitative index referring to deep growth determinants considered in the study is democracy index. It is published by the Freedom House and calculated as an average of political rights (PR) and civil liberties (CL). The political rights questions are grouped into three subcategories: electoral process, political pluralism and participation, and functioning of government. The civil liberties questions refer to: freedom of expression and belief, associational and organizational rights, rule of law, personal autonomy and individual rights. The original scale of rating is from 1 to 7, with 1 representing the greatest degree of freedom and 7 the smallest degree of freedom.For the purpose of the study, the original scale has been rescaled by first calculating the average of PR and CL and then by using the following transformation: 1 - (average - 1)/6. Hence, the original value of 7 takes the value of 0 (the smallest degree of freedom) and the original value of 1 remains 1 (the greatest degree of freedom).

While there is no clear evidence on the strong relationship between political participation and levels of long-run growth[6], some empirical results imply that stable and persistent democracy has a stronger effect on development rather than democracy per se (Persson and Tabellini, 2006). Other studies argue that the effect of the political system is indirect, with political systems influencing the quality of institutions and only from there to growth. Moreover, democracy makes governments more accountable and thus improves their commitment to chosen policies (Borner et al., 2004). Also, a new broad-based index of financial development introduced by the IMF in 2016 has been considered in the study.[7] Well-developed financial systems contribute to economic growth by providing funding for capital accumulation and by helping the diffusion of new technologies. They mobilise savings by channeling small savings of individuals into profitable large-scale investments, while offering savers a high degree of liquidity (Bassanini and Scarpetta, 2001). The IMF's index of financial development is created based on nine indices that summarise how developed financial institutions and financial markets are in a given country in terms of their depth (size and liquidity), access (ability of individuals and companies to access financial services), and efficiency

[5] More information on the grading and methodology can be found in Miller et al. (2019), p. 457-469.

[6] See Barro (1997), Brunetti (1997), Durham (1999).

[7] The index database provides data for over 180 countries with annual frequency from 1980 onwards (Svirydzenka, 2016).

(ability of institutions to provide financial services at low cost and with sustainable revenues and the level of activity of capital markets). These indices are then aggregated into an overall index of financial development which ranges between 0 and 1 (with 1 being the best outcome).

Table 1. The set of explanatory variables

Name	Description	Source
GDP per capita	GDP per capita, PPP (constant 2011 international $)	IMF WEO 2018
Gov consumption	Government consumption expenditure (% of GDP)	World Bank WDI
Lend borrowing	General government net lending/borrowing (% of GDP)	IMF WEO 2018
Gross fixed capital formation	Gross fixed capital formation (% of GDP)	World Bank WDI
Trade	Trade (% of GDP)	World Bank WDI
Total investment	Total investment (% of GDP)	IMF WEO 2018
Inflation	Inflation, consumer prices (annual %)	World Bank WDI
Life expectancy	Life expectancy at birth (years)	World Bank WDI
Fertility rate	Fertility rate (births per woman)	World Bank WDI
Population 15_64	Population ages 15–64 (% of total)	World Bank WDI
Population	Population ages 15–64 (% of total)	World Bank WDI
Population growth	Population growth (annual %)	World Bank WDI
Interest rate	Long-term interest rate (%)	Eurostat
FDI net inflows	FDI, net inflows (% of GDP)	World Bank WDI
Service value added	Services, value added (% of GDP)	World Bank WDI
Stock market capitalisation	Stock market capitalization to GDP (%)	World Bank WDI
Gerd	Gross domestic expenditures on R&D (% of GDP)	World Bank WDI
Berd	Business enterprise expenditure on R&D (% of GDP)	World Bank WDI
Education	Mean years of schooling	UNESCO UIS
Economic freedom	Index of economic freedom (0–100 scale; 100 = the best outcome)	Heritage Foundation
Democracy index	Democracy index: average of civil liberties and political rights (0–1 scale; 1 = the best outcome)	Freedom House
Financial development	Index of financial development (0-1 scale; 1 = the best outcome)	IMF

