International Economics 171 (2022) 143–173

Contents lists available at ScienceDirect

International Economics

journal homepage: www.elsevier.com/locate/inteco

Are there any robust determinants of growth in Europe? A Bayesian Model Averaging approach

Sara D'Andrea [a,b,*]

[a] Department of Economics and Law, Sapienza University of Rome, Via del Castro Laurenziano, 9, Italy
[b] Sogei S.p.A, Italy

ARTICLE INFO

JEL classification:
O47
C38
C11

Keywords:
Bayesian model averaging
Growth econometrics
Economic growth
Bayesian methods

ABSTRACT

Quantitative growth economists often have to deal with model uncertainty (Barro et al. (2003)) and the issue of open-endedness of theories (Brock and Durlauf (2001)). Bayesian Model Averaging (BMA) is the best statistical tool to evaluate the variables to include in a growth regression.

This work aims to investigate the robustness of the determinants of growth in Europe from 2002 to 2019. Our dataset is composed of 70 explanatory variables for 19 European countries. We compare different BMA estimates by combining 2 model priors with 5 coefficient priors and we find that no variable is robust to all our specifications.

Our results support neoclassical growth theories, as the initial level of GDP per capita and savings are robust determinants of growth. Other robust determinants include the share of manufacturing in GDP, demography, public accounts, wage and labor contract regulation, and fixed capital accumulation.

1. Introduction

Since the seminal contribution of Solow (1956), several economists have tried to identify the main determinants of economic growth both theoretically and econometrically. In this context, the best attempt was surely made by scholars like Lucas Jr (1988) or Romer (1990).

As pointed out by Brock and Durlauf (2001), one of the main issues related to quantitative growth analysis is the *open-endedness* of theories. With this expression, the authors refer to the possibility that the validity of a growth theory does not imply the exclusion of another. For instance, the causal relationship between demography and economic growth does not prevent international trade or human capital from being statistically relevant, too.

West et al. (2003) develop a tree structure to define the types of uncertainty surrounding growth regressions. They argue that quantitative growth economists have to take account of possible interactions among theories, and call this phenomenon *specification uncertainty*. Moreover, a given theory may be tested using more than a unique variable. The choice of these variables is also subject to *measurement uncertainty*. Finally, *heterogeneity uncertainty* refers to the misspecification of the set of countries following a common linear model.

Dealing with these kinds of uncertainty is one of the aims of this paper. We will refer to this issue as *model uncertainty* (Durlauf et al. (2008)) and we will discuss an empirical strategy to identify the most robust determinants of growth in this framework. To test the validity of several causal relationships simultaneously we will rely on Bayesian Model Averaging (BMA, henceforth) estimates, first

* Department of Economics and Law, Sapienza University of Rome, Via del Castro Laurenziano, 9, Italy.
E-mail addresses: sara.dandrea@uniroma1.it, sdandrea@sogei.it.

https://doi.org/10.1016/j.inteco.2022.06.001
Received 26 February 2022; Received in revised form 13 June 2022; Accepted 14 June 2022
Available online 24 June 2022

developed by Leamer and Leamer (1978) and Raftery (1995).

In light of the recent health and economic crisis triggered by Covid-19, we believe it is essential to investigate which policies can lead to recovery and stimulate long-term economic growth. An unprecedented crisis deserves unprecedented growth policies, both in the instrument and in the amount financed: this is the case of the large plans approved with the Recovery Fund in European countries. Although the amounts granted are enormous, with this research we aim to provide policy suggestions for using them to finance the most productive investments in the long term. Therefore, since several determinants of growth have been identified in the literature in Europe, we question which growth determinant should be the most relevant for this work. The answer to this question comprises an innovative method.

We aim to select the main determinants of growth, but we only focus on European countries. Working with this restricted sample allows us to analyze if the ongoing integration leads countries to prosperity or not. For example, with our database, we can infer if the single currency adoption or the presence of a European institution or agency is relevant or not for explaining the growth path of that country. Furthermore, we decided to insert in our dataset also variables related to inequality, environmental policy, and gender gap. We do not find in literature BMA analysis conducted on this sample with these additional variables, in the hope that further research can provide more attention to this point. Thus, the first extension we provide to the existing literature concerns our dataset. The dependent variable in our sample is the average annual growth rate of GDP per capita from 2002 to 2019 and our sample includes only 19 European countries.

Thus, we identify a strategy to select the most robust determinants of growth in our sample, by changing the model prior and the *g*-prior of a BMA set-up. The methodology used to perform this simple robustness test is a second innovation we bring in this field. We identify 10 different combinations of model priors and coefficient priors, mixing 2 different model priors (Fixed and Random theta) with 5 *g*-priors (UIP, HQ, RIC, Hyper, and EBL[1]). For every estimated model, we define the threshold value of the Posterior Inclusion Probability (PIP, henceforth), and only the variables with a probability higher or equal to the threshold are selected. Then, the variables selected by at least 4 different combinations of priors out of 10 are considered robust. We then analyze the Posterior Mean to Posterior Standard Deviation (PM/PSD) ratio simulated with the 10 priors combinations. Variables for which this ratio is greater than unity in absolute terms in at least 2 specifications are considered robust. We decide to develop this type of robustness test because, as the literature shows, the number and category of variables selected via the BMA methodology vary according to the priors used. Our aim is therefore not to prefer a combination of priors, but to choose the most robust variables by comparing the results that these 10 combinations return. Finally, we comment on the expected values of the coefficients and the sign certainty probability of the robust variables estimated via BMA under the 10 different prior combinations. We find that the most robust determinants of economic growth in Europe are the initial level of GDP per capita, the share of manufacturing in GDP, and the fertility rate. These results confirm the *conditional convergence* hypothesis. Countries with the lowest initial level of GDP per capita show higher growth rates. Moreover, as these are mainly Central and Eastern Europe (CEE, henceforth) countries, they also have the highest initial share of manufacturing in GDP and the highest initial fertility rates.

Another robust determinant is the saving rate, confirming the Solow (1956) growth model. Interest expenditure on debt is also considered robust and negatively affects economic growth. More worker-friendly labor contract regulations seem to boost growth in our sample.

The analysis of the other robust variables according to our methodology reveals controversial results. The initial level of inequality is positively related to economic growth, but this result could be driven by the strong growth of ex-communist countries over the time horizon considered. Finally, the stock of fixed capital is a robust determinant of growth, but the relationship might be non-linear.

The remainder of this paper is structured as follows. In Section 2, we discuss the existing literature on the topic of our research. In Section 3, we describe the econometric methodology used for our estimates. In Section 4, we conduct a theoretical experiment to strengthen the validity of the methodology used. The variables collected in our dataset and some descriptive statistics are explored in Section 5. In Section 6, we describe the computational procedure used and we discuss the results of our study. Section 7 shows some robustness checks. Finally, Section 8 concludes.

2. Related literature

Quantitative growth analysis mainly focuses on the identification of a causal relationship between relevant factors and income growth in different countries. A complete description of the statistical models used and of the variable selection process is provided by Durlauf et al. (2005). In particular, the authors identify 145 potential determinants of growth reviewing all the explanatory variables of cross-country growth regressions in the literature from 1990.

In developed countries, the key macroeconomic determinants are physical capital, fiscal policy, human capital, trade, demographics, monetary policy, and financial and technological factors. Indeed, foreign aid, FDI, fiscal policy, investment, trade, human capital development, demographics, monetary policy, natural resources, reforms, and geographic, regional, political and financial factors are relevant regressors in developing countries.[2]

In a frequentist approach, Grogan and Moers (2001) find that institutions, macroeconomic stability, and FDI boost growth in transition countries, while Barro et al. (2003) provide evidence for the *conditional convergence* hypothesis. Human capital, international trade, investment, and regional factors are statistically significant variables in this paper. Besides, monetary and financial conditions,

[1] This notation will be clarified in Section 3.

[2] More on this topic is in Chirwa and Odhiambo (2016).

technology, and private sector development are found to be robust in CEE by Próchniak (2011). Finally, Kutan and Yigit (2007) suggest that structural operations such as Cohesion Funds increase the steady-state levels of GDP per capita, but they are correlated with a short-run lower growth for the net contributors. Economic integration (i. e., participation in the EU) stimulates productivity growth, income, and convergence rate in all countries considered and a spillover effect in the technology diffusion is found.

First of all, model uncertainty in a Bayesian framework is presented by Fernandez et al. (2001b): applying a BMA with a uniform prior on model probabilities and a RIC *g*-prior[3] to a sample of 72 countries from 1960 to 1992, they find that initial GDP and life expectancy are the main variables to be included in the model. Other important determinants are rule of law, number of years the economy has been open, degree of capitalism, and equipment and non-equipment investment. The model used is described in a second paper by Fernandez et al. (2001a). Here the authors provide a benchmark prior that can be used in any model or sample. By using a normal linear regression model with uncertainty in the choice of regressors, they find that the best *g*-prior is a decreasing function of the sample size and suggest that the *g*-prior selection should depend on the number of variables and the sample size.

Secondly, Sala-i Martin et al. (2004) provide evidence for 18 significant variables, among which we find primary schooling enrolment rate in 1960, the average price of investment goods between 1960 and 1964 (with a negative sign), the initial level of per capita GDP, the density of the population in coastal areas, life expectancy in 1960, the fraction of GDP in mining, and the number of years an economy has been open. The share of government consumption in GDP and the public investment share both have a negative coefficient. The authors use a Bayesian Averaging of Classical Estimates (BACE, henceforth) model on a sample of 88 countries, from 1960 to 1996.

Masanjala and Papageorgiou (2008) use a BMA with a uniform model prior focusing on African countries from 1960 to 1992 and find that mining, initial primary education, and primary exports affect their sample differently from the rest of the world.

Using a BMA with dilution prior for theories on three different samples, Durlauf et al. (2008) find evidence for conditional convergence. Investment, population growth, government consumption, and inflation have significant effects on growth, and the authors affirm that macroeconomic policy is the most important factor of economic growth. Indeed, recent new theories are not found to be robust: they include variables such as ethnic fractionalization, geography, institutions, and religion. The most relevant theory for explaining the variation in TFP growth is the one related to externalities in the production function.

Furthermore, Eicher et al. (2011) compare the results obtained with 12 different parameter priors on the same dataset used by Fernandez et al. (2001b). The best prior is the Unit Information Prior (UIP, hereinafter) and gives posterior model probabilities similar to the Schwarz criterion BIC. The authors also find that the UIP combined with a uniform model prior performs better than the prior chosen by Sala-i Martin et al. (2004). A first critic to Sala-i Martin et al. (2004) is moved by Ciccone and Jarociński (2010), who change the dependent variable adopting the PWT0, PWT1, and PWT2 income estimates from 1960 to 1996. The posterior inclusion probability of a variable depends on the errors in measurements and the income estimates adopted when using agnostic priors. For example, fertility, religious variables, primary exports, openness, and nominal government GDP share should be included. Feldkircher and Zeugner (2012) argue that in the revisions of PWT, different countries are considered (88 PWT 6.0 to 79 PWT 6.2), and that the estimates are conducted on a common sample. They suggest reducing the instability of a variable posterior inclusion probability using a hyper *g*-prior.

By adopting the same framework as Fernandez et al. (2001b) on a sample of European regions, Błażejowski et al. (2016) estimate that the main driver of economic growth is education, followed by the initial level of GDP per capita. Other important variables are expenditure on gross capital and variables related to tourism, while research and development has only weak evidence.

Moreover, Moral-Benito (2012) finds evidence for country-specific effects and identifies initial GDP as a robust determinant. Investment price, distance to major world cities, political rights, trade openness, population structure, and geographical dummies are significant variables. Aiyar et al. (2013) prove that significant variables related to growth slowdowns concern institutions, demography, macroeconomic conditions, economic structure, and foreign trade. Indeed, focusing mainly on the macroeconomic conditions of the economy, Arin et al. (2019) suggest that cyclically adjusted budget balance, productive expenditure, and top corporate tax rates affect growth in the short run. Moreover, productive expenditures and other revenues are robust positive determinants for growth, while top corporate tax rates negatively affect economic growth, both in the medium and in the long run.

Błażejowski et al. (2019) affirm that the main determinant of growth is the initial level of GDP per capita, followed by gross domestic savings and gross fixed capital formation. The regional variable concerning Asian countries matters too, as well as the stock of migrants and education expenditure. Their results are in line with the "Asian development model".

Furthermore, from a methodological perspective, Leon-Gonzalez and Montolio (2015) use a BMA strategy applied to panel data, changing the set of regressors, instruments, and exogeneity restrictions. They show the effectiveness of this tool when the model space is large. Moral-Benito (2016) use a BMA with likelihood function for dynamic panels and weakly exogenous regressors. The panel dataset consists of 73 countries from 1960-to 2000. Among the 10 candidate variables, none is robust. Mirestean and Tsangarides (2016) use a Limited-Information BMA (LIBMA) framework on a panel dataset, accounting for model uncertainty, dynamics, and endogeneity. They find that initial income, physical and human capital accumulation, macroe-conomic policy, geography, and ethnic heterogeneity are robust determinants of growth.

Finally, Bruns and Ioannidis (2020) show that inferences about the determinants of growth through the BMA are unstable across periods, but identify variables related to demographics, education, trade, investment, and religion as robust determinants. The authors use a dataset of 63 countries between 1960 and 1996 (inspired by Fernandez et al. (2001b) and Sala-i Martin et al. (2004)).

[3] More on the specification of model prior and *g*-prior is in Section 3.

3. Econometric methodology

BMA, was firstly introduced by Leamer and Leamer (1978). Raftery (1995) presents the Bayesian approach to hypothesis testing, model selection, and accounting for model uncertainty with an application to sociology. Hoeting et al. (1999) prove the supremacy of BMA predictive performance involving different data and model classes.

In addition, Raftery et al. (1997) demonstrates the BMA performing power when a subset of predictors is correlated. We adopt their notation in developing the model.

We assume a linear regression model with a constant of the form

$$y=\beta_0+\beta_1x_1+\beta_2x_2+\ldots+\beta_Kx_K+\varepsilon, \tag{1}$$

where y is the dependent variable and we have K potential explanatory variables $x_1, x_2, \ldots, x_K$. We define the set of all possible models $M = \{M_1, \ldots, M_J\}$, with $J = 2^K$ representing all the regressors combinations. The posterior distribution of the quantity of interest Δ is estimated through the BMA. It is a weighted average of the posterior distribution under each model, with weights equal to the posterior model probabilities

$$P(\Delta|D)=\sum_{j=1}^{J}P(\Delta|M_j,D)P(M_j|D). \tag{2}$$

The j-th posterior model probability represents the probability that the j-th model has of being the true model. Since this is a probability, its value ranges from 0 to 1. By applying the Bayes rule, we calculate the weights (or the posterior model probabilities, equivalently), as follows

$$P(M_j|D)=\frac{P(D|M_j)P(M_j)}{P(D)}, \tag{3}$$

where $P\ (M_j)$ represents the model prior,

$$P(D)=\sum_{i=1}^{J}P(D|M_i)P(M_i) \tag{4}$$

is the weighted average of all the marginal likelihoods and the marginal likelihood of model j is

$$P(D|M_j)=\int P(D|\theta_j,M_j)P(\theta_j|M_j)d\theta_j, \tag{5}$$

where θ_j is the vector of parameters of model j. If we apply this procedure to (1), the quantity we want to estimate is the set of the beta coefficients $\Delta = \{\beta_1, \ldots, \beta_K\}$. The posterior distribution of the general β_k coefficient is

$$P(\beta_k|D)=\sum_{j=\beta_k\in M_j}P(\beta_k|M_j)P(M_j|D). \tag{6}$$

The expected value of the β_k coefficient is

$$E(\beta_k|D)=\sum_{j=\beta_k\in M_j}\widehat{\beta}_kP(M_j|D) \tag{7}$$

and the variance is

$$V[\beta_k|D]=\sum_{j=\beta_k\in M_j}\left(Var[\beta_k|D,M_j]+\widehat{\beta}_k^{\,2}\right)P(M_j|D)-E[\beta_k|D]^2. \tag{8}$$

Hoeting et al. (1999) prove that BMA variance estimates are higher than any model that does not take account of uncertainty.

We are interested in estimating the Posterior Inclusion Probability (PIP) of every variable, obtained summing up the posterior probabilities of the set of all the models that include β_k (i.e. in which $\beta_k \neq 0$). The PIP is our benchmark estimate, as it indicates the probability of each explanatory variable to belong to the true model generating the response variable. Formally, this quantity is:

$$P(\beta_k\neq 0|D)=\sum_{j=\beta_k\in M_j}P(M_j|D) \tag{9}$$

We can use different model priors to estimate the posterior distribution in (7). Clyde and George (2004) discuss the evolution of the Bayesian approach to model uncertainty and of the prior selection process. However, in this paper we rely only on two different specifications:

1. Firstly, we specify a Fixed Model Prior distribution like and we select the expected model size $\overline{m} = K\theta$.

$$P(M_j) = \theta^{k_j}(1-\theta)^{K-k_j} \tag{10}$$

2. Secondly, we rely on a Random Theta Prior developed by Ley and Steel (2009), who suggest a binomial-beta hyperprior on the *a priori* inclusion probability. The mass of its distribution is centered near the prior model size, but an hyperprior on the inclusion probability θ from a Beta distribution is put, to take account of uncertainty around the model size.

We decide not to rely on a Uniform Model Prior, in which all models are supposed to have the same weight on the posterior distribution and the prior model size is equal to $\overline{m} = K/2$. This prior was excluded for a problem of numerosity of our dataset: in fact, the prior model size (i.e., the number of variables that *a priori* we intend to include in the final regression) would be equal to $K/2$ (= 35, in our case), thus greater than the number of countries (, which is 19). Therefore, we do not report the estimates obtained with this model prior, but use the estimated posterior model size (15,[4] which is smaller than 19) as a reference to fit the prior model size with the Fixed and the Random Theta.[5]

For the regression coefficients, we rely on Zellner (1986) *g*-prior, by assuming a normal distribution:

$$\beta_k \Big| g \sim N\left(0, \sigma^2\left(\frac{1}{g}X_k'X_k\right)^{-1}\right). \tag{11}$$

We do not make any assumption about the sign or the magnitude of the coefficients; we only assume that the variance-covariance structure is proportional to the data. The prior for σ^2 is the default prior used in Zellner (1986), thus we rely on a improper prior where $p(\sigma)$ a [1] (Zeugner (2011)). The *g*-prior is a hyper-parameter that determines the strength of the researcher's prior belief that the coefficients are zero. A small (large) value of *g* indicates that the researcher is very sure (uncertain) that the coefficients are zero. Values of this prior close to infinity are equivalent to placing a flat prior on β. Several authors provided discussions on how to select the *g*-prior according to the model, the number of variables observed in the data, and the sample size. In this model, we follow the *g*-prior specification[6] provided by Fernandez et al. (2001a):

1. Unit Information Prior (UIP),[7] $g = n$. In this case, the Bayes factors approximate the BIC criterion by Schwarz (1978);
2. Risk Inflation Criterion (RIC),[8] $g = k^2$;
3. Hannan-Quinn Prior (HQ)[9] $g = (\ln n)^3$;
4. Hyper Prior (hyper)[10], where we have a family of priors on g, depending on the parameter $a > 2$: $\pi(g) = [(a-2)/2](1+g)^{-a/2}$, with $g > 0$;
5. Local Empirical Bayes g-parameter (EBL), as in Liang et al. (2008).

We don't rely on the Benchmark Prior (BRIC), $g = \max\{n, k^2\}$, suggested by Fernandez et al. (2001a), since it would be equivalent to the RIC (because in our dataset $k^2 > n$). Some estimates would have repeated and this would have distorted the procedure for selecting the most robust variables.

A discussion of objective Bayesian methods based on noninformative priors and of the implementation procedure of the model is provided by Wasserman (2000). Liang et al. (2008) prove that BRIC, RIC, and hyper-*g* are consistent in model selection and that the hyper-*g* prior is also consistent in prediction. Indeed, Ley and Steel (2009) clarify the trade-off between the choice of the model prior and the *g*-prior. The RIC *g*-prior is recommended. For instance, Eicher et al. (2011) suggest to use a UIP prior.

We will assess the robustness of our variables by using all the priors presented above .[11]

Markov Chain Monte Carlo methods are used to draw from the posterior, since the integral in (5) can be computationally unfeasible.[12]

4. Simulation experiment

To test the validity of the proposed method, we perform a simple simulation exercise. We generate 15 random observations for each

[4] This result is shown in the last column of Table 10 in the Appendix.
[5] The step forward would be to reiterate this procedure until a stationary model size is reached, which is left for future research.
[6] We do not discuss all the existing priors, since it is out of the scope of this paper.
[7] See Kass and Wasserman (1995).
[8] Developed by Foster and George (1994).
[9] From Hannan and Quinn (1979).
[10] Introduced by Strawderman (1971) and Cui and George (2008).
[11] A justification for this choice is in Masanjala and Papageorgiou (2008). They find that prior selection is not important in this context, since proper and improper priors lead to similar results.
[12] For a complete description of the algorithm, see Raftery et al. (1997) or Hoeting et al. (1999).

