Title:

Institutional determinants of budgetary expenditures. A BMA-based re-evaluation of contemporary theories for OECD countries[1]

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Abstract:

The article tackles the problem of institutional determinants of public expenditures. Within the traditions of public choice and institutional economics, it tests several theories ranging from the fiscal commons framework, Political Business/Budget Cycle (PBC) and path dependence to veto players theory. Its novelty compared to previous research stems from an attempt to test several theories simultaneously, dealing with model uncertainty by utilizing sensitivity analysis within the Bayesian Model Averaging framework with a vast prior structure in terms of model, g and multicollinearity dilution priors. The results confirm a number of hypotheses tested in the area of fiscal management across the recent decades within the group of developed economies, giving especially strong support to the tragedy of the fiscal commons and path dependence concepts, while only partial support to veto players theory. In contrast, explanations based on political budget cycle (PBC) theory are dismissed. Among other interesting findings reported in the study, Scandinavian countries turn out to be the most fiscally responsible when other institutional factors are taken into account. Similarly, contrary to other recent research into the issue of EU fiscal institutional framework, Euro area countries are characterized by limited public expenditures.

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1. Introduction

The problem of explaining the differences in public expenditures and their dynamics among democratic states is an old one, dating at least a century with posing of so-called Wagner's law (Wagner, 1958). From the practical standpoint, the problem is important, as public expenditures are linked with the magnitude of public deficits and debts, and indirectly affect fiscal sustainability. This issue in turn is still considered one of the most important problems with regards to risks of financial crises, although it lost some prominence in recent years in favor of external imbalances of a country generally (Afonso *et al*., 2019). It is being actively pursued across disciplines of political science and economics (Persson and Tabellini, 2003). This issue has seen a variety of explanations from both disciplines ranging from empirical (Wildavsky, 1964) to theoretical ones (Wagner, 2007 and 2012). Within economics, the most prominent explanation for the differences in public expenditures is connected to the concept of the "tragedy of the fiscal commons" attributed to the problem first posed by Hardin (1968) who tried to explain the overexploitation of common natural resources. This issue was most vividly described in the area of public finance by Buchanan and Tullock (1962). The basic premise of the concept relates to the positive relationship between expenditures and the number of political actors that are able to "tap into" the fiscal resource (Możdżeń, 2013, 2018). Over decades, this problem has been tackled by a number of scholars working within the framework of public choice theory and new institutional economics (Poterba, Von Hagen, 1999). In this vein of research, institutional features of the political system which put constraints on the discretionary powers of particular actors contribute to controlling the size and dynamics of public expenditures as well as working against the so-called "deficit bias" of the democratic process. This is the tradition which this article is also strongly linked to. There are, of course, different explanations for the dynamics of the budgetary process (and public finance in general), which include e.g. political ideology (Veto Players Theory - Tsebelis, 2002), internal power struggles within the political system (Selectorate Theory - De Mesquita *et al*., 2003) or ease of access to the political sphere by external interest groups (Access Point Theory - Ehrlich, 2011, State Capture Theory - see Alwasiak *et al.,* 2013). One has to acknowledge an important vein of research into political budget cycles which deals with the dynamics of public expenditures and deficits with relation to electoral cycle (Rogoff, 1990; Drazen and Eslava, 2005; Drazen, 2000; Shi and Svensson, 2002; Alwasiak *et al.,* 2014; Foremny et al. 2018). Overall however, it seems that the "tragedy of the fiscal commons" (ToFC) approach is the one with strongest theoretical and empirical basis to date.

The novelty of the present article is based on the fact, that it is working with a variety of hypotheses stemming from different enumerated theoretical approaches and strives to reevaluate them with the use of sensitivity analysis within the Bayesian model averaging framework. The research utilizes relatively recent data (2001-2012) for selected OECD countries in order to test for the influence of political institutions on budgetary expenditures.

The remainder of the paper is structured as follows. Section 2 presents literature review and comprises 3 subsections devoted to institutions of power legitimacy, institutions of internal power relations and budgetary rules. The data set used for estimation and Bayesian model averaging estimation strategy is described in section 3. The estimation results are discussed in Section 4, while conclusions/summary and discussion are provided in Section 5.