In the empirical investigation of the sources of economic growth also macroeconomic variables have been considered. Economic growth has been measured by GDP per capita at purchasing power parity (PPP) in constant prices. The variables associated with monetary and fiscal policies refer to: inflation, interest rates, government consumption and government balance. Economic theory points to a negative relationship between inflation and growth while empirical evidence is somehow mixed and point to a nonlinear association. At some (low) rate of inflation, the relationship could be positive or nonexistent, but at higher rates it becomes negative (Bruno and Easterly, 1998). Nevertheless, higher inflation is associated with lower growth because lower real balances reduce the efficiency of factors of production. Inflation also disturbs efficient resource allocation by obscuring the signaling role of relative price changes – the most important guide to efficient economic decision making. While inflation distorts price and wage fluctuations (sand), at the same time it facilitates adjustment to shocks when wages are rigid downwards (grease). When inflation is low, the net impact of grease and sand effects may be positive. However, at higher inflation rates, sand effects are expected to dominate as grease effect is bounded by the size of real shocks (Khan and Senhadij, 2000). With regard to interest rates, an increase in interest rates moderates economic growth. Higher interest rates increase the cost of borrowing, reduce disposable income and therefore limit the growth in consumer spending and investment.It should be noted, however, that high nominal and real interest rates may not decrease economic growth if there are mechanisms such as low inflation expectations, economy's attractiveness to foreign investors, the technological transfer effect and the accumulation of domestic savings(Drobyshevsky et al., 2017).Fiscal policy conduct can also affect output and growth. It is acknowledged that a high level of fiscal deficit may lead in the longer run to a crowding-out of the private sector, higher interest rates, and distortions through future tax increases which affect the efficient allocation of resources. Therefore one can expect a negative impact of the government deficit on economic growth in the long run. Temporarily, however, an increase in the fiscal deficit caused by higher government spending may have an expansionary effect on the growth rate as long as it is not used for the service of higher interest rate liabilities. In empirical research, the relationship between government deficit and economic growth has been found to be weak (Levine and Renelt, 1992).Government consumption as a percentage of GDP is used in empirical studies as a proxy for the size of government. Its negative impact on the growth rate stems from the underlying rationale that public spending is supposedly less productive than private. Moreover, tax distortions to finance government consumption may be harmful to economic growth (Barro and Lee, 1994). Furthermore, variables related to components of aggregate demand have also been examined: the level of investment as well as trade. Trade facilitates more efficient production of goods and services by shifting production to countries that have comparative advantage in producing them. Aside from the benefits stemming from comparative advantages, additional gains from trade arise through economies of scale, exposure to competition and the diffusion of knowledge(Frankel and Romer, 1999; Alcalá and Ciccone, 2004).As a consequence, this can result both in higher overall efficiency and possibly a higher level of investment (since the adoption of foreign technologies requires investment in new types of capital) (Bassanini and Scarpetta, 2001).More investment provides, in turn, more production capacity and contributes to capital formation. A rise in capital spending has important effects on both the demand and supply side of the economy – including a positive multiplier effect on national income. Since foreign direct investment has been an important source of financing for transition economies, it has also been considered in the study. A significant and positive impact of foreign direct investments on transition economies has been acknowledged by many studies.[8] FDI helps to cover the current account deficit, fiscal deficit (in case of privatisation-related FDI), and supplements inadequate domestic resources to finance both ownership change and capital formation. Also, compared with other financing options FDI facilitates transfer of technology, know-how and skills, and helps local enterprises to obtain management expertise (Krkoska, 2001).The accumulation of physical and human capital have also been analysed as the basic determinants of economic growth, proxied by gross fixed capital formation and mean years of schooling.[9]Expenditure on research and development (R&D) measured by two indices - GERD (Gross domestic expenditure on R&D as % of GDP) and BERD (Business enterprise expenditure on R&D as % of GDP) - has also been considered as aninvestment in knowledge. It translates into new technologies as well as moreefficient ways of using existing resources of physical and human capital (Bassanini and Scarpetta, 2001). In addition, the value added in services has been included as services are generally perceived as the most productive sector which highly influences the economic growth. It is also viewed that the expansion of the service sector in the CEE-4 countries was one of the key factors which significantly stimulated the economic growth in the region since the transition. Finally, the remaining variables related with demography and health situation such as life expectancy, fertility rate, population level and growth have also been considered.

[8] See for example Neuhaus (2006) and Krkoska (2001).

[9]Average number of years of education received by people ages 25 and older, converted from educational attainment levels using official durations of each level. Barro and Lee (2013).