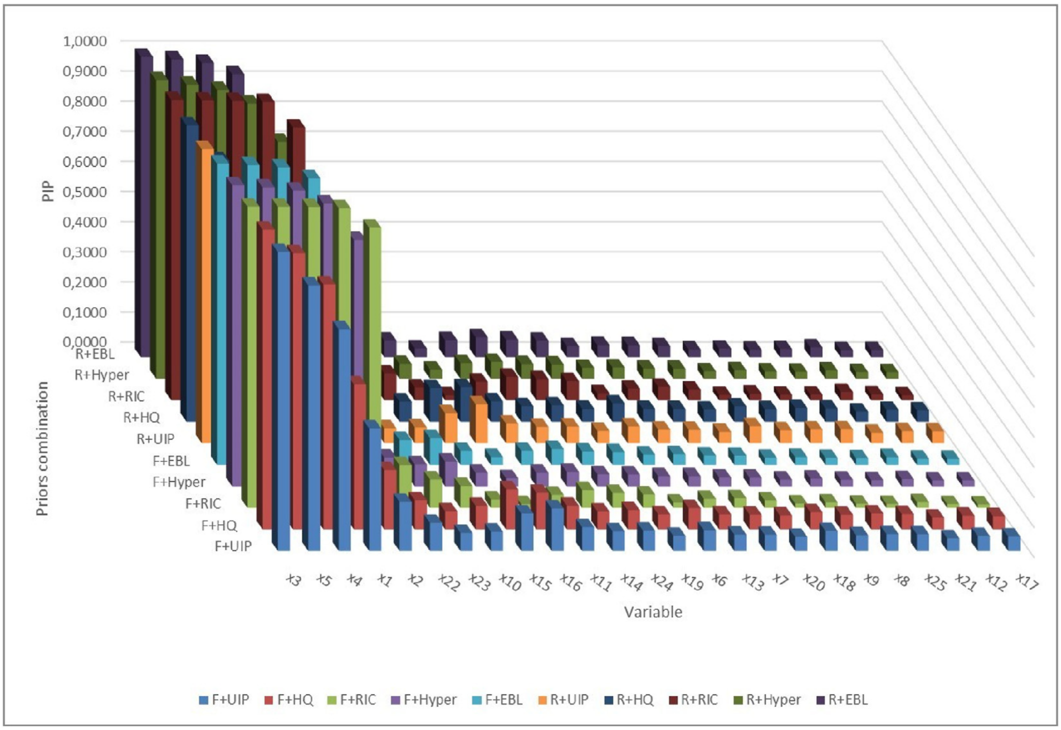

Fig. 1. Posterior inclusion probabilities of simulation excercise. This Figure shows the Posterior Inclusion Probabilities (PIPs) for each explanatory variable used in the simulation exercise (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the average PIPs across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

of the 25 possible explanatory variables (x_1, x_2, …, x_{25}) as reported in Table A.1 in Appendix, and calculate the dependent variable according to the following formula, in which the true values of the coefficients (β_1, β_2, …,β_5) have already been inserted:

$$y_i = 0.5\, x_{1\ i} + 1.1\, x_{2\ i} - 0.6\, x_{3\ i} - 0.8\, x_{4\ i} + 2.5\, x_{5\ i} + \epsilon_i. \tag{12}$$

Thus, only 5 variables out of 25 are included in the true data generating process. It is important to note that some variables not included in the real model have the same distribution or parameters very close to the variables belonging to (12) and could therefore "confuse" the BMA algorithm.

We then proceed to estimate the PIPs and PM/PSD ratios by combining each of the 2 model priors with each of the 5 *g*-priors. We use a birth-death MCMC algorithm to draw from the posterior distribution, considering 2,000,000 iterations, with a burn-in of 1,000,000 and we keep the best 2000 models.[13] Since we know that the true number of variables included in regression (12) is 5, we set the prior model size accordingly. Table A.2 in the Appendix also shows the posterior model sizes for each priors combination.

We can then determine that a variable is selected by the model if it has a PIP greater than the threshold k^*/K where k^* is the posterior model size (in our case 5) and K is the total number of possible explanatory variables ($K = 25$): thus, the threshold is 0.2 (=5/25).

Table A.3 in the Appendix reports the PIPs for every variable estimated with every combination of the model prior and *g*-prior (listed in descending order based on the PIP mean). The PIPs greater than 0.2 and the variables selected by at least 6/10 priors combinations are in bold font.

Fig. 1 shows the PIPs for each variable for each prior combination. From a quick graphical inspection, we see that the PIPs of the variables included in the true model are higher than the rest of the dataset. Moreover, by combining Fig. 1 with Table A.3 in the Appendix, we can see how this robustness test on the BMA method allows us to find the variables that are part of the true data generating process. In fact, the variables x_1, x_2, …, x_5 were selected from at least 6 different combinations of prior out of 10. It is worth noting that some combinations of priors fail to select all 5 variables included in the true model, so a comparison of estimates using different combinations of priors is deemed necessary, especially when we do not know how many and which variables belong to the true regression we intend to estimate, as in Sections 6 and 7.

We then turn to examine the PM/PSD ratios and follow the rule by Raftery (1995) for setting the threshold[14]:

[13] We use the same inputs needed by the RStudio *bms* package employed in the estimates referring to the real dataset. To explore this further, see Section 6.

[14] Other rules on how to set threshold values are set out in Section 6.

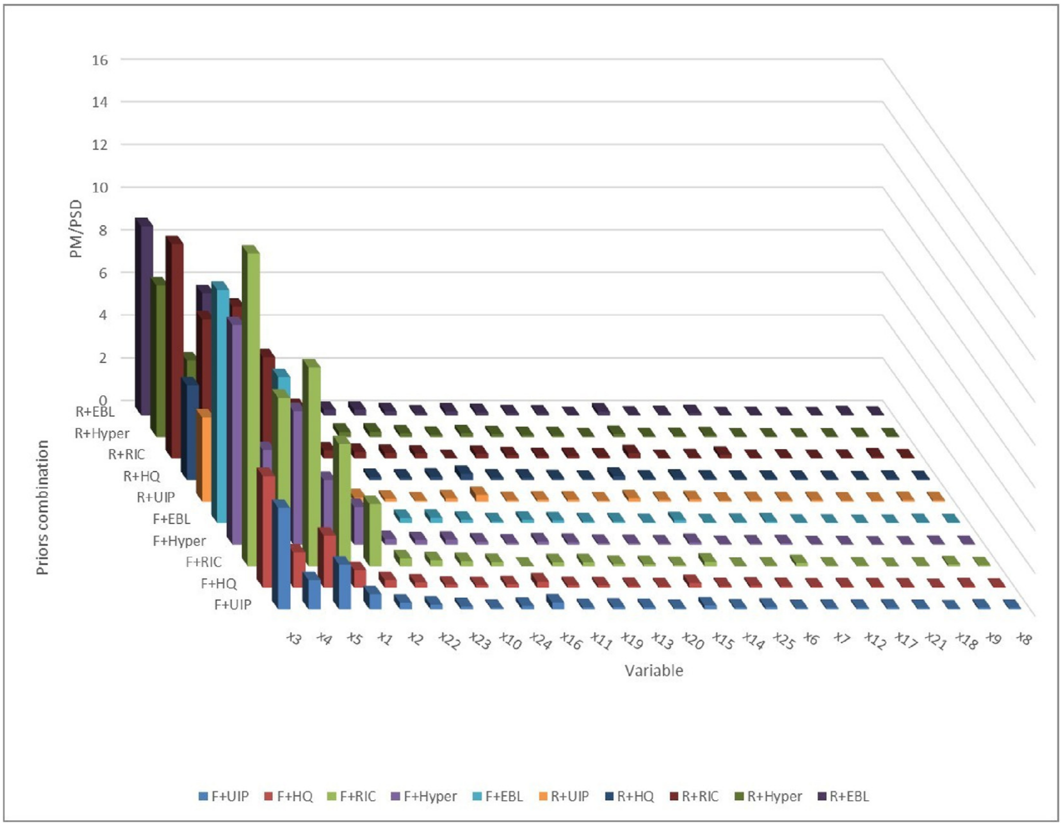

Fig. 2. Absolute posterior mean to posterior standard deviation ratios of the simulation excercise. This Figure shows the absolute Posterior Mean to Posterior Standard Deviation (PM/PSD) ratios for each explanatory variable used in the simulation experiment (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the average absolute PM/PSD ratios across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

Table 1
Coefficient estimates of the simulation excercise.

Model Prior	*g*-Prior	x_1	x_2	x_3	x_4	x_5
Fixed	UIP	0.2303*** (1.0000)	0.2020*** (0.9994)	−0.6139*** (1.0000)	−0.7480*** (1.0000)	2.5989*** (1.0000)
	HQ	0.2663*** (1.0000)	0.2293*** (0.9995)	−0.6171*** (1.0000)	−0.8250*** (1.0000)	2.7178*** (1.0000)
	RIC	0.5263*** (1.0000)	0.9573*** (1.0000)	−0.5909*** (1.0000)	−0.9049*** (1.0000)	2.8690*** (1.0000)
	Hyper	0.5016*** (1.0000)	0.8414*** (1.0000)	−0.5917*** (1.0000)	−0.9024*** (1.0000)	2.8432*** (1.0000)
	EBL	0.5073*** (1.0000)	0.8552*** (1.0000)	−0.5925*** (1.0000)	−0.9074*** (1.0000)	2.8567*** (1.0000)
Random	UIP	0.1986*** (1.0000)	0.1654*** (0.9994)	−0.6100*** (1.0000)	−0.6394*** (1.0000)	2.4031*** (1.0000)
	HQ	0.2368*** (1.0000)	0.1950*** (0.9995)	−0.6162*** (1.0000)	−0.7359*** (1.0000)	2.5810*** (1.0000)
	RIC	0.5264*** (1.0000)	0.9455*** (0.9999)	−0.5907*** (1.0000)	−0.8967*** (1.0000)	2.8774*** (1.0000)
	Hyper	0.4888*** (1.0000)	0.8126*** (1.0000)	−0.5887*** (1.0000)	−0.8808*** (1.0000)	2.8088*** (1.0000)
	EBL	0.5014*** (1.0000)	0.8386*** (1.0000)	−0.5929*** (1.0000)	−0.8963*** (1.0000)	2.8548*** (1.0000)
Mean		0.3984	0.6042	−0.6005	−0.8337	2.7411
True value		0.5000	1.1000	−0.6000	−0.8000	2.5000

This Table shows the estimates of the expected values of the coefficients for the 5 selected variables, one for each column. The first 5 rows refer to Fixed model prior, while rows 6 to 10 refer to Random theta. Rows 1 and 6 show the estimated coefficients with UIP *g*-prior, 2 and 7 with HQ, 3 and 8 with RIC, 4 and 9 with Hyper-*g*, and 5 and 10 with EBL. The 11th row shows the average coefficient between priors combinations and the last row shows the true value. It also shows the sign certainty probabilities in brackets. For negative coefficients, we report the trasformed sign certainty probability, calculated as 1 minus the estimated value. This statistic is significant at a $\alpha = 0.10$ level, if the value is higher than 0.95 (*); it is significant at a $\alpha = 0.05$ level, if the value is higher than 0.975 (**); it is significant at a $\alpha = 0.01$ level, if the value is higher than 0.995 (***).

a variable is selected from the model if the ratio in absolute value is greater than unity. Table A.4 in the Appendix shows the PM/PSD ratios for each variable for each priors combination, where in bold font are highlighted the ratios that exceed the threshold and the variables selected from at least 6 out of 10 priors combinations. Fig. 2 shows the absolute value of PM/PSD ratios for each variable for each priors combination. Also, in this case, confirming the results that have emerged so far, it can be seen that the variables belonging to

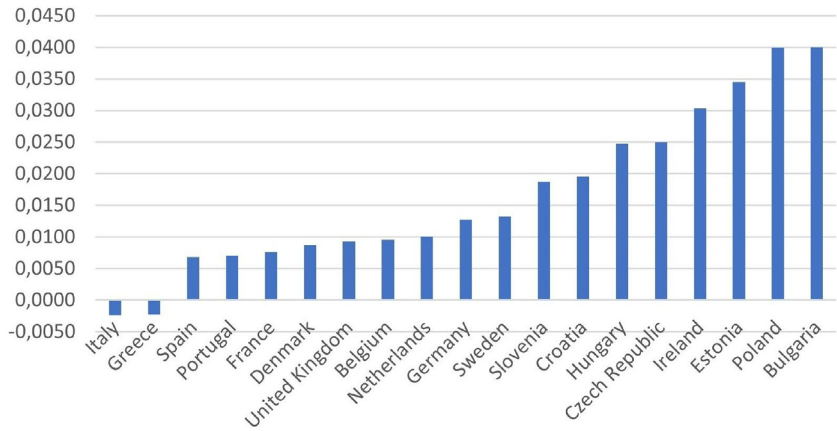

Fig. 3. Growth rates. This Figure shows the economic growth rates from the Eurostat database used as the dependent variable and calculated using the formula in (13) of the 19 countries considered in the sample. They are sorted in ascending order from lowest to highest.

the true model have much higher values than the variables not included in the regression and are precisely the 5 variables selected from at least 6 different priors combinations in Table A.4.

Finally, after selecting the variables, we examine the expected values of the estimated coefficients for each of them for each combination of priors, as shown in Table 1. This Table shows the estimates of the expected values of the coefficients for the 5 selected variables, one for each column. The first 5 rows refer to the Fixed model prior, while rows 6 to 10 refer to Random theta. Rows 1 and 6 show the estimated coefficients with UIP *g*-prior, 2 and 7 with HQ, 3 and 8 with RIC, 4 and 9 with Hyper-*g*, and 5 and 10 with EBL. The 11th row shows the average coefficient between priors combinations and the last row shows the true value. The sign certainty probabilities are also reported in parentheses, and the significance of the coefficient estimates is assigned accordingly. It can be seen immediately that all coefficients are significant at a $\alpha = 0.01$ level and that the sign of the coefficients is always equal to that of the true coefficients in (12). Moreover, for some coefficients (x_1, x_3, x_4, x_5) the mean of the estimated expected values is close or very close to the true value of the coefficients. In this way, we have shown that this method not only allows one to find the explanatory variables belonging to the true model but that one can determine the sign of the relation.

It should be noted that the results of this methodological experiment do not lead to problems of interpretation or fixing threshold values, as we have *a priori* knowledge of the number of variables that belong to the true model. Therefore, it was not necessary to decide how to fix the prior model size or the threshold value of the PIPs. However, this issue characterizes estimation with real datasets; we show how to solve it in Sections 6 and 7.

5. Data

Our sample includes 19 countries located in Europe. The dependent variable is the average annual growth rate of GDP per capita from 2002 to 2019. The variable is constructed using this formulation:

$$g = \frac{\log(GDP_T) - \log(GDP_t)}{T - t} \tag{13}$$

where *GDP* represents the GDP per capita in PPP (constant 2017 $) from the Eurostat database, $T = 2019$ is the last year of our sample and $t = 2002$ is the first year. Since the GDP per capita growth rate is calculated as reported in (13), we decide to set the last year of our sample to 2019. Had we considered 2020 or 2021, the average annual growth rate would most likely have been negative for many countries in the sample; this would lead to distorted information about economic growth trends in Europe in the early 2000s and biased final results.

Fig. 3 shows the growth rates of the countries in the sample. Bulgaria, Poland, Estonia, and Ireland experienced the highest average annual economic growth, with values greater than 0.03. Indeed, Italy, Greece, Spain, and Portugal present the lowest value. In particular, only Italy and Greece experienced a recession in the years considered.

From this preliminary analysis, it seems that CEE countries grew at a rate higher than the average rate of growth of our sample (and of the founding countries of the European Union), supporting the *catching-up* hypothesis.

At the end of the sample, excluding Ireland, we find the so-called *PIIGS* countries, i.e. the countries with explosive public debts during the financial crisis of 2008–2011.

To implement the model described in Section 3, we construct a dataset in which we include 70 potential regressors. Table A.6 of the Appendix reports the variable names, the proxies used, the units of measure, and the sources.

Given our agnostic initial position on which theory performs better in our econometric method, the explana-tory variables collected for this analysis describe different characteristics of the economy. Relying on classical growth theories (Solow (1956)), we include

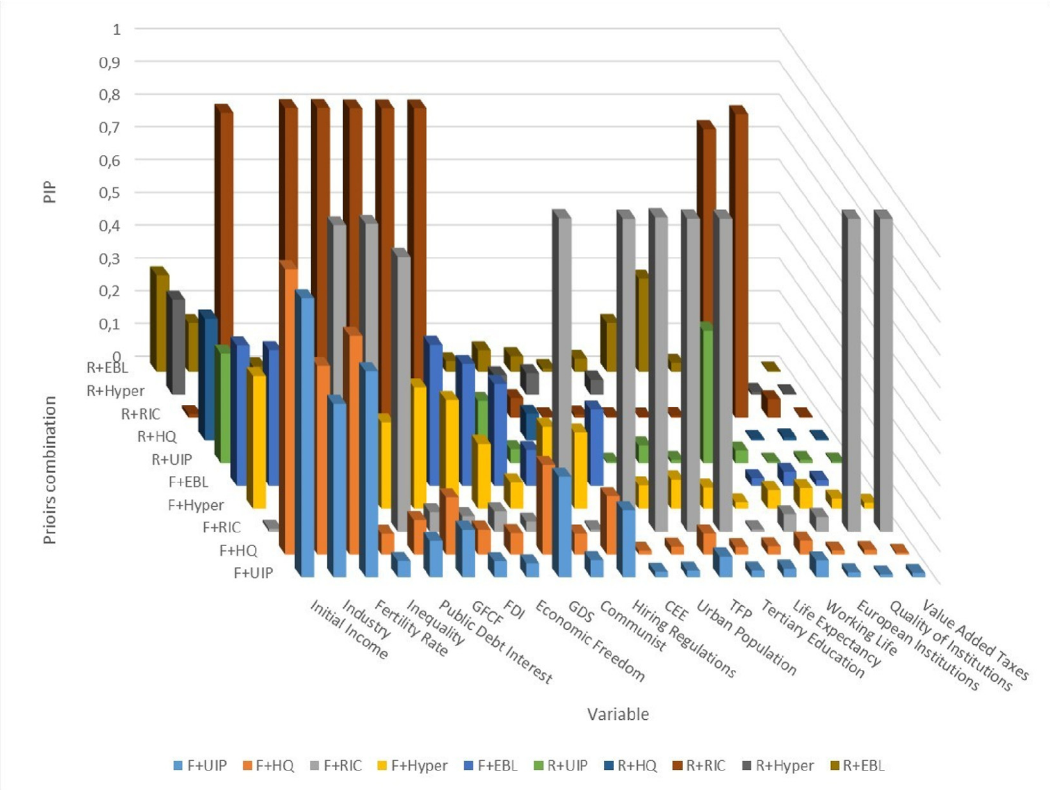

Fig. 4. Posterior inclusion probabilities of the best 20 explanatory variables. This Figure shows the Posterior Inclusion Probabilities (PIPs) for the best 20 explanatory variables (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the average PIPs across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

variables related to investment and demography. Furthermore, following Romer (1990) and Lucas Jr (1988), we insert variables concerning human capital and R&D and innovation.

From the seminal works by Sala-i Martin et al. (2004) and Fernandez et al. (2001b), we include regressors capturing the economic structure and the macroeconomic conditions of the countries, and variables related to geography and international trade.

Also, given the common characteristics of the countries with the lowest rate of growth, regressors concerning public finance, public debt, and the financial sector are collected.

Following the logic of Acemoglu and Robinson (2012), our dataset includes also variables related to the institutional framework of the sample.

Finally, to extend the literature exposed in Section 2, we insert also variables related to 3 new research fields.

We include dummy variables related to the European Union integration process, regarding the membership at the beginning of the sample, the adoption of the single currency during the whole sample, or the presence of at least one European institution or agency in the country. The initial level of inequality and the growth of inequality are also used. Finally, variables related to climate and environmental policy are collected.

Table A.7 in the Appendix reports the descriptive statistics of the dataset. The dependent variable is in the first row, whereas all the regressors are exposed in alphabetic order. The table reports the mean, the standard deviation, the minimum, and the maximum. These values are 0 and 1 for the dummies included.

6. Results

To assess the robustness of each variable as a determinant of growth, we compare 10 different BMA estimates, combining 2 model priors and 5 *g*-priors.[15]

To fix the prior model size (for both model priors), we rely on the posterior model size estimated with the Uniform model prior. Our

[15] The econometric methodology adopted has been introduced in Section 3.

results suggest that the maximum number of variables to be included in the regression is 15, as shown in Column 4 of Table A.8 of the Appendix.[16]

It is redundant to specify the different values of g in every *g*-prior.[17] For the Hyper prior, we select the default value of $a = 2.1053$.

Given that we collect 70 explanatory variables, the dimension of the set of all possible models is 270, whose estimation would be unfeasible or very time-consuming. This is the reason why we rely on Bayesian methods. Thus, we use a birth-death MCMC algorithm to draw from the posterior distribution, considering 2,000,000 iterations, with a burn-in of 1,000,000. Our results refer to the best 2000 models.[18] We use the *bms* package for the software RStudio, following Amini and Parmeter (2011) and Zeugner (2011).