2. Review of current research

The results of the research presented below are a part to the fast-growing empirical trend of research into the institutional determinants of the political process, in particular the budget

process. However, recalling them will allow us to theoretically and empirically consolidate the current knowledge on the impact of institutions on the budget process. Considering a fairly large variety of hypotheses on the relationship between institutions and political results, and especially the consequences in the political and economic sphere (budget process), the presentation of research should facilitate the process of formulating basic intuitions linking institutional variables with fiscal results. The results will be presented in three categories: institutions of political power legitimacy, institutions of internal system relations and rules of the budget process.

2.1. Institutions of power legitimacy

Institutions of power legitimacy in established democracies should be understood as simply electoral institutions. Research into the applied rules of the emergence of power and their impact on the actions of actors in the political system are relatively well developed and offer interesting conclusions.

Focusing on parliamentary elections, it should be noted that their institutional characteristics fundamentally differ in several dimensions. Political science analyzes in detail many of these dimensions, but they focus on three ones in particular: the range (size) of the district, the electoral formula, and the structure of electoral lists. This is important because, as Persson and Tabellini (2003) point out, these institutional dimensions are relatively frequently examined in relation to the size and structure of public spending (including budget expenditure). Researchers analyzing in detail the issues of electoral systems indicate that individual dimensions are highly correlated, i.e. certain properties of individual systems tend to coexist frequently (Cox, 1997).

It is generally assumed that in a system with large constituencies, politicians put more emphasis on broad political programs, whereas in smaller ones they look for more specifically addressed proposals. In other words, large districts should favor the provision of general public goods or programs of broad social transfers, while in a system with small districts we should observe more programs targeting specific districts - in particular, the pivotal ones (Persson and Tabellini, 1999; Milesi-Ferretti, Perotti and Rostagno, 2002).

Along with an increase in the range of the electoral district, the minimum percentage of votes necessary to obtain the majority (or formulation of majority coalition) also increases on average. In an extreme case, one can imagine in single-mandate constituencies a situation in which obtaining 25% of the votes at the national level gives the minimum parliamentary majority, whereas for a constituency covering the whole country in the majority system, the minimum threshold is 50% of votes. The consequence of this fact should be the desire to mobilize larger parts of the population in systems with large districts by means of more general programs, and in the case of small districts - the use of transfers for specific parts of the population (Lizzeri and Persico, 2001).

In connection with the need to gain the support of a larger part of society in large districts, some researchers suggest the existence of relatively higher total public expenditure in such systems (Milesi-Ferretti, Perotti and Rostagno, 2002), while others assume that the effect should be ambiguous (Persson and Tabellini, 2001).

The electoral formula decides how votes are converted into seats. In the majoritarian formula, only the candidates with the largest percentage of votes in the district receive seats. As part of the proportional formula, the number of seats depends on the percentage of votes obtained. Duverger's law states that in elections taking place in accordance with the majority formula, one should observe the emergence of stable two-party systems, and in the case of a proportional formula the political landscape should be more unstable and diverse, with high

party and government fractionalization. Moreover, as Persson and Tabellini (2003) argue, in majoritarian systems we should expect a greater increase in the occurrence of political budget cycles than in the proportional or mixed formula due to the increased responsibility of politicians to their electorate. However, the PBC as a political phenomenon is increasingly subject to rejection, at least in the advanced countries (Drazen, 2000; Philips, 2016).

The structure of electoral lists determines how citizens give their votes; by voting for individual candidates or for entire lists. From the political point of view, there is no doubt that in the situation of voting for the electoral lists, much greater power lies in the hands of the people and the groups that construct them, while voting for individual candidates shifts the main plane of competition to the individual level. From the point of view of consequences in the area of public policy implemented within the alternative structures of electoral lists, one can expect, as Persson and Tabellini (2003) show, that voting for electoral lists limits the incentives for individual candidates to display behavior consistent with the preferences of their voters. Therefore, they can try to increase their own well-being at the expense of the community to a higher degree. They have to take into account the preferences of the entities deciding on the shape of electoral lists, so that their interest in implementing the interests of the broad electorate is "filtered" by trying to please the party leadership in particular. As a rule, Persson and Tabellini (2001), similarly to Carey and Shugart (1995), predict that the list-voting system should generate a larger percentage of parliamentarians interested in abusing the system. On the other hand, increased loyalty to the party establishment at the expense of voters in a given district should reduce the interest of candidates who start in systems based on electoral lists (especially closed ones) in favoring the particular interest of their district (Pfeil, 2016).