4. Methodology[10]

Due to a model uncertainty in applied econometrics to explain variation of the response variable - economic growth - Bayesian Model Averaging (BMA) has become a popular alternative to the selection problem of explanatory variables. In the search for a satisfactory statistical model of growth, the main area of effort has been the selection of appropriate variables to include in growth regressions (Moral-Benito, 2007). Since the choice of exogenous variables is highly subjective and reflects views of the researcher on what the true model is, different preselected sets of independent variables can lead to different conclusions including a risk of omitted variables bias (Próchniak and Witkowski, 2013).BMA addresses model uncertainty in a canonical regression problem and has gained popularity in empirical studies over the last two decades. For the purpose of the study, the Bayesian Model Sampling (BMS) package for R presented by Zeugner and Feldkircher (2015) has been employed. It implements Bayesian Model Averaging for linear regression models. The BMS package allows sampling data according to different g-priors and model priors, and leaves thechoice of different samplers.

Given a linear model structure, with *y* being the dependent variable, α_γ a constant, β_γ the coefficients, and ε a normal IID error term with variance σ^2:

$$y = \alpha_\gamma + X_\gamma \beta_\gamma + \varepsilon \qquad \varepsilon \sim N(0, \sigma^2 I) \tag{1}$$

a selection problem occurs when there are many potential explanatory variables in a matrix *X*. The inference based on a single linear model including all variables$X_\gamma \in \{X\}$ is inefficient and even infeasible with a limited number of observations.BMA offers a solution to the problem by estimating models for all possible combinations of {*X*} and constructing a weighted average over all of them. With *X* containing *K* potential variables, this means estimating 2^K models. The model weights for this averaging stem from posterior model probabilities that arise from Bayes' theorem:

$$p(M_\gamma | y, X) = \frac{p(y|M_\gamma, X)p(M_\gamma)}{p(y|X)} = \frac{p(y|M_\gamma, X)\, p(M_\gamma)}{\sum_{s=1}^{2^K} p(y|M_s, X)\, p(M_s)} \tag{2}$$

where *p(y|X)* is the integrated likelihood which is constant over all models. Hence, the posterior model probability (PMP) $p(M_\gamma|y, X)$ is proportional to the marginal likelihood of the model $p(y|M_\gamma, X)$ (the probability of thedata given the model M_γ) multiplied by a prior model probability $p(M_\gamma)$, which indicates how

[10] Zeugner and Feldkircher (2015).

probablethe researcher thinks model M_γ is before looking at the data.[11] After re-normalization, the PMPs can be inferred and, thus, the model weighted posterior distribution for any statistic ϑ (e.g. thecoefficients β):

$$p\ (\vartheta|y, X) = \sum_{\gamma=1}^{2^K} p\ (\theta|M_\gamma\ , y, X)\ p\ \left(M_\gamma \middle| X, y\right) \quad (3)$$

The model prior $p(M_\gamma)$ is provided by the researcher and should reflect prior beliefs. Very often, a uniform prior probability is chosen for each model $p(M_\gamma) \propto 1$ to represent the lack of prior knowledge.

With regard to the estimation framework, the literature standard is to use a 'Bayesian regression' linear model with a specific prior structure called 'Zellner's g prior'. For each individual model M_γ, a normal error structure as in (5.1) is assumed. In order to obtain posterior distributions, the priors on the model parameters need to be specified. Placing 'improper' priors on the constant and error variance means they are evenly distributed over their domain: $p(\alpha_\gamma) \propto 1$, i.e. there is complete prior uncertainty where the constant is located. Similarly $p(\sigma) \propto \sigma^{-1}$. As far as the crucial prior on regression coefficients β_γ is concerned, the researcher formulates prior beliefs on coefficients into a normal distribution with a specified mean and variance before looking into the data *(y, X)*. Often a conservative prior mean of zero for the coefficients is assumed to reflect that not much is known about them. Their variance structure is defined according to Zellner's g: $\sigma^2(\frac{1}{g}X'_\gamma X_\gamma)^{-1}$ as follows:

$$\beta_\gamma\ |g \sim N\ (0, \sigma^2(\tfrac{1}{g}X'_\gamma X_\gamma)^{-1}) \quad (4)$$

The hyperparameter *g* expresses how certain the researcher is that coefficients are indeed zero. A small *g* means few prior coefficient variance and thus implies the researcher is quite certain that the coefficients are indeed zero. Conversely, a large *g* means that the researcher is very uncertain that coefficients are zero.