Table A.9 in the Appendix reports the PIPs for every variable estimated with every combination of the model prior and *g*-prior (listed in descending order based on the PIP means). This statistic represents the probability of being included in the final model of every variable. Raftery (1995) states that a variable is considered (weakly) robust if its PIP is greater than 0.5. However, if we were to rely on this threshold, it would be very difficult to select the variables considered robust: according to the estimates reported in Table A.9, at most, we could identify two variables selected from at least 3 different priors combinations out of 10 (and in any case, the final results would not differ from those presented here). Therefore, we prefer to use the rule of thumb used by Sala-i Martin et al. (2004), according to which the inclusion of a variable in the model is conditional on having a PIP greater than k^*/K where k^* represents the posterior model size. We select $k^* = 12$ both for models estimated with a Fixed and a Random theta model prior, as this is the maximum value obtained for posterior model size with Fixed or Random theta model prior.[19] Thus, we select only the variables with a PIP greater than the threshold value $12/70 = 0.1714$ (whose PIPs are in bold font in the Table).

In the first 5 columns of Table A.9 (not taking into account the column defining the variables), we report the PIP using the Fixed model prior, while, from column 6 onwards, the PIPs using the Random theta model prior are shown. Table A.9 presents the estimates obtained for every model prior combined with a different *g*-prior: columns 1 and 6 refer to the UIP specification, columns 2 and 7 to the HQ, columns 3 and 8 to the RIC, columns 4 and 9 to the Hyper-*g* and, finally, columns 5 and 10 to the EBL.

Variables with a PIP greater than the threshold value 0.1714 in at least 4 different specifications are in bold font. Moreover, the same results are shown in Fig. 4, for the sake of ease of interpretation: in fact, Fig. 4 shows the PIPs for the first 20 variables (sorted in descending order based on the mean of the PIPs) for each prior combination.

The first result achieved is the absence of variables robust to all the 10 specifications. Nevertheless, we consider just robust the variables that are selected by at least 4 different specifications, at least at this stage. According to the estimates reported in Table A.9, the initial level of GDP per capita turns out to be the most robust of the variables in our dataset, as it is selected by 8 out of 10 different priors combinations. This result confirms the theory of *conditional convergence* and *catching up*, according to which countries with lower levels of initial income tend to achieve higher rates of economic growth than others over the same time horizon[20]. Moreover, this result is in line with the main applications of BMA to growth theory (Fernandez et al. (2001b); Sala-i Martin et al. (2004); Błażejowski et al. (2016)).

The share of manufacturing in GDP is considered a robust variable because it is selected by 6 out of 10 different prior combinations, followed by initial savings (GDS), which is selected by 5 out of 10 prior combinations. To extend our set of robust variables, we can also include those that are selected by 4 out of 10 prior combinations. We then find the fertility rate, the initial level of inequality as measured by the Gini index, the initial capital stock (GFCF), the severeness of labor contract restrictions (Hiring regulations), and life expectancy.

These results are consistent with the Solow (1956) growth model, according to which growth is generated primarily by savings (and thus by the stock of invested capital). The robustness of manufacturing shares in GDP and fertility rate could confirm again the *conditional convergence* hypothesis because the countries with the highest initial levels of these variables are also those with the lowest initial GDP per capita.[21]

We cannot yet comment on the direction of the relationship (positive, negative, or null), especially since it is not taken for granted *a priori* for fertility rate and labor contracts regulation. Regarding the fertility rate, higher initial levels may lead to a growth in population-level (which would decrease final GDP per capita, at the same GDP) and/or a growth in the workforce (increasing output and final GDP per capita). By analyzing the coefficients we might be able to understand whether the first effect will dominate over the other or vice versa (or whether they cancel out).

Two effects are also identified concerning labor contract regulation. This index has values near 1, if fixed-term contracts are prohibited for permanent tasks if the maximum length of fixed-term contracts is 3 years, and if the share of the minimum wage over value added is more than 0.75. Theoretically, an increase in this index represents higher labor costs for the firm and higher prices. This inflationary effect should not lead to an increase in output. But we can identify a second effect: higher minimum wages and more restrictions in labor contracts move up the whole distribution of wages, leading to a higher level of GDP per capita.

Another important statistic useful for selecting regressors under BMA is analyzed in Table A.10. Here we report the estimated Posterior Mean to PM/PSD ratios values for each variable for each combination of priors.

The variables are listed in descending order based on the absolute value of the average PM/PSD ratio. The corresponding graph is

[16] We round up to the next integer value.

[17] See Section 3.

[18] This is necessary to have standardized results over the different combinations of priors, since the number of models visited is different, according to the acceptance-rejection phases of the MCMC algorithm. In this way, our estimates are also robust to different algorithm specifications.

[19] This is the maximum value reported in Columns 2–3 of Table 10 of the Appendix.

[20] We can already confirm this result, since the coefficients are negative, as Table 2 shows.

[21] This result is confirmed by the analysis of the coefficients in Table 2.

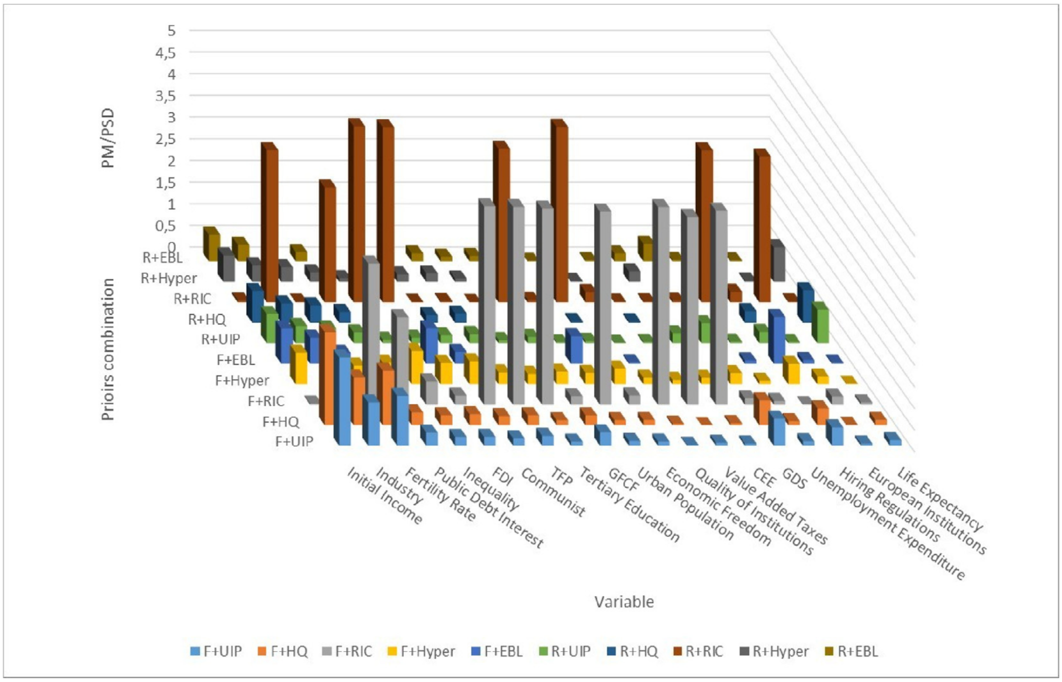

Fig. 5. Absolute posterior mean to posterior standard deviation ratios of the best 20 explanatory variables. This Figure shows the absolute Posterior Mean to Posterior Standard Deviation (PM/PSD) ratios for the best 20 explanatory variables (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the average absolute PM/PSD ratios across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

shown in Fig. 5, which shows the absolute values of the PM/PSD ratios of the top 20 variables (sorted in descending order according to the mean of these absolute values) for each priors combination.

Raftery (1995) proposes as a selection criterion the choice of variables whose PM/PSD ratio is greater than 1 in absolute terms, while for Masanjala and Papageorgiou (2008) the threshold is 1.3. Finally, Sala-i Martin et al. (2004) set the threshold at 2. We decide to rely on the Raftery (1995) criterion, to select variables that exceed the threshold in at least 2 different prior combinations.[22] PM/PSD values greater than 1 in absolute value are in bold, as are variables that pass this test on at least 2 prior combinations.

According to the estimates reported in Table A.10, no variable is hyper-robust. However, we can keep the 4 variables with a PM/PSD ratio greater than one in absolute terms in at least 2 prior combinations. These are the initial level of GDP per capita, the share of manufacturing in GDP, the fertility rate, and interest expenditure on public debt. Regarding the first 3, we can call them "robust", in that they have already been selected according to the procedure for comparing the estimates of the PIP analyzed in Table A.9. Thus, we have further confirmation of the *catching-up* theory in Europe.

An interesting result emerges concerning interest expenditure on debt: we expect the sign of this relationship to be negative, as can be seen by looking at Fig. 3. In our sample, the countries with the lowest growth rate are those whose public debts exploded following the crises of 2008 and 2011, and who therefore increased their interest spending on debt relative to the others.

In Table 2 we report the expected value of the coefficients and the sign certainty probabilities estimated using the 10 priors combinations for each variable selected by the statistics analyzed. Here, we intend to comment only on the direction of the relationship between each variable and the economic growth rate, so the magnitude of the coefficients will not be analyzed, only their sign. The Table shows the estimates of the expected values of the coefficients for the selected variables, one for each column. The first 5 rows refer to the Fixed model prior, while rows 6 to 10 refer to Random theta. Rows 1 and 6 show the estimated coefficients with UIP *g*-prior, 2 and 7 with HQ, 3 and 8 with RIC, 4 and 9 with Hyper-*g*, and 5 and 10 with EBL. The 11th row shows the average coefficient between priors combinations.

As we expected, the initial level of GDP per capita has a negative sign in all prior specifications, again confirming the theory of *conditional convergence*. In addition, the sign certainty probabilities indicate that this sign is significant at the 99% level in 8 out of 10 combinations.

Further confirmation of this theory is obtained by analyzing the expected value of the coefficients of the share of manufacturing in GDP and the fertility rate, both positive, if we exclude the null value of the fertility rate in the combination Random theta model prior and RIC *g*-prior. The countries with the lowest initial levels of GDP per capita (mainly located in CEE) are also those with the highest

[22] We set the threshold of priors combinations to 2 to select 4 variables, otherwise none would be chosen. In any case, we will only call these variables "robust" if they are also selected by 4 out of 10 priors according to the PIP criterion in Table A.9.

Table 2
Coefficient estimates.

Model Prior	*g*-Prior	Initial Income	Industry	Fertility Rate	Inequality	Life Exp.	Hiring Reg.	GFCF	GDS	P. Debt Interest
F	UIP	−0.0287*** (1.0000)	0.0930** (0.9944)	0.0164*** (0.9990)	0.0086*** (0.9952)	0.3071* (0.9644)	0.0036** (0.9792)	−0.0453*** (0.9985)	0.0368*** (0.9966)	−0.0574*** (0.9987)
	HQ	−0.0301*** (1.0000)	0.1023*** (0.9976)	0.0176*** (1.0000)	0.0116*** (1.0000)	0.2857 (0.9497)	0.0030** (0.9856)	−0.0550*** (0.9962)	0.0333** (0.9927)	−0.0542** (0.9937)
	RIC	−0.0000 (0.8123)	0.0010 (0.7195)	0.0067*** (1.0000)	0.0352*** (1.0000)	−0.0255 (0.8750)	0.0000 (0.2260)	−0.0272 (0.6822)	0.0010 (0.8952)	−0.0784** (0.9911)
	Hyper	−0.0125*** (0.9995)	0.0242 (0.7246)	0.0044 (0.9419)	0.0833** (0.9916)	0.0302 (0.4903)	0.0043* (0.9836)	−0.1093 (0.9258)	0.0097 (0.9412)	−0.1159* (0.9278)
	EBL	−0.0184*** (0.9995)	0.0301 (0.9256)	0.0015 (0.8897)	0.1077*** (0.9993)	−0.0534 (0.7178)	0.0114** (0.9907)	−0.1431*** (0.9961)	0.0382* (0.9642)	−0.0909* (0.9781)
R	UIP	−0.0101*** (1.0000)	0.0235*** (0.9966)	0.0031*** (0.9993)	0.0012*** (1.0000)	8.1832*** (0.9998)	0.0015*** (0.9975)	−0.0103** (0.9933)	0.0224*** (0.9979)	−0.0388*** (0.9989)
	HQ	−0.0115*** (1.0000)	0.0291*** (0.9947)	0.0041*** (0.9995)	0.0013*** (1.0000)	7.9461*** (0.9998)	0.0016*** (0.9975)	−0.0126** (0.9933)	0.0241*** (0.9979)	−0.0391*** (1.0000)
	RIC	−0.0001 (0.2889)	0.0684*** (0.9984)	0.0000 (0.8661)	0.3313*** (1.0000)	−0.0016* (0.9640)	0.0017** (0.9993)	−0.4703*** (1.0000)	0.0002* (0.9583)	−0.1223*** (1.0000)
	Hyper	−0.0088*** (1.0000)	0.0224*** (0.9976)	0.0030*** (0.9988)	0.0015*** (1.0000)	8.4504*** (1.0000)	0.0012*** (0.9972)	−0.0088** (0.9885)	0.0181*** (0.9987)	−0.0289*** (0.9974)
	EBL	−0.0093*** (1.0000)	0.0234*** (0.9701)	0.0034 (0.7961)	0.0027*** (1.0000)	5.8111*** (1.0000)	0.0013** (0.9949)	−0.0106** (0.9870)	0.01833** (0.9925)	−0.0289*** (0.9970)
Mean		−0.0130	0.0417	0.0060	0.0584	3.0909	0.0030	−0.0893	0.0202	−0.0655

This Table shows the estimates of the expected values of the coefficients for the selected variables, one for each column. The first 5 rows refer to Fixed model prior, while rows 6 to 10 refer to Random theta. Rows 1 and 6 show the estimated coefficients with UIP *g*-prior, 2 and 7 with HQ, 3 and 8 with RIC, 4 and 9 with Hyper-*g*, and 5 and 10 with EBL. The 11th row shows the average coefficient between priors combinations. It also shows the sign certainty probabilities in brackets. For negative coefficients, we report the trasformed sign certainty probability, calculated as 1 minus the estimated value. This statistic is significant at a $\alpha = 0.10$ level, if the value is higher than 0.95 (*); it is significant at a $\alpha = 0.05$ level, if the value is higher than 0.975 (**); it is significant at a $\alpha = 0.01$ level, if the value is higher than 0.995 (***).

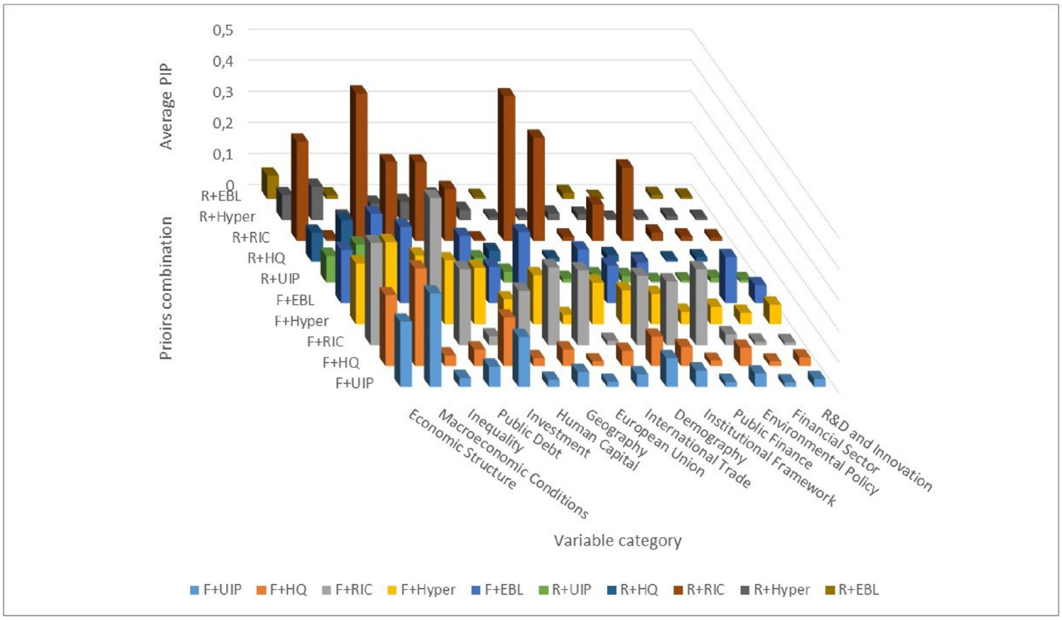

Fig. 6. Average posterior inclusion probabilities by variable category. This Figure shows the average Posterior Inclusion Probabilities (PIPs) for the variables categories (on the x-axis) for each combination of priors (on the y-axis). Categories are sorted in descending order based on the average PIPs across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

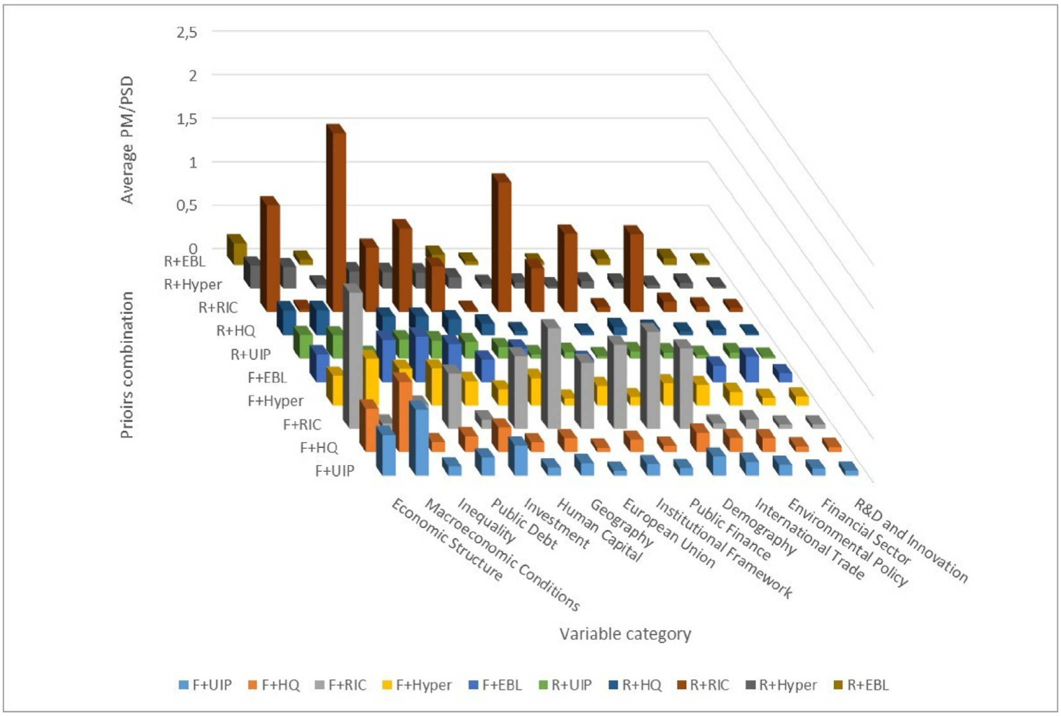

Fig. 7. Absolute average posterior mean to posterior standard deviation ratios by variable category. This Figure shows the absolute average Posterior Mean to Posterior Standard Deviation (PM/PSD) ratios for the variables categories (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the absolute average PM/PSD ratios across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

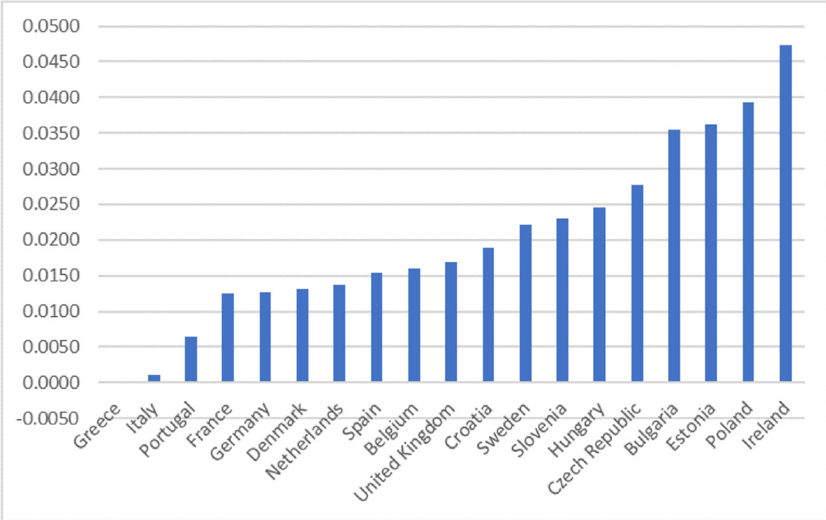

Fig. 8. Growth rates from the world bank database. This Figure shows the economic growth rates from the WorldBank database used as the dependent variable in this Section of the 19 countries. They are sorted in ascending order from lowest to highest.

initial shares of manufacturing in GDP and with the highest fertility rate, as well as those that have exhibited the greatest economic growth over the analyzed time horizon.

Regarding the fertility rate, it thus appears that the stimulus effect of the labor force outweighs the population growth effect, raising the final level of GDP per capita.

The initial level of inequality seems to positively impact growth, probably still driven by the large inequalities of the early 2000s in the ex-communist countries.

Life expectancy shows mixed signs, so we cannot comment on this result. Certainly, if it were necessary to choose a demographic variable, given the results obtained, we would use the fertility rate.

Regarding the severity of labor contract restrictions, we can infer from the expected values of the coefficients that economic growth in our sample is demand-driven. Theoretically, an increase in this index represents higher labor costs for the firm and higher prices. This inflationary effect should not lead to an increase in output. But we can identify a second effect: higher minimum wages and more restrictions in labor contracts move up the whole distribution of wages, leading to a higher level of GDP per capita. In this context, the second effect prevails the first. Thus, labor contracts that are more favorable to employees seem to boost economic growth in our framework. Sign certainty probabilities are also significant at least at the 95% level in 9 out of 10 priors specifications.