As for empirical literature, some general traits with regard to the influence of the institutions of power legitimacy on budgetary expenditures can be observed. In a study covering a panel of 90 countries, Persson and Tabellini (2004) discover that countries that have adopted a majoritarian electoral system are characterized by an average smaller public sphere than countries using a proportional system. In their investigation on the panel of 60 democratic states, the same researchers (2003) prove that all the studied countries in the 1970s and 1980s experienced an increase in the relative size of the public sphere; however, countries with a proportional representation witnessed greater dynamics of growth as compared to those using majoritarian solutions. In addition, Milesi-Ferretti, Perotti and Rostagno (2002) indicate that the governments elected on the basis of the majoritarian system are characterized by a lower relative level of spending on public goods and broad redistribution programs than governments based on a proportional system. Similar conclusions can be drawn from studies conducted on 83 countries by Persson and Tabellini (2003), but the results indicate that this is a consequence of the relatively younger populations of countries with majoritarian and presidential systems. Researchers also point to a greater tendency to generate budget deficits in countries with proportional electoral systems, due to their impact on government fragmentation. However, interestingly enough, the fragmentation itself seems to be more important for the rise of government expenditure in parliamentary than presidential systems (Hankla, 2013). At the same time, recent evidence point to government fragmentation influencing deficits by reducing revenues and not by increasing spending (Artés and Jurado 2018).

Hallerberg (2000) argues that the reforms of the electoral system carried out in the first half of the 1990s in Italy and aimed at reducing the proportionality of the system enabled the Italian State to meet the fiscal requirements for candidates to the EMU. After conducting comparative studies of the US states, Wibbels (2003) observed that states in which electoral institutions forced more competition between candidates to local legislatures accumulated

high levels of public debt to a lesser extent compared to those with systems that stimulated less competition. Similar results among OECD countries after the Second World War are presented by Skilling (2001). In turn, Hallerberg and Marier (2004), as a result of research conducted among Latin American countries, stated that the problem of common fiscal resources is more visible in countries where electoral institutions emphasize personal accountability of parliamentarians. De Mesquita *et al.* (2003) on the basis of their "selectorate theory", indicate that the size of the winning coalition (the part of population whose support is needed in order to seize power) relative to the size of the selectorate (the part of population eligible to participate in political competition) shows a positive relationship with the total amount of public expenditure. With this in mind, one can hypothesize that among democratic countries those with higher voter turnout should generate higher public expenditures (Stratmann and Okolski, 2010).

2.2. Institutions of internal power relations

In the case of the second institutional dimension, the degree of centralization/fragmentation of the budget process is a particularly often examined specificity. The dimension is most frequently operationalized in two ways, either with the help of the evaluation of relative strength of finance minister against line ministers, or by assessing the number of actors participating in the budget process. In general, the majority of research focuses on the impact of centralization on the size of budget surpluses/deficits; however, it seems that some conditional conclusions can also be drawn from them for the size of public expenditure. The negative impact of centralization on the size of budget deficits is indicated, among others, by von Hagen (1992), von Hagen and Harden (1994) as well as Hallerberg and von Hagen (1999) and on the basis of the analysis of the situation of individual countries Stienlet (2000 - Belgium), Molander (2000 - Sweden) and Strauch and Von Hagen (1999 - Germany). A large scale historical analysis confirming the importance of centralization to fiscal prudence was done by Dincecco (2010). In the context of Central and Eastern European countries, Gleich (2002) and Yläoutinen (2004) come to similar conclusions. Analogous results for other parts of the world were received by Stein, Grisanti and Talvi (1999 - Latin American countries), Jones, Sanguinetti and Tommasi (1999 - Argentine provinces), and Strauch (1999 - US).