The posterior distribution of coefficients reflects prior uncertainty: given *g*, it follows a t-distribution with expected value $E(\beta_\gamma \middle| y, X, g, M_\gamma) = \frac{g}{1+g}\widehat{\beta_\gamma}$, where $\widehat{\beta_\gamma}$ is the standard OLS estimator for model γ. The expected value of coefficients is thus a convex combination of OLS estimator and prior mean (zero). The more conservative (smaller) *g* is, the more important is the prior, and the more the expected value of coefficients approaches the prior mean zero. As $g \to \infty$, the

[11] Proportionality is expressed with the sign ∝: $p(M_\gamma|y, X) \propto p\ (y|M_\gamma, X)\ p\ (M_\gamma)$.

coefficient estimator approaches the OLS estimator. Also, the posterior variance of β_γ is affected by the choice of g:[12]

$$Cov\,(\beta_\gamma \left| y, X, g, M_\gamma \right) = \frac{(y-\bar{y})'(y-\bar{y})}{N-3} \frac{g}{1+g} (1 - \frac{g}{1+g} R^2_\gamma)\, (X'_\gamma X_\gamma)^{-1} \qquad (5)$$

so the posterior covariance is similar to that of the OLS estimator, times a factor that includes g and R^2, the OLS R-squared for model γ.

For BMA, this prior framework results into a simple marginal likelihood $p(y|M_\gamma, X, g)$ that is related to the R-squared and includes a size penalty factor adjusting for model size k_γ:

$$p(y|M_\gamma, X, g) \propto (y-\bar{y})'(y-\bar{y})^{\frac{-N-1}{2}} (1+g)^{\frac{-k_\gamma}{2}} (1 - \frac{g}{1+g})^{\frac{-N-1}{2}} \qquad (6)$$

The choice of the form of the hyperparameter *g* is crucial. A popular 'default' approach is the 'unit information prior' (UIP), which sets g = N commonly for all models and thus attributes about the same information to the prior as is contained in one observation.

5. Results

The results of the analysis for 2^{21} (2097152) model combinations are presented in Tables 2 - 4 with the corresponding statistics. For each model specification, Tables 2-4 present estimated coefficients obtained with the use of BMS approach for the CEE-4 group, the Euro area-12 and the EU-28 member states. The column PIP represents posterior inclusion probabilities, i.e. the sum of posterior model probabilities (PMPs) for all models where a variable was contained. The next column Post Mean displays the coefficients averaged over all models, including the models in which the variable was not included (implying that the coefficient was zero in that case). The column Post SD reflects the coefficients' posterior standard deviations while the column Cond.Pos.Sign represents the 'posterior probability of a positive coefficient expected value conditional on inclusion', respectively 'sign certainty'. The last column Idx denotes the index of the variables' appearance in the original data set, while the results in the study are sorted by PIP (Zeugner and Feldkircher, 2015).Analysing the CEE-4 countries, the most significant and positive effect on GDP growthhas the economic freedom as it occurs in all models, with the highest PIP of 100 per cent,

[12] *N* denotes here sample size, and $\bar{y}$ the sample mean of the response variable.

and the value of its coefficient inferred from the Post SD and Cond.Pos.Sign being certainly positive (Table 2). This finding is in line withnumerous studies which confirm a positive impact of economic freedom on economic growth.[13] During the transformation, the CEE-4 countries moved from centrally managed to market-oriented economies. This meant the need to significantly expand the scope of economic freedom by the introduction of liberalization and market reforms. Since the regulatory environment in which an economy operates is very important, policy-makers in the region should continue necessary reforms aiming at increasing the scope of economic freedom. The second variable which exerts a significant impact on economic growth with the posterior model probability of 99.86 per cent is long-term interest rate. Almost all of posterior model mass rests on models that include this covariate. In all encountered models containing this variable, its (expected value of) coefficient has a negative sign. This result is confirmed by all major economic schools of thought which claim that higher interest rates hinder economic growth. High inflation along with the lack of proven record of monetary and fiscal credibility during the transition led to adaptive-inflation expectations in the CEE-4 region. Therefore, long-term interest rates as an average of expected future short-term interest rates were very high in the 1990s. The remaining variables which exert a significant impact on economic growth - life expectancy and democracy index - appear in above 94 per cent of models. The coefficient signs for these two variables are certainly positive in all models which include them. While empirical evidence is mixed about the causal impact of life expectancy on economic performance, recent studies show that living longer may have initially a negative effect on growth, but once fertility declines the effect becomes significantly positive.[14] Increased life expectance in the CEE-4 countries, thanks to improved health conditions observed in the post-transition years, might have contributed to a drop in mortality and, thus, in fertility rates and consequently to a reduction in population growth. Acceleration in human capital formation might have led, in turn, to increased income per capita in the region. Also obtained evidence that democracy has a significant positive effect on GDP per capita in the CEE-4 countries finds its explanation in empirical literature.[15] Political transformation and democratization process which began in the early 1990s made the governments in the region more accountable and improved their commitment to chosen policies. This, as a result, provided a more