Moreover, as regards investment in fixed capital, the expected values of the coefficients all have a negative sign. This result would not seem to be in line with the main growth theories mentioned above, but the relationship could be non-linear. We leave the further development of this report to the experts in this field of research.

The sign of savings is positive in all 10 priors combinations: this result is therefore in line with the Solow (1956) growth model.

Finally, interest expenditure on public debt always presents a negative coefficient and always with a significant sign certainty probability at least at the 90% level. There is no doubt that the real economy of the countries that had to increase their public debts following the crises of 2008 and 2001, with a consequent increase in interest expenditure (due both to an increase in riskiness and to an increase in the debt itself), slowed down considerably during the period analyzed.

In conclusion, we analyze PIPs and PM/PSD ratios by variable category to generically select determinants of growth and provide policy advice.

We first group the 70 variables into the 15 categories reported in italic font in Table A.6 in the Appendix. For each category, we calculate the mean PIPs and the mean absolute PM/PSD ratios and report the values obtained in Tables 13 and 14 in the Appendix, respectively. The PIPs and the absolute values of PM/PSD ratios greater than the thresholds already used in this Section are highlighted in bold font, as are categories selected from at least 4/10 priors combinations in Table A.11 and at least 2/10 priors combinations in Table A.12. These results are also shown in Figs. 6 and 7.

When analyzing PIPs, the determinant categories of economic growth in Europe are economic structure, macroeconomic conditions, and inequality, while only economic structure is a robust category when looking at PM/PSD absolute ratios. From this initial analysis, we can deduce that investments in manufacturing, services, and TFP are the primary driver of growth in Europe during the period under consideration. These are followed by the macroeconomic context of departure and the level of inequality.

7. Robustness checks

We propose in this Section a robustness check of the previously discussed results, using the same dataset described in Table A.6 in the Appendix for the 70 explanatory variables and changing the dependent variable. As a proxy for the economic growth rate of the

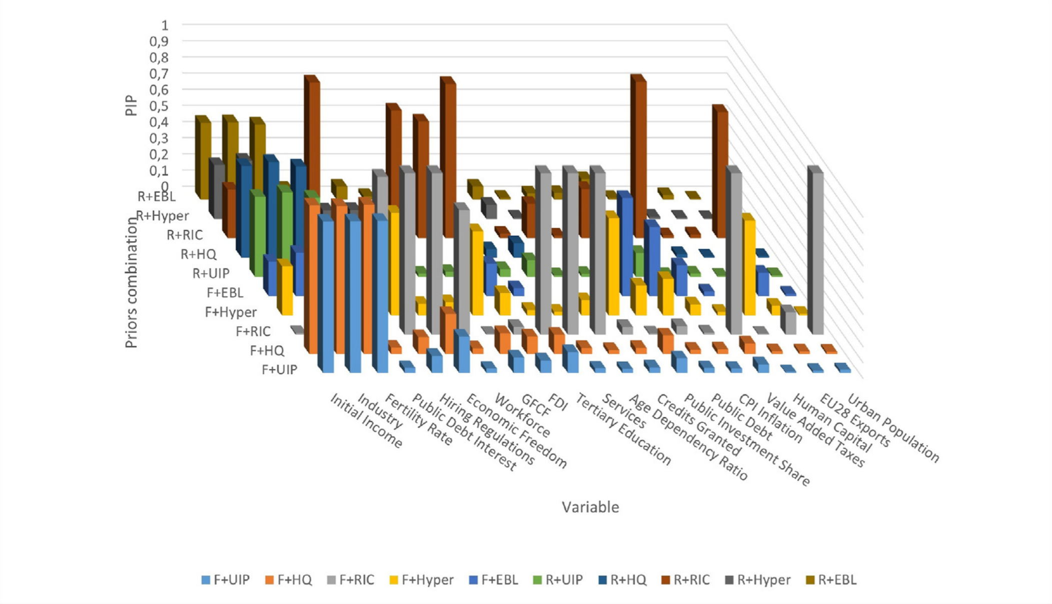

Fig. 9. Posterior inclusion probabilities of the best 20 explanatory variables (change in the dependent variable). This Figure shows the Posterior Inclusion Probabilities (PIPs) for the best 20 explanatory variables of the robustness checks (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the average PIPs across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

European countries considered, we use this time the World Bank growth rate. Fig. 8 shows the growth rates used in this Section as dependent variable.

We repeat the same experiment reported in Section 6 and analyze the results obtained for PIPs and PM/PSD ratios, both by single variable and by variable categories, but do not go on to investigate the estimated coefficients.

We are here interested in testing whether the previously selected variables are valid, even by slightly changing the proxy of the dependent variable. The inputs of the RStudio *bms* package are not changed: we set the prior model size to15,[23] use a birth-death MCMC algorithm, consider 2,000,000 iterations with a burn-in of 1,000,000 and analyze the best 2000 models.[24] The 2 model priors and 5 *g*-priors are also the same as those already described in Section 3 and employed in the estimates in Sections 4 and 6.

Table A.13 in the Appendix shows the estimated posterior model sizes for each combination of priors. Following the rule observed earlier, we choose the maximum value and set the posterior model size k^* to14.[25] Then, according to the rule of thumb proposed by Sala-i Martin et al. (2004), to be included in the model, a variable must have a PIP greater than 14 = 0.2. The estimates of PIPs for each variable for each priors combination are shown in Table A.14 in the Appendix, where in bold font we find the PIPs greater than the threshold and the variables selected from at least 4/10 priors combinations. Fig. 9 shows the same result, referring to the best 20 explanatory variables sorted in descending order according to the average PIP across priors combinations.

We obtain results that are more "parsimonious" than the benchmark ones: only 4 variables are selected from at least 4/10 priors combinations.[26] All these variables were already mentioned among the most robust in Section 6. In particular, the initial level of GDP per capita is selected from 9/10 priors combinations, the share of manufacturing in GDP and the fertility rate from 8/10, and interest on public debt[27] from 4/10.

Therefore, this result, confirms the importance of initial conditions, production structure, demographic trends, and the public finance situation in determining economic growth in Europe.

In addition, we analyze the PM/PSD ratios reported in Table A.15 in the Appendix, where in bold font are highlighted the ratios greater than unity in absolute value and the variables selected from at least 2/10 priors combinations. The corresponding graph is provided by Fig. 10, which shows the absolute values concerning the best 20 explanatory variables ordered by the absolute value of the mean PM/PSD ratios across priors combinations.

The 4 variables discussed under the PIPs results also emerge here. To these are added: labor market recruitment conditions,

[23] We assume that the prior model size does not change with the change in the dependent variable since the numerosity of the explanatory variables is the same as in Section 6. In addition, we choose to use the same value for consistency.

[24] This is needed to be coherent with the algorithm employed in Section 6.

[25] This is the maximum value shown in Table A.13 in the Appendix.

[26] This result is probably achieved because the PIP threshold used in this Section is higher than that in Section 6 (0.20 > 0.1714).

[27] Recall that these variables had also led to easy and clear logical interpretation of the signs of the coefficients estimates reported in Table 2.

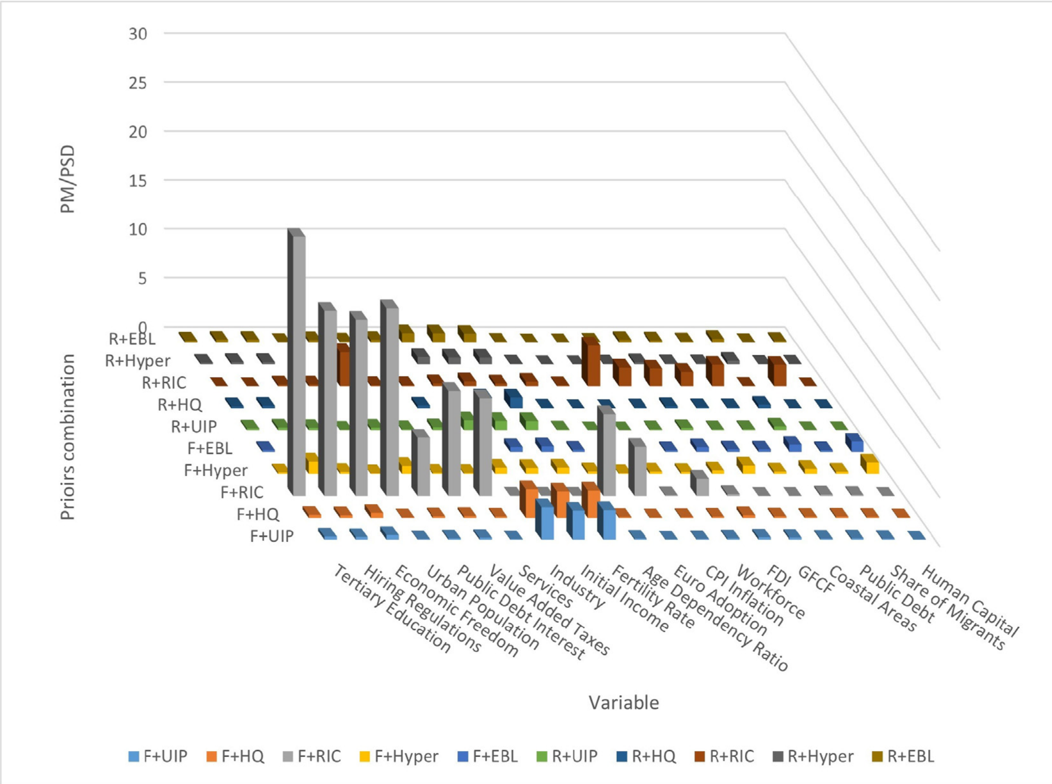

Fig. 10. Absolute posterior mean to posterior standard deviation ratios of the best 20 explanatory variables (change in the dependent variable). This Figure shows the absolute Posterior Mean to Posterior Standard Deviation (PM/PSD) ratios for the best 20 explanatory variables of the robustness checks (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the average absolute PM/PSD ratios across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

workforce, and human capital.

In light of what has been discussed so far, and comparing the results obtained in Section 6 with those just described, we can select 5 variables that are fundamental to economic growth in Europe from 2002 to 2019: the initial level of GDP per capita, the fertility rate, the share of manufacturing in GDP, interest expenditure on debt and hiring regulations. These variables have been selected in the two Sections and present no ambiguity in the direction of the link to economic growth, commented on earlier.

To eliminate the multicollinearity problem, we finally report in Table A.16, the correlation coefficient between these variables. We discretionally set the critical threshold at 0.8 in absolute value, beyond which the coefficient estimates would be biased, and ensure that no pair of variables exposes us to this risk.[28]

It is also important to note that the selection of some variables in Section 6 that were not chosen in this Section and vice versa, unlike the clarity in the choice reported in the simulation experiment in Section 4, is attributable to the probably non-linear relationship between growth rate and any explanatory variable.

This relationship is certainly not mathematical, as in (1). No model can capture with extreme certainty the fundamental variables, also because they may differ from country to country or over time. Nonetheless, with this methodology, we have tried to clarify and give a contribution concerning the *mare magnum* of the possible determinants of growth.

In conclusion, we analyze the PIPs and PM/PSD ratios averaged by variable category, shown in Tables 19 and 20 in the Appendix, respectively. Again, PIPs greater than 0.2 and PM/PSD ratios greater than unity in absolute value are highlighted in bold font, as are the categories selected from at least 4/10 priors combinations in Table A.17 and at least 2/10 priors combinations in Table A.18. Figs. 11 and 12 show the PIPs and absolute value of PM/PSD ratios for each category of variables for each priors combination. Variables are sorted in descending order according to the mean of the statistic considered across priors combinations. Confirming previous findings, the economic structure is again a key category regarding economic growth, as well as macroeconomic conditions.

[28] We can compare this result with the correlation coefficients between the variables in the simulation exercise shown in Table A.5 in the Appendix. Even then, although we were aware of the distribution of each variable and which ones were included in the true model, none of the correlations had critical values.

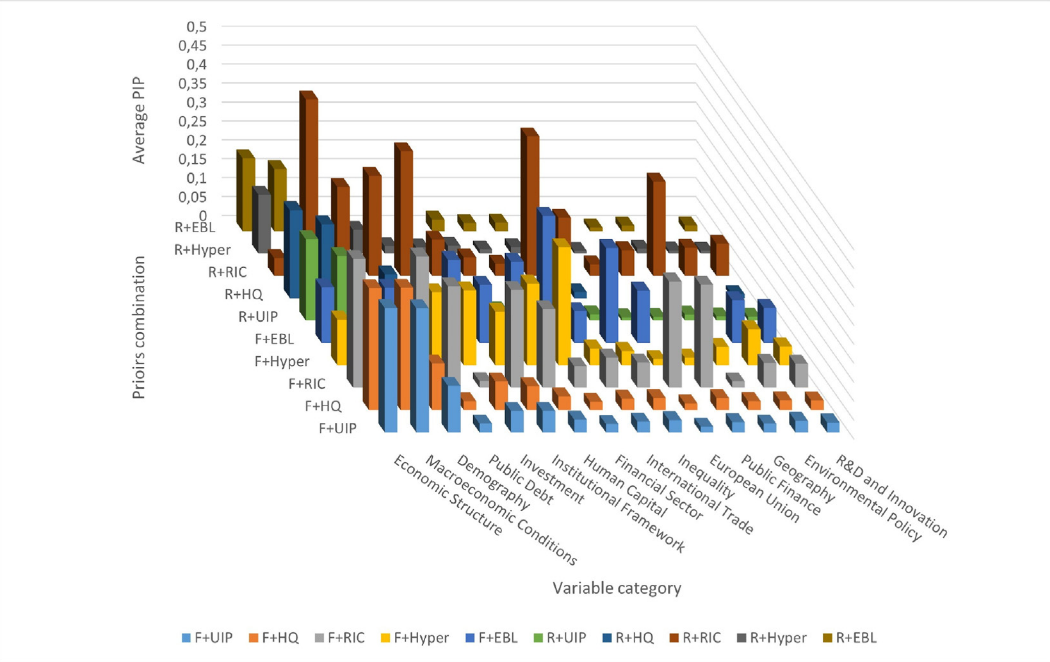

Fig. 11. Average posterior inclusion probabilities by variables category (change in the dependent variable). This Figure shows the average Posterior Inclusion Probabilities (PIPs) for the variables categories of the robustness checks (on the x-axis) for each combination of priors (on the y-axis). Categories are sorted in descending order based on the average PIPs across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

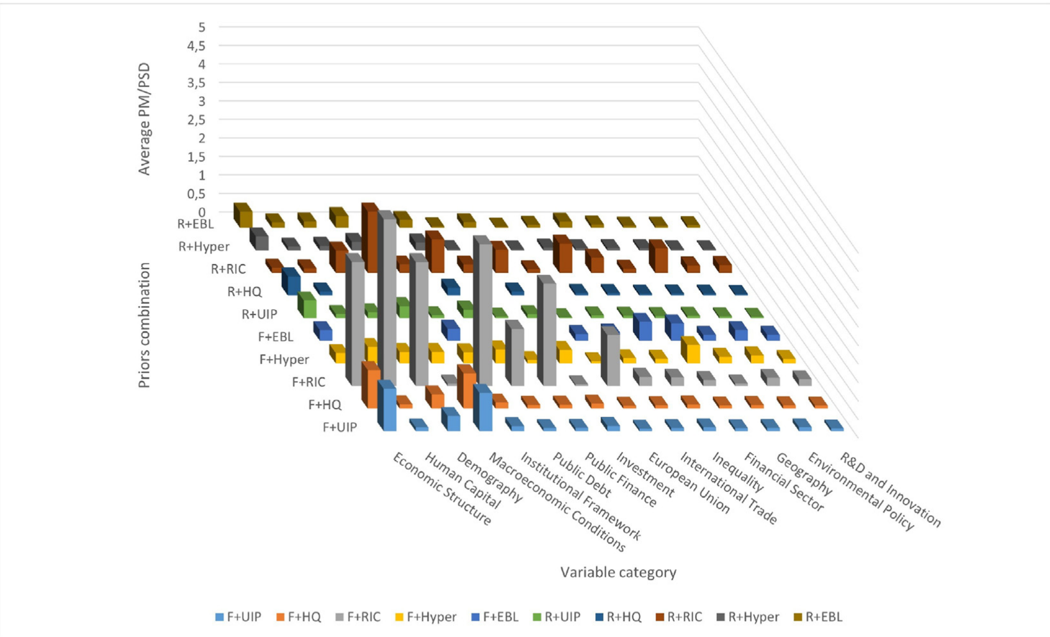

Fig. 12. Absolute average posterior mean to posterior standard deviation ratios by variables category (change in the dependent variable). This Figure shows the absolute average Posterior Mean to Posterior Standard Deviation (PM/PSD) ratios for the variables categories of the robustness checks (on the x-axis) for each combination of priors (on the y-axis). Variables are sorted in descending order based on the absolute average PM/PSD ratios across priors combinations. F stands for "Fixed model prior", while "R" stands for "Random Theta model prior". The abbreviations used for *g*-priors are described in Section 3.

8. Conclusion and further extensions

In this work, we assessed the robustness of the determinants of growth in Europe from 2002 to 2019 by performing 10 different BMA estimations. These posterior models are derived from 2 different specifications of the model prior and 5 different specifications of the coefficient prior (Zellner (1986) *g*-prior). Among the 70 explanatory variables in our database, the most robust variables were those selected both by analyzing the PIPs and the PM/PSD ratios estimated with the 10 priors combinations.

We find evidence for the *catching-up* process: the initial level of income is the most robust variable in our sample and it is negatively related to growth. This finding is also supported by the robustness of the share of the manufacturing sector in GDP since countries with the lowest initial level of GDP per capita are also the ones with the highest share of manufacturing in GDP and with the highest growth rates on average.

Higher fertility rates boost growth, by increasing the labor force in the country. This effect prevails the negative effect of an increase in the population, supporting again the *conditional convergence* hypothesis. Domestic saving positively affects growth and is one of the most robust determinants. In contrast, interest expenditure on debt dampens growth in our sample.

In addition, less flexible labor contracts and higher minimum wage are positive and robust determinants of growth. We would have expected an inflationary effect caused by higher production costs for the employer. Yet, according to our findings, a labor market that stabilizes the workforce and guarantees higher minimum wages stimulates economic growth. Further research is needed to understand whether the transmission channel of this effect is an increase in productivity.

The initial level of inequality and the stock of fixed capital can be considered robust variables when analyzing the PIPs. Yet, estimates of the direction of their impact on growth show controversial results or are difficult to interpret here. Future works could clarify this point, also considering different proxies.

The clearest result that emerges from a comparison of the benchmark estimates with the robustness checks allows us to state with certainty that the fundamental and most robust determinants of growth are: the initial level of GDP per capita, the fertility rate, the share of manufacturing in GDP, interest expenditure on debt and hiring regulations. To draw policy implications, this study would direct investment towards targeted economic sectors in European countries, in particular, the secondary and tertiary sectors. The manufacturing sector still proves to be one of the main drivers of growth on the continent, even though several technological innovations have occurred since the initial years of our sample. We believe that increased productivity via TFP and/or better working conditions for employees can stimulate recovery in the immediate term and growth in the longer term. Policies aimed at reversing the demographic decline, better conditions of entry and stabilization in the labor market, and reduction of interest expenditure on debt (and on the public debt itself) are desirable soon, also thanks to the use of the Recovery Fund, allocated by the European Commission.

To extend this work, a more complete sample should be considered, possibly including more countries or collecting data covering a longer time horizon. We also suggest using other *g*-prior specifications, as presented by Fernandez et al. (2001a), changing the model prior size in the Fixed prior specification, performing a different MCMC algorithm, increasing the number of iterations, or the number of best models considered. It should be noted that the results obtained also derive from a certain degree of discretion: probably different priors or another MCMC algorithm would lead to different inferences. Of fundamental importance is the final number of variables included in the dataset and the choice of critical thresholds: as the number of possible explanatory variables increases, the critical threshold in the selection based on PIPs might decrease. With this study, however, we have shown that although these threshold values are not high (and indeed, lower than 0.5), by comparing different priors combinations we still select a very small group of variables. We leave to future work the commitment to curb as much as possible the degree of discretion present in the proposed methodology.

Moreover, further extension of the Bayesian Model Averaging framework should rely on the jointness of growth determinants (Doppelhofer and Weeks (2009)), on the use of limited information criteria (Chen et al. (2009); Mirestean and Tsangarides (2009)) or on the Measurement Error Model Averaging approach (Doppelhofer et al. (2016)).

These new methods are well beyond the scope of our paper, but we expect that scholars will focus on the Weighted Average Least Square approach (Magnus et al. (2010); Magnus and Wang (2014)) in the future. This method is computationally superior and time-saving to BMA and the results are not affected by the selection of the *g*-prior.

To conclude, the natural continuation of this research in the future would be to use a panel approach, taking account of endogeneity and the dynamics of the time series, for instance by implementing the Limited Information Bayesian Model Averaging (LIBMA) methodology proposed by Leon-Gonzalez and Montolio (2015), Moral-Benito (2016), or Mirestean and Tsangarides (2016). We could also use a machine-learning algorithm to select the main determinants of growth as soon as the panel extension of our database is ready. Complementary work to this could also be accomplished by implementing a Frequentist Model Averaging (FMA) approach (Hansen (2007)).