[13] See Heckelman (2000), Dawson (2003), Weede (2006), Piątek et al. (2013), Próchniak and Witkowski (2014).
[14] See among others Acemoglu and Johnson (2006), Lorentzen et al. (2008), Kunze (2014).
[15] See Papaioannou and Siourounis (2008), Persson and Tabellini (2008), Bates et al. (2012), Acemoglu et al. (2014).

stable environment for investment and economic reforms. The remaining variables - fertility rate, service value added, trade, stock market capitalization, financial development and population - occur in above 57 per cent of models and its effect on GDP is almost certainly positive.

Table 2. CEE-4 countries

Estimator	PIP	Post Mean	Post SD	Cond.Pos.Sign	Idx
Economic Freedom	1.0000	294.6697	52.8096	1.0000	4
Interest Rate	0.9986	-408.967	106.9823	0.0000	12
Life Expectancy	0.9750	788.8843	266.6119	1.0000	14
Democracy Index	0.9432	8907.835	3654.2610	1.0000	2
Fertility Rate	0.7620	4074.524	2838.2940	1.0000	6
Service Value Added	0.7554	278.8441	199.9739	1.0000	18
Trade	0.7532	27.0693	19.1767	0.9992	21
Stock Market Capitalisation	0.6504	54.0173	46.2290	1.0000	19
Financial Development	0.5886	6473.9140	6354.3660	0.9986	7
Population	0.5680	-66.5649	69.72243	0.0003	15
Gross Fixed Capital Formation	0.4358	-39.5849	193.0274	0.5465	10
Total Investment	0.4222	116.2782	183.8212	0.9910	20
Gov Consumption	0.2638	3.5041	196.8994	0.5458	9
Population Growth	0.1864	140.9713	562.1510	0.9045	17
BERD	0.1692	206.3737	829.8443	0.8333	3
Education	0.1642	124.1031	391.5314	0.9451	1
GERD	0.1410	0.0000	0.0000	0.9375	8
Population 15-64	0.1330	-17.8102	78.1295	0.0751	16
Lend Borrowing	0.1134	4.4298	32.2864	0.7513	13
Inflation	0.1062	0.0107	1.2124	0.4915	11
FDI Net Inflows	0.0918	0.6658	5.4265	0.9782	5

As far as the advanced economies of the Euro area-12 are concerned, the importance of the variables in explaining the data given in the PIP column representing posterior inclusion probabilities (PMPs) differs to a large extent (Table 3). The sum of PMPs was highest for all models where BERD, government consumption, service value added and trade were included. With 100 per cent, all of posterior model mass rests on models that contain the above four variables. With regard to their coefficient signs, it appears that in all encountered models containing these variables, the values of coefficients for BERD, service value added and trade are certainly positive, while for government consumption – negative. The Euro area-12 countries have already the status of the innovation-driven economies while within the CEE-4 group only the Czech Republic has recently emerged as the most active country in innovations and in technology-make strategies. The significant and positive impact of business sector R&D expenditure on economic growth in the Euro area-12 reflects those countries' high development status with growth being knowledge-driven. R&D activity in the business sector accounts for the majority of overall R&D expenditure in most OECD countries and has greater impact on output growth than publicly financed R&D. Public-sector R&D expenditure is often directed at making improvements in areas not directly related to growth, such as defense and medical research, and its effect on growth could be diffused and slow to emerge. R&D activity in the business sector accounts for the majority of overall R&D expenditure in most OECD countries and has greater impact on output growth than publicly financed R&D. Public-sector R&D expenditure is often directed at making improvements in areas not directly related to growth, such as defense and medical research, and its effect on growth could be diffused and slow to emerge.[16] In contrast, BERD does not seem to matter much in the CEE-4 region. Consequently, its coefficient is low as the results quite often include models where this coefficient is zero. Recent studies have indicated a systemic disadvantage of Central Eastern European countries relative to the Euro area and their limited potential for knowledge-based growth. In the 1990s, the CEE-4 lacked the capability to develop frontier technologies and technological progress in these countries took place mainly through the adoption and imitation of technologies developed by advanced economies. The importance of services in stimulating the Euro area's economic growth can be explained with the rising contribution of the service sector to GDP in high-income countries in the past two decades.[17] Services are generally perceived as the most productive sector which highly influences the economic growth. The expansion of the service sector has also been observed in the CEE-4 countries since the transition, yet the increase in services' share of GDP in the region has been less pronounced. Trade intensification and its significant and positive impact on economic growth in the Euro area-12 is considered as one of the successes of the single currency introduction.Scholars such as Bun and Klaassen (2002), De Nardis and Vicarelli (2003), Berger and Nitsch (2005) estimated the effect of increased bilateral commercial transactions within the