Acknowledgements

The author would like to sincerely thank Carmelo P. Parello for his guidance in the research activity. Special thanks for their valuable comments are addressed to Krzysztof Beck, Francesco Ravazzolo, and Maxime Fajeau. Without their valuable contribution, the present work would not be as complete and robust against several criticisms. The author would like to thank Barbara Rossi, Stefan Zeugner, Jamel Trabelsi, Andreas Sintos, Pantelis Karapanagiotis, Paolo Onorati, Federica Vassalli, Sugara Seneviratne, and Nicu Sprincean for their suggestions. Finally, the author thanks the anonymous reviewers for their valuable comments. The views expressed in this paper are those of the author and do not necessarily reflect those of Sapienza University of Rome or Sogei S. p.A.

Appendix

Table A.1
Variables in the Simulation Excercise

Variable Name	Distribution	Included in the True Model
x_1	Ordered Numbers from 1 to 15	Yes
x_2	$N(-1, 10)$	Yes
x_3	$\chi^2(10)$	Yes
x_4	$U(-5, 5)$	Yes
x_5	$Bin(10, 0.5)$	Yes
x_6	$N(2, 10)$	No
x_7	$N(5, 6)$	No
x_8	$N(-3, 10)$	No
x_9	$N(-7, 3)$	No
x_{10}	$N(1, 99)$	No
x_{11}	$N(4, 100)$	No
x_{12}	$N(0, 10)$	No
x_{13}	$\chi^2(2)$	No
x_{14}	$\chi^2(4)$	No
x_{15}	$\chi^2(60)$	No
x_{16}	$\chi^2(5)$	No
x_{17}	$U(-1, 3)$	No
x_{18}	$U(0, 5)$	No
x_{19}	$U(-5, 10)$	No
x_{20}	$U(-15, 0)$	No
x_{21}	$U(-8, 8)$	No
x_{22}	$Bin(5, 0.5)$	No
x_{23}	$Bin(10, 0.2)$	No
x_{24}	$Bin(100, 0.5)$	No
x_{25}	$Bin(50, 0.8)$	No
ε	$N(0, 1)$	Yes

Table A.2
Posterior Model Size of the Simulation Excercise

g-prior/Model Prior	Fixed	Random
UIP	5.15	5.08
HQ	5.22	5.20
RIC	5.71	5.94
Hyper	5.58	5.66
EBL	5.66	5.89

Table A.3
Posterior Inclusion Probabilities of the Simulation Excercise

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
x_3	**0.9922**	**0.9948**	**1.0000**	**0.9990**	**0.9993**	**0.9758**	**0.9835**	**0.9963**	**0.9904**	**0.9964**
x_5	**0.8814**	**0.9166**	**0.9998**	**0.9921**	**0.9947**	**0.8130**	**0.8677**	**0.9948**	**0.9756**	**0.9880**
x_4	**0.7357**	**0.8130**	**0.9989**	**0.9814**	**0.9869**	**0.6279**	**0.7239**	**0.9931**	**0.9582**	**0.9763**
x_1	**0.4065**	**0.4815**	**0.9948**	**0.9385**	**0.9507**	**0.3434**	**0.4217**	**0.9899**	**0.9131**	**0.9391**
x_2	0.1626	0.1970	**0.9299**	**0.8182**	**0.8297**	0.1327	0.1665	**0.9052**	**0.7858**	**0.8067**
x_{22}	0.0934	0.0970	0.1420	0.0952	0.1123	0.0738	0.0812	0.1535	0.1011	0.1214
x_{23}	0.0597	0.0602	0.0943	0.0729	0.0822	0.0495	0.0530	0.1240	0.0854	0.1025
x_{10}	0.0640	0.0783	0.0728	0.0821	0.0881	0.0525	0.0671	0.0890	0.0881	0.0990
x_{15}	0.1242	0.1329	0.0277	0.0451	0.0461	0.0997	0.1126	0.0424	0.0491	0.0551
x_{16}	0.1409	0.1217	0.0124	0.0271	0.0257	0.1295	0.1146	0.0165	0.0301	0.0289
$x11$	0.0788	0.0786	0.0435	0.0448	0.0465	0.0651	0.0676	0.0614	0.0518	0.0568
x_{14}	0.0647	0.0593	0.0594	0.0478	0.0522	0.0544	0.0514	0.0777	0.0558	0.0662
x_{24}	0.0671	0.0638	0.0496	0.0402	0.0442	0.0555	0.0544	0.0700	0.0486	0.0583
x_{19}	0.0500	0.0501	0.0445	0.0394	0.0421	0.0413	0.0430	0.0634	0.0471	0.0548
x_6	0.0689	0.0708	0.0177	0.0336	0.0338	0.0559	0.0608	0.0227	0.0358	0.0367
x_{13}	0.0541	0.0500	0.0299	0.0334	0.0349	0.0454	0.0427	0.0386	0.0372	0.0405
x_7	0.0537	0.0492	0.0320	0.0289	0.0310	0.0446	0.0424	0.0446	0.0336	0.0397
x_{20}	0.0465	0.0466	0.0250	0.0288	0.0302	0.0381	0.0404	0.0346	0.0328	0.0368
x_{18}	0.0658	0.0571	0.0145	0.0225	0.0229	0.0566	0.0510	0.0177	0.0245	0.0254
x_9	0.0523	0.0491	0.0182	0.0257	0.0256	0.0431	0.0419	0.0216	0.0280	0.0284

(*continued on next page*)

Table A.3 (*continued*)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
x_8	0.0558	0.0529	0.0138	0.0221	0.0225	0.0460	0.0459	0.0181	0.0239	0.0250
x_{25}	0.0556	0.0512	0.0129	0.0205	0.0216	0.0463	0.0441	0.0185	0.0231	0.0270
x_{21}	0.0420	0.0390	0.0190	0.0240	0.0254	0.0347	0.0336	0.0274	0.0272	0.0325
x_{12}	0.0495	0.0459	0.0125	0.0198	0.0202	0.0404	0.0395	0.0189	0.0220	0.0234
x_{17}	0.0479	0.0439	0.0114	0.0196	0.0199	0.0398	0.0378	0.0163	0.0214	0.0239

Table A.4
Posterior Mean to Posterior Standard Deviation Ratios of the Simulation Excercise

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
x_3	**−4.7406**	**−5.2182**	**−14.6481**	**−10.2756**	**−10.9222**	**−3.9373**	**−4.4339**	**−10.0431**	**−7.0963**	**−8.8649**
x_4	**−1.3682**	**−1.6494**	**−7.8809**	**−4.4262**	**−4.9090**	**−1.1180**	**−1.3650**	**−6.5143**	**−3.5821**	**−4.3062**
x_5	**2.0871**	**2.4457**	**9.3081**	**6.2470**	**6.8382**	**1.7351 2.0706**	**7.1060**	**4.7132**	**5.7267**	
x_1	0.7045	0.8282	**5.7131**	**3.0285**	**3.3140**	0.6209	0.7396	**4.7457**	**2.6393**	**3.0331**
x_2	0.3099	0.3634	**2.9074**	**1.7671**	**1.8603**	0.2776	0.3290	**2.3961**	**1.6114**	**1.7128**
x_{22}	−0.2246	−0.2442	−0.3665	−0.2630	−0.2956	−0.1973	−0.2193	−0.3790	−0.2710	−0.3078
x_{23}	−0.1431	−0.1474	−0.2822	−0.2145	−0.2373	−0.1308	−0.1393	−0.3072	−0.2351	−0.2585
x_{10}	−0.0678	−0.1237	−0.2391	−0.2354	−0.2487	−0.0572	−0.1106	−0.2594	−0.2417	−0.2630
x_{24}	−0.1683	−0.1653	−0.1932	−0.1448	−0.1597	−0.1522	−0.1521	−0.2283	−0.1637	−0.1890
x_{16}	0.3188	0.2903	0.0189	0.0928	0.0845	0.3125	0.2863	0.0123	0.0972	0.0858
x_{11}	0.1002	0.1283	0.1826	0.1517	0.1611	0.0733	0.1086	0.2161	0.1648	0.1821
x_{19}	−0.1158	−0.1227	−0.1833	−0.1230	−0.1366	−0.0985	−0.1080	−0.1570	−0.1281	−0.1493
x_{13}	−0.1029	−0.0846	−0.1047	−0.0789	−0.0829	−0.0979	−0.0802	−0.1118	−0.0864	−0.0955
x_{20}	−0.0602	−0.0674	−0.0975	−0.0733	−0.0821	−0.0544	−0.0608	−0.1217	−0.0805	−0.0868
x_{15}	0.1857	0.2168	−0.0541	0.0557	0.0439	0.1552	0.1879	−0.0872	0.0306	0.0178
x_{14}	0.0808	0.0745	−0.2139	−0.1175	−0.1399	0.0797	0.0724	−0.2460	−0.1371	−0.1750
x_{25}	−0.1179	−0.1036	−0.0079	−0.0317	−0.0320	−0.1118	−0.0977	−0.0115	−0.0332	−0.0357
x_6	0.0598	0.0818	0.0325	0.0521	0.0537	0.0481	0.0695	0.0478	0.0491	0.0550
x_7	−0.0667	−0.0558	0.1445	0.0624	0.0785	−0.0694	−0.0597	0.1731	0.0783	0.1071
x_{12}	−0.0690	−0.0641	−0.0305	−0.0211	−0.0195	−0.0652	−0.0611	0.0179	−0.0193	−0.0152
x_{17}	0.0771	0.0620	0.0326	0.0208	0.0192	0.0720	0.0590	−0.0353	0.0132	0.0195
x_{21}	−0.0561	−0.0546	0.0011	0.0036	0.0032	−0.0494	−0.0484	−0.0147	−0.0040	−0.0088
x_{18}	−0.0379	−0.0261	−0.0289	−0.0100	−0.0086	−0.0431	−0.0294	−0.0239	−0.0099	−0.0088
x_9	−0.0799	−0.0673	0.0875	0.0345	0.0430	−0.0772	−0.0642	0.0918	0.0404	0.0508
x_8	0.0632	0.0430	−0.0517	−0.0289	−0.0355	0.0676	0.0461	−0.0427	−0.0249	−0.0317

Table A.5
Correlation of the True Variables of the Simulation Excercise

	x_1	x_2	x_3	x_4	x_5
x_1	1.0000	0.0182	−0.2484	−0.3014	0.1640
x_2	0.0182	1.0000	−0.2060	−0.0609	0.0948
x_3	−0.2484	−0.2060	1.0000	0.3178	0.1527
x_4	−0.3014	−0.0609	0.3178	1.0000	0.0980
x_5	0.1640	0.0948	0.1527	0.0980	1.0000

Table A.6
Variables

Variable name	Proxy	Measure	Source
Dependent Variable			
Growth Rate	Average log Difference of GDP per Capita PPP, Constant 2017 International $ (2002–2019)	Percentage	WorldBank
Investment			
GDS	Gross Domestic Savings, Average 2002–2005	Percentage of GDP	WorldBank
GFCF	Gross Fixed Capital Formation, Average 2002–2005	Percentage of GDP	WorldBank
GFCF Growth	(GFCF, 2019-GFCF, 2002)/GFCF 2002	Percentage	WorldBank
Public Investment Share	Government Investment Share of GDP, Average 2002–2005,	Percentage of GDP	Eurostat

(*continued on next page*)

Table A.6 (*continued*)

Variable name	Proxy	Measure	Source
Demography			
Age Dependency Ratio	Age Dependency Ratio, Average 2002–2005	Percentage of Working Age Population	WorldBank
Female Participation Rate	Labor Force Participation Rate, Female, Average 2002–2005	Percentage of Female Population Age 15+	WorldBank
Fertility Rate	Total Aged Fertility Rate, Average 2002–2005	Number	Eurostat
Population	Log of the Total Population on 1 January, Average 2002–2005	Millions	Eurostat
Share of Migrants	International Migrant Stock in 2005[a]	Percentage of Total Population	WorldBank
Urban Population	Fraction of Urban Population, Average 2002–2005	Percentage of Total Population	WorldBank
Urban Population Growth	(UP[b]2019-UP2002)/UP 2002	Percentage	WorldBank
Workforce	Active Persons, Age 15–64, Average 2002–2005	Percentage of Total Population	Eurostat
Workforce Growth	(WF[c] 2019-WF, 2002)/WF 2002	Percentage	Eurostat
Human capital			
Education Expenditure	General Government Expenditure on Education, Average 2002–2005	Percentage of GDP	Eurostat
Human Capita	Index of Human Capital per Person[d] Average 2002–2005	Index (0–1)	PWT 9.0
Life Expectancy	1/Total Life Expectancy (Less than 1 year), Average 2002–2005	Number	Eurostat
Primary Education	Population with Educational Level 0–2, Age 15–64, Average 2002–2005[e]	Percentage of Total Population	Eurostat
Tertiary Education	Population with Educational Level 5–8, Age 15–64, Average 2002–2005[e]	Percentage of Total Population	Eurostat
Working Life	1/Duration of Working Life, Average 2002-205	Number	Eurostat
Geography			
CEE	Central-Eastern European Countries, dummy	1 = Yes, 0 = No	OECD [f]
Coastal Areas	Log of the Total Length of the Boundary between the Land Area (including Islands) and the Sea[g]	Km	CIA
Distance from Brussels	Log of the Distance from Capital Cities to Brussels	Km	EC[h]
Mediterranean Countries	Countries surrounding the Mediterranean Sea Dummy	1 = Yes, 0 = No	
R&D and Innovation			
Basic Research Expenditure	General Government Expenditure on Basic Research, Average 2002–2005	Percentage of GDP	Eurostat
Business R&D Personnel	Fraction of Research and Development Personnel, Average 2002–2005[i]	Percentage of Active Population	Eurostat
Higher Education R&D	Fraction of Research and Development Personnel, Average 2002–2005[i]	Percentage of Active Population	Eurostat
High-Tech Patent	log of High-Tech Patent Applications to the EPO, Average 2002–2005	Per Million Inhabitants	Eurostat
Patent	log of Patent Applications to the EPO, Average 2002–2005	PPS per Inhabitants	Eurostat
Property Protection	Protection of Property Rights, Average 2002–2005	Index (0–1)	FI[j]
Economic Structure			
Industry	Industry (including Construction), Value Added, Average 2002–2005	Percentage of GDP	WorldBan
Services	Services, Value Added, Average 2002–2005	Percentage of GDP	WorldBank
TFP	TFP (2011 = 1), Average 2002–2005	Constant National Prices	PWT 9.0
International Trade			
EU28 Exports	Share of Exports vs EU28 Partners Average 2002–2005	Percentage of Exports of EU28	Eurostat
EU28 Imports	Share of Imports vs EU28 Partners, Average 2002–2005	Percentage of Imports of EU28	Eurostat
Extra-EU Exports	Share of Exports vs Extra-EU28 Partners, Average 2002–2005	Percentage of Exports of EU28	Eurostat
Extra-EU Imports	Share of Imports vs Extra-EU28 Partners, Average 2002–2005	Percentage of Imports of EU28	Eurostat
FDI	Foreign Direct Investment, Net Inflows, Average 2002–2005	Percentage of GDP	WorldBank
Trade Openness	(Exports + Imports)/GDP, Average 2002–2005	Percentage of GDP	WorldBank
Macroeconomic Conditions			
CPI Inflation	HICP (2015 = 100), Average 2002–2005	Index (0–1)	Eurostat
Exchange Rate Volatility	Standard Deviation (2002–2019), Nominal Effective Exchange Rates[k]	Percentage	AMECO
Initial Income	Log of GDP per Capita in 2002, (constant 2017 international $)	PPP	WorldBank
Public Finance			
Income Taxes	Taxes on Income, Average 2002–2005	Percentage of GDP	Eurostat
Total Tax Receipts	Total Tax Receipts, General Government, Average 2002–2005	Percentage of GDP	Eurostat
Unemployment Expenditure	General Government Expenditure on Unemployment, Average 2002–2005	Percentage of GDP	Eurostat
Value Added Taxes	Value Added Type Taxes (VAT), Average 2002–2005	Percentage of GDP	Eurostat
Public Debt			
Public Debt	Consolidated Gross Government Debt, Average 2002–2005	Percentage of GDP	Eurostat
Public Debt Growth	Rate of Growth of Consolidated Gross Government Debt/GDP, 2002–2019	Percentage of GDP	Eurostat
Public Debt Interest	Payable Interest, Average 2002–2005	Percentage of GDP	Eurostat
Public Debt Square	Square of Consolidated Gross Government Debt, Average 2002–2005	Percentage of GDP	Eurostat
Financial Sector			
Credit Market Regulations	Credit Market Regulations, Average 2002–2005	Index (0–1)	FI
Credits Granted	Domestic Dredit to Private Sector by Banks, Average 2002–2005	Percentage of GDP	WorldBank
European Union			
EU Members	Members of the European Union in 2002,Dummy	1 = Yes, 0 = No	Wikipedia[l]
Euro Adoption	Adoption of the Euro as Official Currency (during the Sample Period), Dummy	1 = Yes, 0 = No	EC[m]
European Agencies	Coutries with a European Institution and/or Agency, Dummy	1 = Yes, 0 = No	EC[n]

(*continued on next page*)

Table A.6 (*continued*)

Variable name	Proxy	Measure	Source
European Institutions	Coutries with a European Institution, Dummy	1 = Yes, 0 = No	EC[n]
Environmental Policy			
Energy Efficiency	Primary Energy Consumption (Oil Equivalent), Average 2002–2005	Tonnes per Inhabitant	Eurostat
Environmental Taxes	Total Environmental Taxes, Average 2002–2005	Percentage of GDP[o]	Eurostat and AMECO
Inequality			
Inequality	Top 1% Income Share, Average 2002–2005	Percentage	WID[p]
Inequality Growth	Top 1% Income Share Growth, 2002–2017	Percentage	WID
Institutional Framework			
Communis	Ex Communist Economies, Dummy	1 = Yes, 0 = No	
Contracts	Legal Enforcement of Contracts, Average 2002–2005[r]	Index (0–1)	FI[q]
Corruption	Corruption among Public Officials, Average 2002–2018[t]	Index (0–1)	EIU[s]
Democracy and Freedom	Voice and Accountability, Average 2002–2018[t]	Index (0–1)	EIU
Ease of Doing Business	Starting a Business, Average 2002–2005[r]	Index (0–1)	FI
Economic Freedom	Economic Freedom Summary Index, Average 2002–2005	Index (0–1)	FI
Government Integrity	Government Integrity, Average 2002–2005	Index (0–1)	HF
Legislative Framework	Rule of Law, Average 2002–2018[t]	Index (0–1)	EIU
Hiring Regulations	Hiring Regulations and Minimum Wage, Average 2002–2005[r]	Index (0–1)	FI
Quality of Institutions	Government Effectiveness, Average 2002–2018[t]	Index (0–1)	EIU

[a] Observations are available only for 2000, 2005, 2010 and 2015.
[b] Urban Population.
[c] Workforce.
[d] Based on Years of Schooling and Returns to Education.
[e] for Austria: Average 2004–2005.
[f] https://stats.oecd.org/glossary/detail.asp?ID=303.
[g] The variable takes value 0 if there are no coastal areas in the country considered.
[h] https://erasmus-plus.ec.europa.eu/resources-and-tools/distance-calculator.
[i] For countries with missing data, the average of available data is used.
[j] Fraser Institute, Economic Freedom Dataset https://www.fraserinstitute.org/economic-freedom/dataset?geozone=world&page=dataset&min-year=2&max-year=0&filter=1&year=2002.
[k] Performance Relative to the Rest of 37 Industrial Countries, Double Export Weights.
[l] https://en.wikipedia.org/wiki/Enlargement_of_the_European_Union.
[m] https://european-union.europa.eu/institutions-law-budget/euro/countries-using-euro_en.
[n] https://european-union.europa.eu/institutions-law-budget/institutions-and-bodies/institutions-and-bodies-profiles_en.
[o] For GDP the variable used is Gross Domestic Product at 2015 reference levels.
[p] https://wid.world/data/.
[q] Heritage Foundation, Index of Economic Freedom https://www.heritage.org/index/explore?view=by-region-country-year&u=637329800430927214.
[r] For Luxembourg: only 2005.
[s] Economist Intelligence Unit, www.eiu.com.
[t] For Luxembourg: Average 2006–2018.

Table A.7
Descriptive Statistics

Variable	Mean	St. Dev	Min	Max
Growth Rate	0.016	0.013	−0.002	0.040
Age Dependency Ratio	0.479	0.037	0.410	0.538
Basic Research Expenditure	0.004	0.003	0.000	0.012
Business R&D Personnel	0.004	0.003	0.001	0.011
CEE	0.368	0.482	0.000	1.000
Communist	0.211	0.408	0.000	1.000
Coastal Areas	2.911	1.210	0.000	4.136
Contracts	0.522	0.110	0.318	0.715
Corruption	0.656	0.216	0.250	1.000
CPI Inflation	0.786	0.065	0.644	0.880
Credit Market Regulations	0.917	0.066	0.801	1.000
Credits Granted	0.751	0.388	0.199	1.462
Democracy and Freedom	0.777	0.079	0.623	0.917
Distance from Brussels	2.789	0.714	0.000	3.320
Ease of Doing Business	0.087	0.007	0.074	0.098
Economic Freedom	0.751	0.051	0.639	0.848
Education Expenditure	0.053	0.010	0.036	0.068

(*continued on next page*)

Table A.7 (*continued*)

Variable	Mean	St. Dev	Min	Max
Energy Efficiency	3.444	0.924	2.063	5.506
Environmental Taxes	0.015	0.010	0.000	0.029
EU Members	0.579	0.494	0.000	1.000
EU28 Exports	0.049	0.056	0.002	0.224
EU28 Imports	0.048	0.051	0.002	0.189
Euro Adoption	0.842	0.365	0.000	1.000
European Agencies	0.158	0.365	0.000	1.000
European Institutions	0.579	0.494	0.000	1.000
Exchange Rate Volatility	4.106	2.576	1.357	10.334
Extra-EU Exports	0.049	0.066	0.001	0.268
Extra- EU Imports	0.050	0.057	0.002	0.190
FDI	0.058	0.043	0.005	0.152
Female Participation Rate	0.492	0.060	0.377	0.602
Fertility Rate	1.489	0.236	1.218	1.927
GDS	0.234	0.064	0.125	0.397
GFCF	0.038	0.011	0.020	0.063
GFCF Growth	−0.047	0.312	−0.587	0.536
Government Integrity	0.628	0.186	0.378	0.958
Greenhouse Gas Emission	0.980	0.171	0.570	1.270
Higher Education R&D	0.003	0.001	0.001	0.005
High-Tech Patent	0.776	0.755	−0.395	1.834
Hiring Regulations	0.672	0.216	0.220	0.945
Human Capital	3.095	0.330	2.235	3.603
Income Taxes	0.108	0.052	0.054	0.278
Industry	0.250	0.038	0.195	0.335
Inequality	0.103	0.024	0.062	0.175
Inequality Growth	0.082	0.136	−0.340	0.345
Initial Income	10.363	0.406	9.366	10.855
Legislative Framework	0.794	0.129	0.542	0.982
Life Expectancy	0.013	0.000	0.012	0.014
Mediterranean Countries	0.263	0.440	0.000	1.000
Patent	1.351	0.834	−0.167	2.968
Population	4.105	0.504	3.137	4.916
Primary Education	0.345	0.137	0.177	0.750
Property Protection	0.656	0.171	0.326	0.889
Public Debt	0.527	0.262	0.053	1.059
Public Debt Growth	0.415	0.574	−0.600	1.497
Public Debt Interest	0.026	0.013	0.002	0.051
Public Debt Square	0.347	0.334	0.003	1.121
Public Investment Share	0.038	0.012	0.020	0.063
Quality of Institutions	0.642	0.187	0.301	0.963
Services	0.607	0.048	0.542	0.684
Share of Migrants	0.090	0.042	0.008	0.172
Tertiary Education	0.191	0.062	0.096	0.272
TFP	1.005	0.060	0.898	1.153
Total Tax Receipts	0.256	0.071	0.192	0.463
Trade Openness	0.870	0.319	0.477	1.513
Unemployment Expenditure	0.013	0.010	0.003	0.042
Urban Population	0.716	0.114	0.512	0.973
Urban Population Growth	0.059	0.050	−0.028	0.181
Value Added Taxes	0.075	0.015	0.057	0.121
Workforce	0.693	0.055	0.605	0.797
Workforce Growth	0.082	0.052	−0.006	0.216
Working Life	0.030	0.003	0.026	0.036

Table A.8
Posterior Model Size

g-prior/Model Prior	Fixed	Random	Uniform
UIP	11.07	4.95	14.85
HQ	11.09	4.89	14.84
RIC	12.82	12.46	14.98
Hyper	11.32	4.97	14.78
EBL	11.90	6.40	15.02

Table A.9
Posterior Inclusion Probabilities

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Initial Income	**0.8513**	**0.8705**	0.0084	**0.4049**	**0.4290**	**0.3347**	**0.3714**	0.0105	**0.2901**	**0.2950**
Industry	**0.5291**	**0.5756**	0.0243	**0.3328**	**0.4146**	0.1529	**0.1810**	**0.9305**	0.1411	0.1493
Fertility Rate	**0.6280**	**0.6672**	**0.9350**	**0.2252** 0.1065	0.1188	0.1536	0.0079	0.1131	0.1576	
Inequality	0.0496	0.0629	**0.9392**	**0.4180**	**0.4641**	0.0106	0.0103	**0.9445**	0.0107	0.0174
Public Debt Interest	0.1114	0.1045	**0.8386**	**0.2634**	0.1553	0.0749	0.0729	**0.9448**	0.0578	0.0556
GFCF	0.1447	**0.1740**	0.0592	**0.3704**	**0.3907**	0.0388	0.0453	**0.9437**	0.0337	0.0407
FDI	0.0489	0.0754	0.0473	**0.3317**	**0.4308**	0.0213	0.0200	**0.9437**	0.0192	0.0181
Economic Freedom	0.0422	0.0648	0.0616	**0.1981**	**0.3724**	0.0106	0.0117	**0.9437**	0.0098	0.0104
GDS	**0.3069**	**0.2733**	0.0302	0.0801	**0.3108**	**0.1901**	**0.2013**	0.0076	0.1526	0.1526
Hiring Regulations	0.2042	**0.1774**	0.0065	**0.2325**	**0.6514**	0.0774	0.0813	0.0590	0.0592	0.0663
CEE	0.0166	0.0116	**0.9550**	0.0370	**0.2331**	0.0618	0.0568	0.0037	0.0655	0.0479
Urban Population	0.0198	0.0234	**0.9593**	0.0714	**0.2957**	0.0044	0.0040	0.0094	0.0055	0.0111
TFP	0.0634	0.0636	**0.9555**	0.0892	0.0551	0.0537	0.0523	0.0039	0.0457	0.0398
Tertiary Education	0.0201	0.0221	**0.9551**	0.0648	**0.2725**	0.0099	0.0095	0.0025	0.0098	0.1498
Life Expectancy	0.0258	0.0243	0.0067	0.0201	0.0158	**0.4045**	**0.3876**	0.0049	**0.4141**	**0.2850**
Communist	0.0522	0.0633	**0.9567**	**0.2502**	0.1098	0.0424	0.0384	0.0007	0.0370	0.0328
Working Life	0.0513	0.0424	0.0530	0.0574	0.0240	0.0388	0.0385	**0.8801**	0.0280	0.0278
European Institutions	0.0146	0.0120	0.0445	0.0634	0.0431	0.0045	0.0047	**0.9265**	0.0036	0.0038
Quality of Institutions	0.0084	0.0136	**0.9552**	0.0309	0.0181	0.0097	0.0090	0.0557	0.0081	0.0071
Value Added Taxes	0.0126	0.0052	**0.9550**	0.0187	0.0288	0.0048	0.0048	0.0033	0.0039	0.0036
Unemployment Expenditure	0.0181	0.0204	0.0127	0.0155	0.0200	0.0051	0.0051	**0.9303**	0.0040	0.0038
EU Members	0.0182	0.0170	**0.9009**	0.0181	0.0087	0.0197	0.0177	0.0023	0.0228	0.0144
Euro Adoption	0.0186	0.0162	0.0055	0.0192	0.0189	0.0048	0.0045	**0.9298**	0.0037	0.0035
Coastal Areas	0.0702	0.0931	0.0163	**0.3131**	**0.4901**	0.0094	0.0108	0.0014	0.0092	0.0111
Public Debt Square	0.0511	0.0406	0.0592	**0.1996**	**0.4042**	0.0688	0.0650	0.0057	0.0572	0.0511
Extra-EU Imports	0.0396	0.0485	0.0076	0.0265	0.0218	0.0070	0.0075	**0.6905**	0.0065	0.0066
CPI Inflation	0.0350	0.0465	0.0189	**0.2693**	**0.3672**	0.0254	0.0236	0.0064	0.0243	0.0344
Public Debt	0.0590	0.0422	0.0727	0.1657	0.1282	0.1003	0.0931	0.0606	0.0840	0.0740
Public Investment Share	0.1696	0.1438	0.0189	0.1691	0.1093	0.0426	0.0501	0.0564	0.0366	0.0414
Mediterranean Countries	0.0990	0.0965	0.0077	**0.2309**	0.1704	0.0645	0.0679	0.0083	0.0511	0.0551
Public Debt Growth	0.0402	0.0248	0.0071	**0.1933**	**0.4163**	0.0115	0.0112	0.0014	0.0092	0.0235
Workforce	0.0666	0.0505	0.0196	**0.1793**	0.1630	0.0396	0.0405	0.0750	0.0310	0.0341
EU28 Imports	0.0322	0.0332	0.0099	0.0820	**0.3025**	0.0054	0.0052	0.1510	0.0068	0.0150
Trade Openness	0.0464	0.0483	0.0050	**0.2946**	0.1216	0.0249	0.0234	0.0050	0.0204	0.0233
Democracy and Freedom	0.1469	**0.2229**	0.0076	0.0723	0.0370	0.0146	0.0204	0.0219	0.0182	0.0214
Greenhouse Gas Emission	0.1030	0.1395	0.0348	0.1012	0.1328	0.0094	0.0115	0.0025	0.0124	0.0241
Population	0.0298	0.0305	0.0181	0.1008	**0.3164**	0.0064	0.0066	0.0030	0.0062	0.0114
Human Capital	0.0171	0.0258	0.0120	**0.1968**	**0.1893**	0.0054	0.0052	0.0546	0.0050	0.0063
Services	0.0368	0.0435	0.0083	0.1668	0.0471	0.0507	0.0459	0.0220	0.0515	0.0382
Property Protection	0.0274	0.0273	0.0101	**0.2033**	0.0906	0.0132	0.0130	0.0305	0.0121	0.0126
EU28 Exports	0.0351	0.0578	0.0052	0.0396	0.1382	0.0063	0.0071	0.1092	0.0058	0.0092
Primary Education	0.0093	0.0186	0.0117	0.1023	0.1456	0.0088	0.0081	0.0564	0.0080	0.0078
Credit Market Regulations	0.0125	0.0159	0.0064	0.0152	**0.2703**	0.0040	0.0040	0.0240	0.0039	0.0086
Patent	0.0155	0.0220	0.0095	0.0709	**0.1876**	0.0064	0.0057	0.0067	0.0057	0.0070
Female Participation Rate	0.0213	0.0150	0.0319	0.1478	0.0478	0.0092	0.0089	0.0065	0.0075	0.0088
Share of Migrants	0.0132	0.0170	0.0044	0.1713	0.0699	0.0059	0.0056	0.0019	0.0054	0.0066
Environmental Taxes	0.0188	0.0267	0.0598	0.0473	0.0733	0.0048	0.0048	0.0204	0.0044	0.0043
Exchange Rate Volatility	0.0170	0.0243	0.0100	0.1204	0.0675	0.0052	0.0051	0.0042	0.0050	0.0054
GFCF Growth	0.0229	0.0304	0.0053	0.1056	0.0597	0.0087	0.0081	0.0007	0.0076	0.0079
Extra-EU Exports	0.0416	0.0292	0.0065	0.0275	0.0285	0.0065	0.0066	0.0903	0.0057	0.0059
High-Tech Patent	0.0540	0.0587	0.0045	0.0265	0.0366	0.0121	0.0135	0.0045	0.0115	0.0115
Credits Granted	0.0178	0.0134	0.0154	0.0573 0.0285	0.0259	0.0244	0.0026	0.0208	0.0177	
Income Taxes	0.0191	0.0230	0.0052	0.0918	0.0317	0.0037	0.0037	0.0046	0.0037	0.0041
Government Integrity	0.0246	0.0104	0.0294	0.0539	0.0219	0.0137	0.0133	0.0035	0.0109	0.0100
Legislative Framework	0.0125	0.0176	0.0041	0.0557	0.0598	0.0093	0.0086	0.0028	0.0075	0.0094
Ease of Doing Business	0.0106	0.0171	0.0106	0.0342	0.0115	0.0087	0.0089	0.0683	0.0065	0.0160
Workforce Growth	0.0215	0.0245	0.0049	0.0479	0.0425	0.0072	0.0075	0.0023	0.0061	0.0061
Education Expenditure	0.0140	0.0186	0.0116	0.0392	0.0567	0.0049	0.0050	0.0033	0.0041	0.0059
Total Tax Receipts	0.0145	0.0202	0.0054	0.0298	0.0568	0.0039	0.0041	0.0052	0.0037	0.0034
Basic Research Expenditure	0.0263	0.0310	0.0074	0.0354	0.0082	0.0052	0.0055	0.0169	0.0044	0.0101
Corruption	0.0138	0.0139	0.0097	0.0423	0.0190	0.0119	0.0113	0.0029	0.0096	0.0089
Distance from Brussels	0.0053	0.0114	0.0229	0.0499	0.0231	0.0035	0.0034	0.0052	0.0030	0.0026
Energy Efficiency	0.0083	0.0092	0.0097	0.0190	0.0112	0.0051	0.0048	0.0558	0.0046	0.0034
Age Dependency Ratio	0.0181	0.0147	0.0288	0.0120	0.0193	0.0072	0.0066	0.0046	0.0060	0.0047
Urban Population Growth	0.0137	0.0080	0.0056	0.0258	0.0262	0.0091	0.0082	0.0028	0.0073	0.0065
Business R&D Personnel	0.0183	0.0186	0.0083	0.0233	0.0141	0.0050	0.0045	0.0055	0.0046	0.0040

(*continued on next page*)

Table A.9 (*continued*)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
European Agencies	0.0146	0.0148	0.0131	0.0178	0.0190	0.0056	0.0054	0.0023	0.0045	0.0061
Inequality Growth	0.0069	0.0048	0.0091	0.0243	0.0290	0.0044	0.0041	0.0042	0.0036	0.0061
Higher Education R&D	0.0101	0.0093	0.0171	0.0157	0.0178	0.0049	0.0044	0.0007	0.0041	0.0038
Contracts	0.0073	0.0051	0.0088	0.0113	0.0238	0.0041	0.0038	0.0060	0.0034	0.0184

Table A.10
Posterior Mean to Posterior Standard Deviation Ratios

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Initial Income	**−2.0309**	**−2.1446**	−0.0278	−0.7267	−0.8120	−0.6707	−0.7294	−0.0480	−0.6061	−0.6155
Industry	0.9972	**1.0966**	0.1213	0.3283	0.5982	0.3976	0.4439	**3.5094**	0.3819	0.3823
Fertility Rate	**1.1501**	**1.2534**	**3.2546**	0.4284	0.2499	0.3434	0.4007	−0.0157	0.3370	0.3583
Public Debt Interest	−0.3008	−0.2928	**−2.0156**	−0.4988	−0.3926	−0.2514	−0.2488	**−2.6481**	−0.2167	−0.2131
Inequality	0.1996	0.2279	0.5358	0.7650	0.8997	0.0803	0.0796	**4.0571**	0.0843	0.1171
FDI	0.2016	0.2523	0.2120	0.4896	0.8170	0.1264	0.1230	**4.0394**	0.1193	0.1123
Communist	0.1696	0.2077	**4.5751**	0.5286	0.2712	0.1839	0.1746	−0.0108	0.1719	0.1592
TFP	−0.2256	−0.2271	**−4.5605**	−0.2713	−0.1598	−0.2136	−0.2112	0.0313	−0.1968	−0.1831
Tertiary Education	0.0932	0.1144	**4.5219**	0.2389	0.5703	0.0738	0.0730	0.0061	0.0767	0.1064
GFCF	−0.3086	−0.2269	−0.1969	−0.2864	−0.6856	−0.1423	−0.1460	**−3.5403**	−0.1257	−0.1223
Urban Population	−0.1082	−0.1159	**−4.4523**	−0.2628	−0.6333	−0.0268	−0.0271	0.0593	−0.0468	−0.0891
Economic Freedom	−0.0960	−0.1188	−0.2153	−0.3621	−0.6984	0.0542	0.0391	**−4.0461**	0.0222	0.0136
Quality of Institutions	0.0194	−0.0347	**−4.5570**	−0.1478	−0.0319	−0.0131	−0.0112	−0.2383	−0.0172	−0.0140
Value Added Taxes	−0.0662	0.0008	**4.3309**	0.0957	0.0141	−0.0326	−0.0339	−0.0195	−0.0264	−0.0288
CEE	−0.0471	−0.0470	**−4.4722**	−0.1465	−0.3113	0.2274	0.2146	−0.0272	0.2407	0.1832
GDS	0.6247	0.5733	0.1464	0.2579	0.6174	0.4602	0.4785	0.0449	0.4046	0.4049
Unemployment Expenditure	0.1027	0.0927	−0.0883	0.0792	−0.0779	0.0374	0.0415	**3.5055**	0.0289	0.0338
Hiring Regulations	0.4216	0.3882	0.0103	0.4670	**1.0773**	0.2597	0.2667	0.2441	0.2254	0.2415
European Institutions	0.0480	−0.0092	−0.1895	0.1783	0.0848	0.0323	0.0329	**−3.3592**	0.0260	0.0244
Life Expectancy	0.1275	0.1217	−0.0525	0.0121	−0.0286	0.7720	0.7482	−0.0234	0.7928	0.5982
EU Members	0.0794	0.0942	**−2.7690**	0.0155	−0.0075	−0.1157	−0.1069	0.0177	−0.1311	−0.0934
Public Debt Square	−0.1871	−0.1620	−0.2111	−0.4159	−0.7998	−0.2391	−0.2316	−0.0332	−0.2176	−0.2038
Public Debt	−0.2092	−0.1702	−0.2591	−0.3754	−0.2570	−0.3034	−0.2911	−0.2385	−0.2756	−0.2545
Euro Adoption	0.0598	0.0573	0.0071	−0.0528	0.0376	−0.0214	−0.0186	**−2.5411**	−0.0219	−0.0194
Mediterranean Countries	−0.2826	−0.2785	−0.0175	−0.4138	−0.4059	−0.2340	−0.2397	0.0098	−0.2059	−0.2100
CPI Inflation	0.1532	0.1914	0.1226	0.5634	0.6447	0.1259	0.1227	0.0371	0.1207	0.1577
Coastal Areas	0.2190	0.2601	0.0162	0.4947	0.6889	0.0620	0.0729	0.0208	0.0613	0.0761
Public Investment Share	−0.3231	−0.1850	−0.0407	−0.2856	−0.2395	−0.1646	−0.1621	−0.2200	−0.1488	−0.1431
Services	−0.1716	−0.1766	−0.0041	−0.4244	−0.1958	−0.2064	−0.1957	−0.1219	−0.2116	−0.1785
Working Life	0.1397	0.1361	−0.1972	0.1876	−0.0545	0.1704	0.1698	**−2.5864**	0.1410	0.1412
Trade Openness	0.1903	0.2069	0.0145	0.4958	0.2789	0.1385	0.1353	−0.0020	0.1251	0.1349
Public Debt Growth	−0.1367	−0.1036	−0.0453	−0.4018	−0.6433	−0.0844	−0.0827	−0.0215	−0.0736	−0.0968
Democracy and Freedom	0.3545	0.4529	−0.0420	0.2208	0.1644	0.0784	0.1088	0.1359	0.0991	0.1153
Greenhouse Gas Emission	0.2912	0.3567	−0.0742	0.2223	0.3582	0.0678	0.0812	0.0073	0.0874	0.0996
Workforce	−0.1879	−0.1590	0.1076	−0.3676	−0.3956	−0.1697	−0.1716	0.2626	−0.1461	−0.1547
Primary Education	−0.0626	−0.1078	0.0644	−0.2812	−0.3668	−0.0696	−0.0649	−0.2384	−0.0621	−0.0537
Human Capital	−0.0548	−0.0978	0.0794	−0.3570	−0.3950	0.0218	0.0132	−0.2384	−0.0061	−0.0281
Population	0.1156	0.1110	−0.1173	0.2806	0.4580	0.0206	0.0307	0.0126	0.0230	0.0577
GFCF Growth	0.1229	0.1462	−0.0356	0.2842	0.1958	0.0697	0.0679	−0.0178	0.0669	0.0673
Share of Migrants	0.0740	0.1061	0.0300	0.3513	0.2115	0.0383	0.0379	−0.0070	0.0377	0.0548
Extra-EU Exports	0.1582	0.1212	0.0035	0.0749	0.0638	0.0517	0.0566	0.3011	0.0438	0.0478
Extra-EU Imports	0.1520	0.1573	−0.0452	0.0697	0.0086	0.0399	0.0495	0.3758	0.0361	0.0472
Credits Granted	−0.0765	−0.0426	0.0655	−0.1732	−0.1146	−0.1273	−0.1216	0.0041	−0.1158	−0.1032
Property Protection	−0.0016	0.0324	−0.0761	−0.3127	−0.1504	−0.0378	−0.0296	−0.1440	−0.0384	−0.0382
Environmental Taxes	−0.0413	−0.0591	−0.2289	−0.1381	−0.1638	−0.0167	−0.0120	−0.1004	−0.0163	−0.0165
Exchange Rate Volatility	−0.0807	−0.0885	−0.0264	−0.3129	−0.2300	−0.0049	−0.0098	0.0170	−0.0119	−0.0241
EU28 Imports	0.0821	0.0469	−0.0576	−0.1538	0.3749	0.0212	0.0236	0.2885	0.0290	0.0382
EU28 Exports	0.1489	0.1804	−0.0216	0.1142	−0.2711	0.0433	0.0551	0.3233	0.0407	0.0397
Urban Population Growth	−0.0786	−0.0193	−0.0368	−0.1232	−0.1111	−0.0735	−0.0701	−0.0037	−0.0659	−0.0609
Patent	0.0388	0.0043	0.0732	0.1580	0.2653	−0.0115	0.0002	0.0367	−0.0193	0.0350
High-Tech Patent	0.1965	0.2011	−0.0406	0.0719	−0.0754	0.0538	0.0732	−0.0548	0.0540	0.0685
Distance from Brussels	0.0229	0.0477	0.1067	0.1970	0.1330	−0.0062	−0.0015	0.0261	−0.0041	−0.0043
Female Participation Rate	0.0633	0.0291	−0.1532	0.3268	0.1496	0.0250	0.0313	−0.0572	0.0288	0.0426
Credit Market Regulations	−0.0836	−0.0867	−0.0301	0.0004	0.4625	0.0161	0.0076	0.1222	0.0134	0.0567
Education Expenditure	−0.0669	−0.0976	−0.0698	0.0314	−0.1290	−0.0299	−0.0334	−0.0261	−0.0271	−0.0171