[16] See Bassanini and Scarpetta (2001).

[17] In 2015, services' value added accounted for 74 per cent of GDP in high-income countries, up from 69 per cent in 1997. Buckley and Majumdar (2018), p. 2.

Euro area on trade at around 10-15 per cent level.[18] The insightful analysis by Berger and Nitsch (2005) provides a new perspective on the explanation of increased trade within the Euro area as a continuation of a long-term trend in European economic integration fostered by policy changes. Also Baldwin et al. (2008) argue that the euro induced firms to export a wider range of their products to the Eurozone. Therefore, not only trade in existing products was stimulated; the pro-trade effect also came from newly trade goods. The last variable which enters all models (PIP of 100 per cent) is government consumption. It exerts a negative effect on growth in the Euro area-12 as its coefficient is certainly negative. Studies conducted for the EMU countries by, among others, Turrini (2008), Schuknecht (2009) and Hauptmeier et al. (2011, 2015) show an overall expansionary expenditure stance in the period of 1999-2009 which was mainly driven by increasing public consumption. As a result, fiscal positions were already unsound in the Euro area when the global financial crisis began. Further attempts to smoothen the crisis via expansionary fiscal policies led to over-indebtedness and resource misallocation and, consequently, to the sovereign debt crisis of 2010-2011. Ultimately, output levels and growth trend dropped in the post-crisis years (Schuknecht, 2011). The negative impact of excessive government spending on economic growth stems from the underlying rationale that public spending is less productive and tends to crowd out the private sector. Moreover, excessive budget deficits lead to higher interest rates which are harmful to investment. Also, tax increases to finance government consumption may be harmful to economic growth.

According to the OECD study, taxes and government expenditures affect growth both directly and indirectly through investment. An increase of about one percentage point in the tax pressure could be associated with a direct reduction of about 0.3 per cent in output per capita. Once the investment effect is taken into account, the overall reduction would be about 0.6 - 0.7 per cent (Bassanini and Scarpetta, 2001).[19]

The remaining variables – population growth, fertility rate, stock market capitalization, population and economic freedom – also significantly affect GDP growth with the posterior model probabilities above 75 per cent. Among those covariates, only fertility rate enters the models with a negative sign. This can be explained with the aging process observed in most Euro area countries since the

[18] In the estimations conducted by Rose (2004), based on a meta-analysis, monetary unions can be associated with an effect on trade between 30-90 per cent. See Cindea and Cindea (2012).

[19] See also Barro and Lee (1994).

mid-1960s. In accordance with standard economic theory, low rates of fertility are associated in the long run with diminished economic growth. Due to the aging effect, the labour force declines and unless it is compensated by an increase in total factor productivity and/or an increase in the capital stock, it leads to the output decline. Research by Bloom et al. (2009) provides confirmation that in the long run the economic burdens of old-age dependency dominates the youth dependency decline, and continued low fertility will lead to small working-age shares in the absence of large migration inflows.

Table 3. Euro area-12 countries

Estimator	PIP	Post Mean	Post SD	Cond.Pos.Sign	Idx
BERD	1.0000	6935.8402	788.9942	1.0000	3
Gov. Consumption	1.0000	-904.5066	204.5332	0.0000	9
Service Value Added	1.0000	794.6131	151.1635	1.0000	18
Trade	1.0000	121.4053	14.5121	1.0000	21
Population Growth	0.9896	3314.8417	836.4694	1.0000	17
Fertility Rate	0.9314	-5646.8255	2254.9592	0.0000	6
Stock Market Capitalisation	0.8978	30.0871	13.5892	1.0000	19
Population	0.8762	42.5330	21.3138	1.0000	15
Economic Freedom	0.7516	190.5031	133.5211	1.0000	4
Lend Borrowing	0.3142	73.5131	129.0704	1.0000	13
Financial Development	0.1898	1374.7587	3358.0978	1.0000	7
Interest Rate	0.1384	-26.2808	82.8401	0.0000	12
Gross Fixed Capital Formation	0.1254	35.2844	147.2074	1.0000	10
Total Investment	0.1158	2.4010	107.1230	0.8480	20
Democracy Index	0.1096	875.9971	3769.4281	0.9927	2
Education	0.1044	-35.2479	161.2836	0.0842	1
GERD	0.1042	0.0000	0.0000	0.9904	8
FDI Net Inflows	0.0814	1.3816	6.4150	1.0000	5
Population 15-64	0.0626	-1.3590	96.6434	0.2747	16
Life Expectancy	0.0576	15.4787	83.8371	0.9861	14
Inflation	0.0434	-0.1978	1.6008	0.0000	11

For the 28 member states of the European Union, the most important factors of growth in the examined years 1995-2018 appear to be government consumption, service value added and trade as all of posterior model mass rests on models that include those variables (Table 4). Coefficient signs inferred from the Post SD and Cond.Pos.Sign point to a strong and negative effect of government consumption on economic growth, while two other covariates - service value added and trade – exert a positive impact on GDP. The remaining variables which positively affect growth, and for which the posterior inclusion probabilities are above 63 per cent, include BERD and population growth. The other covariates do not seem to matter much. Consequently their (unconditional) coefficients are quite low as the results quite often include models where these coefficients are zero. The EU-28 encompass the Euro area-12, the CEE-4 as well as 6 new Euro area members[20] and the remaining 6 EU countries. Therefore, it contains a more heterogenous group of countries in terms of their economic development. This can explain why the ordering of the variables has changed compared to the modeling results for the Euro area-12 countries.

Table 4. European Union-28 countries

Estimator	PIP	Post Mean	Post SD	Cond.Pos.Sign	Idx
Gov Consumption	1.0000	-1362.94	268.1440	0.0000	9
Service Value Added	1.0000	901.1249	171.7788	1.0000	18
Trade	1.0000	120.4328	19.3370	1.0000	21
BERD	0.9976	7437.441	1333.2460	1.0000	3
Population Growth	0.6304	1810.075	1604.1640	1.0000	17
Stock Market Capitalisation	0.4310	15.1102	19.6754	1.0000	19
Population	0.3350	15.8351	25.9057	1.0000	15
Economic Freedom	0.2764	73.0259	135.0099	1.0000	4
Interest Rate	0.2704	-104.1780	200.5111	0.0000	12
Lend Borrowing	0.2518	82.1188	167.1212	1.0000	13
Gross Fixed Capital Formation	0.2324	122.9058	291.6189	1.0000	10
Financial Development	0.1848	1785.1150	4398.7160	0.9945	7
Life Expectancy	0.1810	70.5789	208.2639	0.9845	14
Total Investment	0.1584	21.9713	196.7255	0.8270	20
Fertility Rate	0.1512	-650.7590	1854.8770	0.0000	6
GERD	0.1138	0.0000	0.0000	1.0000	8
Inflation	0.0576	-0.4435	2.9640	0.0000	11
Population 15-64	0.0532	18.5719	141.1350	0.8909	16
FDI Net Inflows	0.0518	0.3685	8.8542	0.7297	5

[20] Slovakia has joined the Euro area on January 1, 2009, yet in this analysis is considered as a member of the CEE-4 group.

Education	0.0416	12.2141	106.4495	0.9663	1
Democracy Index	0.0354	346.1998	2983.7020	0.9943	2

6. Conclusion

The purpose of this study has been the examination of the main factors driving economic growth in the CEE-4 countries since the transition with the main focus on macroeconomic policies and institutions. To detect significant changes which have occurred in the last two decades in the region, a wide range of macroeconomic, demographic variables as well as key institutional indicators have been analysed. To avoid a model uncertainty in explaining variation of the response variable - economic growth - a new approach has been employed based on the Bayesian Model Sampling (BMS), which implements Bayesian Model Averaging for linear regression models. The BMS allows sampling data according to different g-priors and model priors, and leaves the choice of different samplers. Another contribution of this comprehensive study has been an empirical analysis of growth determinants in the CEE-4 region in comparison to the Euro area-12 group as well as within the EU-28 block.

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