(*continued on next page*)

Table A.10 (*continued*)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Government Integrity	0.0298	−0.0053	−0.1537	−0.1305	−0.0276	−0.0370	−0.0312	−0.0406	−0.0340	−0.0316
European Agencies	−0.0366	−0.0424	−0.0686	−0.0643	−0.0918	−0.0283	−0.0271	−0.0176	−0.0233	−0.0236
Income Taxes	−0.0892	−0.1027	−0.0154	−0.1885	0.0247	−0.0153	−0.0180	0.0301	−0.0207	−0.0247
Workforce Growth	−0.1082	−0.1296	−0.0389	0.0658	−0.0997	−0.0089	−0.0171	−0.0352	−0.0029	−0.0108
Age Dependency Ratio	−0.0818	−0.0811	0.1210	−0.0651	−0.0915	−0.0497	−0.0477	0.0407	−0.0495	−0.0411
Ease of Doing Business	0.0684	0.0976	−0.0316	0.1440	0.0355	0.0692	0.0707	−0.2274	0.0570	0.0605
Corruption	0.0626	0.0665	0.0187	0.1636	0.0340	−0.0061	0.0025	−0.0213	−0.0072	0.0093
Higher Education R&D	−0.0055	−0.0046	−0.0549	−0.0421	−0.0755	−0.0089	−0.0051	0.0022	−0.0128	−0.0132
Business R&D Personnel	−0.0937	−0.0972	−0.0464	0.0100	0.0324	−0.0053	−0.0067	0.0239	0.0017	−0.0144
Inequality Growth	0.0099	0.0031	−0.0245	0.0736	0.0682	0.0023	0.0032	0.0415	−0.0045	0.0050
Total Tax Receipts	−0.0822	−0.1037	−0.0104	0.0140	0.0976	−0.0219	−0.0260	0.0310	−0.0244	−0.0275
Energy Efficiency	−0.0351	−0.0602	0.0197	−0.1070	−0.0377	0.0398	0.0361	0.2373	0.0170	0.0312
Legislative Framework	0.0508	0.0297	0.0038	−0.0461	−0.1783	0.0318	0.0322	−0.0142	0.0236	0.0012
Contracts	−0.0205	0.0009	0.0351	−0.0405	0.0628	−0.0049	−0.0038	−0.0435	−0.0043	−0.0040
Basic Research Expenditure	0.0077	−0.0867	0.0475	0.1262	−0.0136	0.0125	0.0098	−0.1288	0.0111	0.0115

Table A.11
Average Posterior Inclusion Probabilities by Category

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Economic Structure	**0.2098**	**0.2276**	**0.3294**	**0.1963**	**0.1723**	0.0858	0.0931	**0.3188**	0.0794	0.0758
Macroeconomic Conditions	**0.3011**	**0.3138**	0.0124	**0.2649**	**0.2879**	0.1218	0.1334	0.0070	0.1065	0.1116
Inequality	0.0282	0.0338	**0.4742**	**0.2211**	**0.2466**	0.0075	0.0072	**0.4743**	0.0072	0.0118
Public Debt	0.0654	0.0530	**0.2444**	**0.2055**	**0.2760**	0.0639	0.0606	**0.2531**	0.0520	0.0511
Investment Human	0.1610	0.1554	0.0284	**0.1813**	**0.2176**	0.0701	0.0762	**0.2521**	0.0576	0.0607
Capital	0.0229	0.0253	**0.1750**	0.0801	0.1173	0.0787	0.0756	0.1670	0.0782	0.0804
Geography	0.0478	0.0532	**0.2505**	0.1577	**0.2292**	0.0348	0.0347	0.0046	0.0322	0.0292
European Union	0.0165	0.0150	**0.2410**	0.0296	0.0224	0.0086	0.0081	**0.4652**	0.0086	0.0070
International Trade	0.0406	0.0487	0.0136	0.1336	**0.1739**	0.0119	0.0116	**0.3316**	0.0107	0.0130
Demography	0.0924	0.0945	**0.2231**	0.1091	0.1208	0.0231	0.0268	0.0126	0.0209	0.0274
Institutional Framework	0.0523	0.0608	**0.2049**	0.0977	0.1308	0.0206	0.0210	0.1166	0.0174	0.0190
Public Finance	0.0161	0.0172	**0.2446**	0.0389	0.0343	0.0044	0.0044	**0.2359**	0.0038	0.0037
Environmental Policy	0.0434	0.0585	0.0348	0.0558	0.0724	0.0064	0.0070	0.0262	0.0071	0.0106
Financial Sector	0.0152	0.0146	0.0109	0.0362	0.1494	0.0149	0.0142	0.0133	0.0123	0.0132
R&D and Innovation	0.0253	0.0278	0.0095	0.0625	0.0592	0.0078	0.0078	0.0108	0.0071	0.0082

Table A.12
Absolute Average Posterior Mean to Posterior Standard Deviation Ratios by Category

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Economic Structure	0.4648	0.5001	**1.5620**	0.3413	0.3179	0.2725	0.2836	**1.2209**	0.2634	0.2480
Macroeconomic Conditions	0.7549	0.8082	0.0589	0.5343	0.5622	0.2672	0.2873	0.0340	0.2462	0.2658
Inequality	0.1047	0.1155	0.2802	0.4193	0.4840	0.0413	0.0414	**2.0493**	0.0444	0.0610
Public Debt	0.2085	0.1822	0.6328	0.4230	0.5232	0.2196	0.2136	0.7353	0.1959	0.1920
Investment	0.3448	0.2828	0.1049	0.2785	0.4346	0.2092	0.2136	0.9557	0.1865	0.1844
Human Capital	0.0908	0.1126	0.8309	0.1847	0.2574	0.1896	0.1837	0.5198	0.1843	0.1574
Geography	0.1429	0.1583	**1.1532**	0.3130	0.3848	0.1324	0.1322	0.0210	0.1280	0.1184
European Union	0.0559	0.0508	0.7586	0.0777	0.0554	0.0494	0.0464	**1.4839**	0.0506	0.0402
Institutional Framework	0.1293	0.1422	0.9628	0.2231	0.2539	0.0754	0.0757	0.4999	0.0678	0.0667
Public Finance	0.0851	0.0750	**1.1112**	0.0944	0.0536	0.0268	0.0298	0.8965	0.0251	0.0287
Demography	0.2186	0.2227	0.9235	0.2524	0.2667	0.0840	0.0927	0.0549	0.0820	0.0967
International Trade	0.1555	0.1608	0.0591	0.2330	0.3024	0.0702	0.0739	0.8883	0.0657	0.0700
Environmental Policy	0.1225	0.1587	0.1076	0.1558	0.1866	0.0414	0.0431	0.1150	0.0402	0.0491
Financial Sector	0.0800	0.0646	0.0478	0.0868	0.2886	0.0717	0.0646	0.0631	0.0646	0.0799
R&D and Innovation	0.0573	0.0579	0.0498	0.1004	0.1011	0.0208	0.0204	0.0449	0.0223	0.0295

Table A.13
Posterior Model Size (Change in the Dependent Variable)

g-prior/Model Prior	Fixed	Random
UIP	11.91	5.59
HQ	12.02	5.78
RIC	14.03	13.08
Hyper	12.04	5.55
EBL	12.72	7.23

Table A.14
Posterior Inclusion Probabilities (Change in the Dependent Variable)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Initial Income	**0.9382**	**0.9179**	0.0093	**0.3023**	**0.2123**	**0.4941**	**0.5670**	**0.2999**	**0.3333**	**0.4751**
Industry	**0.9397**	**0.9147**	0.0071	**0.3091**	**0.2667**	**0.5219**	**0.5907**	0.1072	**0.3600**	**0.4782**
Fertility Rate	**0.9422**	**0.9231**	0.0167	**0.3276**	**0.2790**	**0.4885**	**0.5631**	0.1105	**0.3266**	**0.4649**
Public Debt Interest	0.0317	0.0390	**0.9774**	**0.4883**	**0.2706**	0.0743	0.0665	**0.9635**	0.0592	0.0671
Hiring Regulations	0.1070	0.1034	**0.9998**	**0.6330**	**0.5900**	0.0781	0.0742	0.0076	0.0519	0.0833
Economic Freedom	**0.2262**	**0.2464**	**0.9998**	0.0707	0.0214	0.0653	0.0834	0.0544	0.0549	0.0808
Workforce	0.0268	0.0344	**0.7709**	0.0805	0.0742	0.0189	0.0173	**0.7901**	0.0133	0.0215
GFCF	0.0970	0.1282	0.0063	**0.5202**	0.1904	0.0295	0.0339	**0.7211**	0.0243	0.0637
FDI	0.0792	0.1080	0.0475	0.1365	0.1997	0.0623	0.0558	**0.9545**	0.0469	0.0709
Tertiary Education	0.1305	0.1183	**1.0000**	0.0330	0.0483	0.0469	0.0507	0.0047	0.0334	0.0464
Services	0.0291	0.0364	**1.0000**	0.0219	0.0198	0.1018	0.0866	0.0272	0.0868	0.0807
Age Dependency Ratio	0.0244	0.0235	**0.9999**	0.0939	0.0848	0.0097	0.0093	**0.2128**	0.0086	0.0104
Credits Granted	0.0349	0.0367	0.0470	**0.6004**	**0.6524**	0.0169	0.0153	0.0148	0.0175	0.0372
Public Investment Share	0.0927	0.1147	0.0080	0.1839	**0.6064**	0.0295	0.0338	**0.3039**	0.0211	0.0410
Public Debt	0.0312	0.0255	0.0536	**0.2250**	**0.4273**	0.1461	0.1259	0.0673	0.1289	0.1279
CPI Inflation	0.0265	0.0286	0.0126	0.0665	0.1900	0.0109	0.0107	**0.9677**	0.0074	0.0097
Value Added Taxes	0.0552	0.0654	**1.0000**	0.0213	0.0269	0.0195	0.0215	0.0175	0.0123	0.0191
Human Capital	0.0062	0.0172	0.0066	**0.5855**	**0.5441**	0.0058	0.0060	0.0230	0.0081	0.0273
EU28 Exports	0.0136	0.0159	0.1378 0.0595	0.1439	0.0059	0.0060	**0.7805**	0.0047	0.0070	
Urban Population	0.0185	0.0134	**1.0000**	0.0089	0.0137	0.0096	0.0094	0.0401	0.0063	0.0089
Coastal Areas	0.0243	0.0254	0.0126	0.0621	0.0897	0.0206	0.0181	**0.8361**	0.0157	0.0185
Euro Adoption	0.0098	0.0107	**0.9738**	0.0210	0.0461	0.0060	0.0058	0.0142	0.0043	0.0063
Share of Migrants	0.0246	0.0379	0.0382	0.0630	0.0362	0.0067	0.0069	**0.8354**	0.0054	0.0085
Female Participation Rate	0.0105	0.0187	0.0207	0.4063	**0.3543**	0.0106	0.0096	0.0458	0.0118	0.0200
Quality of Institutions	0.0128	0.0160	0.0133	0.0257	0.0913	0.0076	0.0072	**0.6462**	0.0056	0.0147
Greenhouse Gas Emission	0.0440	0.0378	0.0425	**0.2081**	**0.2497**	0.0166	0.0178	0.1524	0.0099	0.0466
Legislative Framework	0.0195	0.0244	0.0067	**0.4331**	**0.2385**	0.0093	0.0095	0.0095	0.0104	0.0255
Urban Population Growth	0.0282	0.0205	0.0085	**0.2081**	**0.3584**	0.0206	0.0183	0.0402	0.0139	0.0304
Primary Education	0.0172	0.0197	0.0153	**0.3928**	**0.2342**	0.0090	0.0083	0.0188	0.0115	0.0158
Democracy and Freedom	0.0585	0.0631	**0.3555**	0.0326	0.1097	0.0180	0.0194	0.0109	0.0106	0.0161
Working Life	0.0249	0.0341	**0.2036**	0.0347	0.0261	0.0549	0.0504	0.1868	0.0338	0.0445
Inequality	0.0448	0.0471	0.0872	0.0488	0.1779	0.0268	0.0260	0.1684	0.0182	0.0414
Property Protection	0.0214	0.0163	0.0272	**0.2058**	**0.3368**	0.0102	0.0103	0.0137	0.0072	0.0229
Education Expenditure	0.0075	0.0082	0.0045	**0.2270**	**0.3312**	0.0049	0.0048	0.0187	0.0036	0.0189
Inequality Growth	0.0199	0.0168	0.0456	0.0259	**0.3231**	0.0054	0.0055	0.1376	0.0042	0.0308
EU Members	0.0158	0.0191	0.0705	0.0094	**0.3411**	0.0138	0.0125	0.0854	0.0126	0.0146
High-Tech Patent	0.0326	0.0296	**0.2608**	0.0146	0.0232	0.0126	0.0146	0.1181	0.0085	0.0110
Communist	0.0756	0.1109	0.0120	0.1159	0.1439	0.0135	0.0151	0.0054	0.0099	0.0146
GDS	0.0152	0.0155	0.0445	0.0167	0.0177	0.0362	0.0310	**0.2600**	0.0253	0.0474
Public Debt Square	0.0153	0.0149	0.0348	0.0300	0.1664	0.0615	0.0518	0.0165	0.0555	0.0512
Extra-EU Imports	0.0204	0.0116	0.0771	0.0087	0.0138	0.0079	0.0080	**0.3288**	0.0060	0.0099
Higher Education R&D	0.0502	0.0517	0.0096	0.0396	0.1165	0.0181	0.0193	0.0684	0.0117	0.0169
Government Integrity	0.0237	0.0303	0.1033	0.0100	0.1526	0.0125	0.0133	0.0131	0.0082	0.0121
Unemployment Expenditure	0.0199	0.0210	0.0424	0.0261	0.1428	0.0059	0.0058	0.0850	0.0045	0.0061
CEE	0.0384	0.0330	0.0151	0.0365	0.0243	0.0161	0.0147	0.1401	0.0149	0.0152
Trade Openness	0.0234	0.0263	0.0191	0.0236	0.0805	0.0383	0.0327	0.0242	0.0343	0.0332
Patent	0.0136	0.0114	0.0161	0.0098	0.0109	0.0070	0.0064	**0.2453**	0.0059	0.0081
Life Expectancy	0.0155	0.0167	0.0117	0.0189	0.1012	0.0366	0.0324	0.0404	0.0302	0.0279
Mediterranean Countries	0.0179	0.0226	0.0274	0.0892	0.0877	0.0200	0.0207	0.0080	0.0157	0.0190
Ease of Doing Business	0.0119	0.0154	0.0210	0.0354	0.0634	0.0057	0.0056	0.1507	0.0042	0.0070
Population	0.0150	0.0123	**0.2288**	0.0058	0.0081	0.0058	0.0056	0.0267	0.0045	0.0058
Environmental Taxes	0.0378	0.0297	0.0452	0.0463	0.0636	0.0101	0.0110	0.0517	0.0081	0.0111
TFP	0.0139	0.0142	0.0118	0.0297	0.1527	0.0198	0.0173	0.0063	0.0185	0.0178
Extra-EU Exports	0.0192	0.0136	0.0979	0.0250	0.0342	0.0054	0.0054	0.0859	0.0045	0.0055

(*continued on next page*)

Table A.14 (*continued*)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
European Institutions	0.0160	0.0148	0.0279	0.0198	0.1569	0.0073	0.0068	0.0070	0.0051	0.0093
GFCF Growth	0.0200	0.0436	0.0109	0.0697	0.0626	0.0081	0.0084	0.0308	0.0060	0.0090
Exchange Rate Volatility	0.0158	0.0214	0.0109	0.0339	0.0213	0.0063	0.0062	0.1306	0.0048	0.0066
Total Tax Receipts	0.0198	0.0216	0.0287	0.0154	0.0229	0.0062	0.0063	0.1229	0.0043	0.0071
Workforce Growth	0.0170	0.0162	0.0296	0.0216	0.1019	0.0072	0.0072	0.0070	0.0051	0.0270
Energy Efficiency	0.0102	0.0096	0.1089	0.0293	0.0255	0.0062	0.0059	0.0186	0.0052	0.0108
Contracts	0.0154	0.0088	0.0401	0.0171	0.0612	0.0049	0.0050	0.0546	0.0034	0.0074
EU28 Imports	0.0140	0.0025	0.0963	0.0103	0.0304	0.0060	0.0058	0.0333	0.0047	0.0062
Credit Market Regulations	0.0094	0.0068	0.0655	0.0231	0.0175	0.0056	0.0053	0.0491	0.0041	0.0052
Basic Research Expenditure	0.0158	0.0158	0.0525	0.0081	0.0087	0.0057	0.0057	0.0442	0.0039	0.0246
Corruption	0.0133	0.0132	0.0264	0.0375	0.0575	0.0080	0.0071	0.0042	0.0057	0.0075
Business R&D Personnel	0.0235	0.0269	0.0112	0.0185	0.0553	0.0068	0.0066	0.0181	0.0050	0.0076
European Institutions Agencies	0.0192	0.0251	0.0476	0.0155	0.0083	0.0057	0.0060	0.0148	0.0040	0.0061
Income Taxes	0.0131	0.0193	0.0137	0.0182	0.0144	0.0056	0.0055	0.0458	0.0039	0.0057
Public Debt Growth	0.0141	0.0134	0.0042	0.0267	0.0172	0.0061	0.0062	0.0093	0.0051	0.0303
Distance from Brussels	0.0116	0.0132	0.0122	0.0043	0.0087	0.0060	0.0056	0.0090	0.0042	0.0071

Table A.15

Posterior Mean to Posterior Standard Deviation Ratios (Change in the Dependent Variable)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Tertiary Education	0.3251	0.3105	**26.3308**	0.1541	0.1896	0.1826	0.1916	0.0117	0.1548	0.1803
Hiring Regulations	0.2743	0.2784	**18.8025**	**1.2495**	**1.1355**	0.2618	0.2533	0.0063	0.2120	0.2767
Urban Population	−0.0625	−0.0587	**−19.0565**	−0.0579	−0.0803	−0.0562	−0.0534	−0.1789	−0.0436	−0.0488
Economic Freedom	0.4771	0.5113	**−17.8951**	0.2013	0.0828	0.2359	0.2742	−0.1775	0.2170	0.2675
Public Debt Interest	−0.1333	−0.1686	**−5.9187**	−0.7989	−0.5265	−0.2560	−0.2409	**−3.458**	**8**−0.2235	−0.2417
Value Added Taxes	−0.1850	−0.2005	**−10.6560**	−0.1170	−0.1224	−0.1055	−0.1138	0.1148	−0.0764	−0.0985
Services	−0.0607	−0.1422	**−9.9187**	−0.0990	−0.1066	−0.3016	−0.2719	−0.1121	−0.2809	−0.2647
Industry	**3.3108**	**2.9052**	0.0364	0.6282	0.5617	**1.0076**	**1.1595**	0.2876	0.7277	0.9280
Initial Income	**−2.9661**	**−2.6784**	−0.0333	−0.5975	−0.4890	−0.9450	**−1.0926**	−0.4877	−0.6845	−0.9157
Fertility Rate	**3.0131**	**2.7772**	0.0322	0.6353	0.5642	0.9338	**1.0836**	0.2731	0.6733	0.8723
Age Dependency Ratio	−0.1084	−0.1062	**8.3093**	−0.2502	−0.2142	−0.0686	−0.0667	−0.4544	−0.0682	−0.0693
CPI Inflation	0.0703	0.0932	0.0813	0.2322	0.4349	0.0030	0.0043	**4.1297**	−0.0019	0.0118
Euro Adoption	0.0378	0.0597	**4.9724**	0.0796	−0.1267	−0.0020	0.0049	−0.0925	−0.0033	−0.0035
Workforce	−0.1353	−0.1350	**−1.7425**	−0.2022	−0.1595	−0.0930	−0.0891	**−1.8904**	−0.0742	−0.0859
FDI	0.2337	0.2850	−0.1949	0.3491	0.4771	0.2247	0.2096	**1.7910**	0.1964	0.2509
GFCF	−0.2009	−0.1591	0.0139	−0.8486	−0.2548	−0.0916	−0.1090	**−1.4482**	−0.0997	−0.2010
Coastal Areas	0.1040	0.1150	−0.0170	0.2335	0.2485	0.1133	0.1041	**2.1821**	0.0989	0.1053
Public Debt	−0.1372	−0.1358	−0.1410	−0.5095	−0.7480	−0.3840	−0.3513	0.0405	−0.3581	−0.3524
Share of Migrants	0.0922	0.1117	0.1052	0.2199	0.1672	0.0199	0.0246	**2.1736**	0.0244	0.0341
Human Capital	−0.0343	−0.0591	−0.0077	**−1.1531**	**−1.0512**	0.0215	0.0233	0.0034	−0.0560	−0.1463
Credits Granted	−0.1300	−0.1465	0.1825	−0.8793	−0.8967	−0.0934	−0.0856	−0.0501	−0.1023	−0.1649
Inequality	0.1489	0.1532	0.2933	0.1493	0.4401	0.1340	0.1302	0.4420	0.1123	0.1874
Working Life	0.1168	0.1429	0.4898	−0.0102	0.1285	0.2142	0.2052	0.4666	0.1590	0.1832
Public Investment Share	−0.1875	−0.1608	0.0264	−0.3260	−0.4476	−0.1012	−0.1166	−0.5438	−0.0905	−0.1390
EU28 Exports	0.0490	0.0176	0.3617	−0.2190	−0.3836	−0.0047	0.0014	−1.8065	−0.0204	−0.0277
Legislative Framework	0.0690	0.1269	0.0508	0.8347	0.5143	0.0520	0.0528	0.0590	0.0703	0.0959
Primary Education	−0.0601	−0.0797	−0.0549	−0.7756	−0.5219	−0.0642	−0.0594	−0.0094	−0.0855	−0.1035
Female Participation Rate	−0.0535	−0.0693	−0.1150	−0.7541	−0.6667	−0.0550	−0.0492	0.1645	−0.0771	−0.1065
Urban Population Growth	−0.1098	−0.0921	−0.0664	−0.4893	−0.6964	−0.1203	−0.1108	0.1819	−0.0975	−0.1573
Public Debt Square	−0.0529	−0.0719	0.0557	−0.1538	−0.4042	−0.2295	−0.2078	−0.1087	−0.2186	−0.2052
Inequality Growth	0.0585	0.0641	0.1581	0.1004	0.5843	0.0002	0.0007	0.3789	−0.0038	0.1417
Communist	0.2119	0.2821	0.0800	0.3202	0.2961	0.0640	0.0729	−0.0170	0.0488	0.0711
Education Expenditure	−0.0218	−0.0381	−0.0487	−0.5144	−0.6816	−0.0102	−0.0115	0.0514	−0.0102	−0.1195
Trade Openness	0.0938	0.1081	−0.1000	0.0969	0.1815	0.1734	0.1577	0.1422	0.1671	0.1613
Higher Education R&D	0.1880	0.1856	0.0735	0.1768	0.3336	0.0842	0.0946	−0.2507	0.0605	0.0838
Quality of Institutions	−0.0141	−0.0464	0.0431	−0.0301	−0.2910	0.0124	0.0131	**1.3048**	0.0036	0.0084
Mediterranean Countries	−0.0864	−0.0963	0.1367	−0.2549	−0.2341	−0.1125	−0.1115	0.0336	−0.1023	−0.1073
Unemployment Expenditure	0.0530	0.0534	0.1896	0.1077	0.1960	−0.0034	−0.0001	0.2868	−0.0055	0.0021
GFCF Growth	0.0965	0.1456	−0.0164	0.1678	0.1804	0.0573	0.0550	0.0004	0.0508	0.0544
Ease of Doing Business	−0.0346	−0.0413	−0.0464	−0.0886	−0.1863	0.0025	−0.0045	−0.3615	0.0042	−0.0052
Property Protection	−0.0033	−0.0380	−0.1157	0.3703	0.4600	0.0026	0.0226	−0.0890	−0.0089	0.1022
European Institutions	0.0777	0.0854	0.1381	0.0852	0.2490	−0.0011	0.0075	−0.0050	−0.0146	0.0179

(*continued on next page*)

Table A.15 (*continued*)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Greenhouse Gas Emission	0.1672	0.1592	0.1707	−0.4034	−0.5011	0.0979	0.1048	−0.3734	0.0720	−0.1221
Patent	0.0011	0.0234	0.0349	−0.0011	−0.0044	−0.0378	−0.0318	−0.4940	−0.0465	−0.0312
TFP	−0.0580	−0.0671	−0.0822	−0.1046	0.1913	−0.1172	−0.1066	−0.0130	−0.1178	−0.1102
Exchange Rate Volatility	−0.0612	−0.0698	0.0797	−0.0942	−0.0964	0.0126	0.0072	−0.3532	0.0054	−0.0149
Basic Research Expenditure	−0.0148	−0.0285	−0.2137	−0.0229	−0.0427	−0.0042	−0.0038	−0.1044	−0.0076	−0.1382
Democracy and Freedom	0.1979	0.2148	−0.7072	0.1556	0.3358	0.0924	0.1015	0.0048	0.0620	0.0830
Energy Efficiency	−0.0028	−0.0104	−0.3172	−0.1323	−0.1256	0.0293	0.0220	0.0338	0.0110	−0.0024
EU Members	0.0580	0.0435	0.2469	−0.0337	−0.2838	−0.0682	−0.0570	−0.2028	−0.0775	−0.0764
Population	0.0415	0.0321	0.5162	0.0378	−0.0117	−0.0191	−0.0137	−0.0949	−0.0275	−0.0184
Extra-EU Imports	0.0567	0.0390	0.2262	−0.0223	−0.0663	−0.0050	0.0061	−0.6516	−0.0203	0.0002
GDS	0.0769	0.0662	−0.1179	0.0996	0.0826	0.1705	0.1559	−0.5130	0.1419	0.2033
Government Integrity	0.0264	−0.0406	−0.3073	−0.0084	−0.2505	0.0434	0.0483	0.0824	0.0226	0.0210
Contracts	−0.0459	−0.0519	0.1791	−0.0336	0.1097	−0.0093	−0.0121	0.2207	−0.0061	−0.0030
Environmental Taxes	0.1433	0.0937	−0.1720	0.1098	0.2368	0.0167	0.0318	−0.1897	0.0083	0.0360
Total Tax Receipts	−0.0820	−0.0975	−0.1478	−0.0547	−0.1144	−0.0410	−0.0422	0.3399	−0.0334	−0.0413
Extra-EU Exports	−0.0425	−0.0644	0.2954	−0.1049	−0.0889	−0.0071	−0.0030	−0.2486	−0.0245	−0.0110
Life Expectancy	0.0477	0.0456	0.0817	−0.0545	−0.2691	0.1685	0.1565	−0.1835	0.1548	0.1436
Corruption	0.0147	0.0325	0.1449	0.0260	0.0056	0.0035	0.0015	0.0365	−0.0034	0.0076
Public Debt Growth	−0.0091	−0.0272	0.0322	−0.0447	−0.0556	−0.0371	−0.0340	0.0165	−0.0420	−0.0440
Income Taxes	−0.0341	−0.0673	−0.0384	−0.0804	−0.0719	−0.0216	−0.0198	0.1604	−0.0210	−0.0240
High-Tech Patent	0.1276	0.1193	−0.5637	0.0739	0.0760	0.0618	0.0779	−0.2621	0.0370	0.0527
Workforce Growth	0.0730	0.0417	−0.1483	0.1095	0.1247	0.0415	0.0441	−0.0097	0.0403	−0.1209
Business R&D Personnel	−0.0863	−0.0883	−0.0840	0.0627	0.0478	−0.0221	−0.0212	0.0719	−0.0241	−0.0084
CEE	−0.1463	−0.1491	0.0419	−0.1776	−0.1357	0.0261	0.0082	0.3716	0.0303	−0.0013
European Institutions Agencies	−0.0824	−0.1135	0.1337	0.0300	−0.0657	−0.0219	−0.0271	0.0929	−0.0183	−0.0232
EU28 Imports	−0.0148	−0.0337	0.2904	−0.0510	0.1132	−0.0254	−0.0208	−0.1115	−0.0333	−0.0239
Credit Market Regulations	−0.0265	−0.0207	−0.1418	−0.1084	−0.0317	0.0205	0.0181	0.1734	0.0215	0.0108
Distance from Brussels	0.0087	0.0301	0.0708	0.0394	−0.0163	−0.0030	0.0014	−0.0645	−0.0046	−0.0042

Table A.16
Correlations among the Selected Determinants

	Fertility Rate	Industry	Initial Income	Hiring Regulations	Public Debt Interest
Fertility Rate	1.000	−0.335	0.636	0.263	−0.095
Industry	−0.335	1.000	−0.188	0.078	−0.460
Initial Income	0.636	−0.188	1.000	0.035	0.225
Hiring Regulations	0.263	0.078	0.035	1.000	0.059
Public Debt Interest	−0.095	−0.460	0.225	0.059	1.000

Table A.17
Average Posterior Inclusion Probabilities by Category (Change in the Dependent Variable)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Economic Structure	**0.3275**	**0.3218**	**0.3396**	0.1203	0.1464	**0.2145**	0.2315	0.0469	0.1551	0.1922
Macroeconomic Conditions	**0.3269**	**0.3226**	0.0110	0.1342	0.1412	0.1704	0.1946	**0.4661**	0.1152	0.1638
Demography	0.1230	0.1222	**0.3459**	0.1351	0.1456	0.0642	0.0719	**0.2343**	0.0440	0.0664
Public Debt	0.0231	0.0232	**0.2675**	0.1925	**0.2204**	0.0720	0.0626	**0.2642**	0.0622	0.0691
Investment	0.0562	0.0755	0.0174	0.1976 **0.2193**	0.0258	0.0268	**0.3290**	0.0192	0.0403	
Institutional Framework	0.0564	0.0632	**0.2578**	0.1411	0.1530	0.0223	0.0240	0.0957	0.0165	0.0269
Human capital	0.0336	0.0357	**0.2070**	**0.2153**	**0.2142**	0.0263	0.0254	0.0487	0.0201	0.0301
Financial Sector	0.0221	0.0218	0.0562	0.3118	0.3349	0.0113	0.0103	0.0320	0.0108	0.0212
International Trade	0.0283	0.0296	0.0793	0.0439	0.0838	0.0210	0.0190	**0.3679**	0.0169	0.0221
Inequality	0.0324	0.0319	0.0664	0.0373	**0.2505**	0.0161	0.0157	0.1530	0.0112	0.0361
European Union	0.0152	0.0174	**0.2800**	0.0164	0.1381	0.0082	0.0078	0.0304	0.0065	0.0091
Public Finance	0.0270	0.0318	**0.2712**	0.0203	0.0518	0.0093	0.0098	0.0678	0.0063	0.0095
Geography	0.0230	0.0235	0.0168	0.0480	0.0526	0.0157	0.0148	**0.2483**	0.0126	0.0150
Environmental Policy	0.0306	0.0257	0.0655	0.0946	0.1129	0.0110	0.0116	0.0742	0.0078	0.0228
R&D and Innovation	0.0262	0.0253	0.0629	0.0494	0.0919	0.0101	0.0105	0.0846	0.0070	0.0152

Table A.18
Absolute Average Posterior Mean to Posterior Standard Deviation Ratios by Category (Change in the Dependent Variable)

Model prior	Fixed					Random				
g-prior	UIP	HQ	RIC	Hyper	EBL	UIP	HQ	RIC	Hyper	EBL
Economic Structure	**1.1432**	**1.0381**	**3.3458**	0.2773	0.2865	0.4755	0.5126	0.1375	0.3755	0.4343
Human capital	0.1010	0.1126	**4.5023**	0.4436	0.4737	0.1102	0.1079	0.1210	0.1034	0.1461
Demography	0.4099	0.3805	**3.3435**	0.3062	0.2983	0.1564	0.1706	0.6024	0.1251	0.1682
Macroeconomic Conditions	**1.0325**	0.9472	0.0648	0.3080	0.3401	0.3202	0.3680	**1.6569**	0.2306	0.3141
Institutional Framework	0.1366	0.1626	**3.8256**	0.2948	0.3207	0.0777	0.0834	0.2270	0.0650	0.0839
Public Debt	0.0831	0.1009	**1.5369**	0.3767	0.4336	0.2267	0.2085	0.9061	0.2105	0.2108
Public Finance	0.0885	0.1047	**2.7579**	0.0899	0.1262	0.0429	0.0440	0.2255	0.0340	0.0415
Investment	0.1405	0.1329	0.0436	0.3605	0.2414	0.1051	0.1091	0.6263	0.0958	0.1494
European Union	0.0640	0.0755	**1.3728**	0.0571	0.1813	0.0233	0.0241	0.0983	0.0284	0.0303
International Trade	0.0817	0.0913	0.2448	0.1405	0.2184	0.0734	0.0664	0.7919	0.0770	0.0792
Inequality	0.1037	0.1086	0.2257	0.1248	0.5122	0.0671	0.0654	0.4105	0.0580	0.1646
Financial Sector	0.0782	0.0836	0.1621	0.4939	0.4642	0.0569	0.0518	0.1118	0.0619	0.0878
Geography	0.0863	0.0976	0.0666	0.1763	0.1587	0.0637	0.0563	0.6629	0.0590	0.0545
Environmental Policy	0.1044	0.0878	0.2200	0.2151	0.2878	0.0480	0.0529	0.1990	0.0305	0.0535
R&D and Innovation	0.0702	0.0805	0.1809	0.1179	0.1608	0.0354	0.0420	0.2120	0.0308	0.0694

References

Acemoglu, D., Robinson, J.A., 2012. Why Nations Fail: the Origins of Power, Prosperity, and Poverty. Currency.
Aiyar, M.S., Duval, M.R.A., Puy, M.D., Wu, M.Y., Zhang, M.L., 2013. Growth Slowdowns and the Middle-Income Trap. International Monetary Fund.
Amini, S.M., Parmeter, C.F., 2011. Bayesian model averaging in r. J. Econ. Soc. Meas. 36 (4), 253–287.
Arin, K.P., Braunfels, E., Doppelhofer, G., 2019. Revisiting the growth effects of fiscal policy: a bayesian model averaging approach. J. Macroecon. 62, 103158.
Barro, R.J., et al., 2003. Determinants of economic growth in a panel of countries. Ann. Econ. Finance 4, 231–274.
Błażejowski, M., Gazda, J., Kwiatkowski, J., 2016. Bayesian Model Averaging in the Studies on Economic Growth in the Eu Regions–Application of the Gretl Bma Package.
Błażejowski, M., Kwiatkowski, J., Gazda, J., 2019. Sources of economic growth: a global perspective. Sustainability 11 (1), 275.
Brock, W.A., Durlauf, S.N., 2001. What have we learned from a decade of empirical research on growth? growth empirics and reality. World Bank Econ. Rev. 15 (2), 229–272.
Bruns, S.B., Ioannidis, J.P., 2020. Determinants of economic growth: different time different answer? J. Macroecon. 63, 103185.
Chen, H., Mirestean, A., Tsangarides, C.G., 2009. Limited Information Bayesian Model Averaging for Dynamic Panels with Short Time Periods.
Chirwa, T.G., Odhiambo, N.M., 2016. Macroeconomic determinants of economic growth: a review of international literature. S. East Eur. J. Econ. Bus. 11 (2).
Ciccone, A., Jarociński, M., 2010. Determinants of economic growth: will data tell? Am. Econ. J. Macroecon. 2 (4), 222–246.
Clyde, M., George, E.I., 2004. Model uncertainty. Stat. Sci. 19 (1), 81–94.
Cui, W., George, E.I., 2008. Empirical bayes vs. fully bayes variable selection. J. Stat. Plann. Inference 138 (4), 888–900.
Doppelhofer, G., Hansen, O.-P., Weeks, M., 2016. Determinants of Long-Term Economic Growth Redux: A Measurement Error Model Averaging (Mema) Approach, vol. 19. NHH Dept. of Economics Discussion Paper.
Doppelhofer, G., Weeks, M., 2009. Jointness of growth determinants. J. Appl. Econom. 24 (2), 209–244.
Durlauf, S.N., Johnson, P.A., Temple, J.R., 2005. Growth econometrics. Handb. Econ. Growth 1, 555–677.
Durlauf, S.N., Kourtellos, A., Tan, C.M., 2008. Are any growth theories robust? Econ. J. 118 (527), 329–346.
Eicher, T.S., Papageorgiou, C., Raftery, A.E., 2011. Default priors and predictive performance in bayesian model averaging, with application to growth determinants. J. Appl. Econom. 26 (1), 30–55.
Feldkircher, M., Zeugner, S., 2012. The impact of data revisions on the robustness of growth determi- nants—a note on 'determinants of economic growth: will data tell? J. Appl. Econom. 27 (4), 686–694.
Fernandez, C., Ley, E., Steel, M.F., 2001a. Benchmark priors for bayesian model averaging. J. Econom. 100 (2), 381–427.
Fernandez, C., Ley, E., Steel, M.F., 2001b. Model uncertainty in cross-country growth regressions. J. Appl. Econom. 16 (5), 563–576.
Foster, D.P., George, E.I., 1994. The risk inflation criterion for multiple regression. Ann. Stat. 22 (4), 1947–1975.
Grogan, L., Moers, L., 2001. Growth empirics with institutional measures for transition countries. Econ. Syst. 25 (4), 323–344.
Hannan, E.J., Quinn, B.G., 1979. The determination of the order of an autoregression. J. Roy. Stat. Soc. B 41 (2), 190–195.
Hansen, B.E., 2007. Least squares model averaging. Econometrica 75 (4), 1175–1189.
Hoeting, J.A., Madigan, D., Raftery, A.E., Volinsky, C.T., 1999. Bayesian model averaging: a tutorial (with comments by m. clyde, david draper and ei george, and a rejoinder by the authors. Stat. Sci. 14 (4), 382–417.
Kass, R.E., Wasserman, L., 1995. A reference bayesian test for nested hypotheses and its relationship to the schwarz criterion. J. Am. Stat. Assoc. 90 (431), 928–934.
Kutan, A.M., Yigit, T.M., 2007. European integration, productivity growth and real convergence. Eur. Econ. Rev. 51 (6), 1370–1395.
Leamer, E.E., Leamer, E.E., 1978. Specification Searches: Ad Hoc Inference with Nonexperimental Data, vol. 53. John Wiley & Sons Incorporated.
Leon-Gonzalez, R., Montolio, D., 2015. Endogeneity and panel data in growth regressions: a bayesian model averaging approach. J. Macroecon. 46, 23–39.
Ley, E., Steel, M.F., 2009. On the effect of prior assumptions in bayesian model averaging with applications to growth regression. J. Appl. Econom. 24 (4), 651–674.
Liang, F., Paulo, R., Molina, G., Clyde, M.A., Berger, J.O., 2008. Mixtures of g priors for bayesian variable selection. J. Am. Stat. Assoc. 103 (481), 410–423.
Lucas Jr., R.E., 1988. On the mechanics of economic development. J. Monetary Econ. 22 (1), 3–42.
Magnus, J.R., Powell, O., Prüfer, P., 2010. A comparison of two model averaging techniques with an application to growth empirics. J. Econom. 154 (2), 139–153.
Magnus, J.R., Wang, W., 2014. Concept-based bayesian model averaging and growth empirics. Oxf. Bull. Econ. Stat. 76 (6), 874–897.
Masanjala, W.H., Papageorgiou, C., 2008. Rough and lonely road to prosperity: a reexamination of the sources of growth in africa using bayesian model averaging. J. Appl. Econom. 23 (5), 671–682.
Mirestean, A., Tsangarides, C.G., 2016. Growth determinants revisited using limited-information bayesian model averaging. J. Appl. Econom. 31 (1), 106–132.
Mirestean, A.T., Tsangarides, C.G., 2009. Growth determinants revisited. IMF Working Papers 2009 (268).
Moral-Benito, E., 2012. Determinants of economic growth: a bayesian panel data approach. Rev. Econ. Stat. 94 (2), 566–579.
Moral-Benito, E., 2016. Growth empirics in panel data under model uncertainty and weak exogeneity. J. Appl. Econom. 31 (3), 584–602.
Próchniak, M., 2011. Determinants of economic growth in central and eastern europe: the global crisis perspective. Post Commun. Econ. 23 (4), 449–468.
Raftery, A.E., 1995. Bayesian model selection in social research. Socio. Methodol. 111–163.

Raftery, A.E., Madigan, D., Hoeting, J.A., 1997. Bayesian model averaging for linear regression models. J. Am. Stat. Assoc. 92 (437), 179–191.
Romer, P.M., 1990. Endogenous technological change. J. Polit. Econ. 98 (5), S71–S102. Part 2.
Sala-i Martin, X., Doppelhofer, G., Miller, R.I., 2004. Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (Bace) Approach. American economic review, pp. 813–835.
Schwarz, G., 1978. Estimating the Dimension of a Model. The annals of statistics, pp. 461–464.
Solow, R.M., 1956. A contribution to the theory of economic growth. Q. J. Econ. 70 (1), 65–94.
Strawderman, W.E., 1971. Proper bayes minimax estimators of the multivariate normal mean. Ann. Math. Stat. 42 (1), 385–388.
Wasserman, L., 2000. Bayesian model selection and model averaging. J. Math. Psychol. 44 (1), 92–107.
West, K.D., Durlauf, S.N., Brock, W.A., 2003. Policy evaluation in uncertain economic environments. Brookings Pap. Econ. Activ. (1), 235–301.
Zellner, A., 1986. On Assessing Prior Distributions and Bayesian Regression Analysis with G-Prior Distributions. Bayesian Inference and Decision Techniques.
Zeugner, S., 2011. Bayesian model averaging with bms. Tutorial to the R-package BMS 1e30.