Regarding the direct relationship between the degree of centralization of the budget process and the size of budget expenditures, the studies conducted by Strauch (1999) and Gleich (2002) also indicate the theoretically expected negative dependence (more centralization meaning less actors involved in the process with decisive voice/lower expenditures).

The institutional endogeneity is quite an interesting topic in this research stream. For example, Wildavsky (1986) and Molander (2000) indicate that increased centralization of the budget process may be a consequence of the state's encounter with a strong fiscal crisis. Examining the countries of Central and Eastern Europe, Gleich and Von Hagen (2002) conclude that countries in which social conflicts were more visible designed institutions that ensure greater centralization of the budget process. According to the authors, this is due to the fact that the parliaments of these countries have got rid of some of the power over budgeting in anticipation of major fiscal difficulties as a consequence of the need to meet the needs of many competitive social groups.

At the same time, in the context of the Veto Players theory, which combines institutional variables with ideological variables (both a larger number of VPs, greater ideological distance between VPs and greater stability of the ruling VP system, should have a negative impact on changes in the budget structure), research of Bawn (1999) and Tsebelis (2002) indicates that the structure of budgets is determined in dynamic terms by variables pointed to by theory – i.e. the more varied the ideological landscape of veto players in the budget process is, the

more stable the relevant budgetary variables (e.g. total budgetary expenditures and their structure) are.

However, researchers working in the public choice tradition suggest, according to the tragedy of the fiscal commons, that the number of political entities involved in the budgetary process positively influence budgetary expenditures and create so-called deficit bias (Buchanan and Tullock, 1962; Wagner, 2012).

Therefore, one could hypothesize that on the one hand institutional constraints on the democratically elected politicians, often guarded by unelected officials should probably favor limiting public expenditures (Keefer and Knack, 2007), and on the other the sheer number of political actors with different constituencies works in the opposite direction.

There is no doubt that the institutions determining the way the power is divided between central authority and local government are one of the most important causes of differences in the manner and level of decision making regarding public policies. There is also no doubt that unitary states (e.g. France and Italy) compared to the federal ones (e.g. Germany and the US) as a rule differ in terms of specific solutions. There is rich theoretical and empirical literature concerning the consequences of diverse institutional systems affecting the ways of power division between the center and local governments as well as the size and structure of public spending at both higher and lower levels (Brennan and Buchanan, 2000; Tiebout, 1956; Weingast, Shepsle and Johnsen, 1981).

As a rule, most of the theoretical models built as part of the public choice research program suggest that the federal structure of the state should bring with it a relative limitation of the total amount of public expenditure (under certain conditions). This may be due to the following factors:

(1) increased competition between individual providers of public services (Brennan and Buchanan 2000) in conjunction with the so-called "voting with the feet" (Tiebout, 1956);
(2) increased ability to internalize the costs of increased spending within a given community (Weingast, Shepsle and Johnsen, 1981).

On the other hand, there are forces that act in the opposite direction, encouraging spending to be increased by federation units, in particular in the event of high transfers from the federal government (in connection with the so-called flypaper effect - Mueller, 2003).

However, there are no unambiguous interpretations regarding the impact of different solutions in the area of the division of power between local governments, maybe above an obvious conclusion that the federal structure of the state reduces the total expenses borne by the central government.

2.3. Rules of the budgetary process

The current of research into the influence of lower-level rules (especially fiscal rules) on budget results is relatively younger than the previously described. There is still a relative lack of research on the endogeneity of these rules (Heineman et al. 2018), and those that exist point out above all that the actors operating at the constitutional level are aware of the consequences of individual institutions in the context of the tragedy of fiscal commons. Therefore, they more often choose, e.g., rules strengthening the role of the Minister of Finance in the budget process in countries with proportional electoral systems and in countries with a more polarized political scene, where political competition is more visible (Hallerberg, 2004).

As for the direct impact of fiscal rules on budget results, it is difficult to find clear results in the current research into the way the behavior of the actors involved in budget preparation is being shaped by them. For example, Poterba and Reuben (1999) indicate that the balanced budget rules and debt rules reduce in principle the interest rate on public debt. But Strauch (1999) notes that in the event of restrictions on the possibility of issuing debt by US state authorities, they tend to substitute instruments subject to restrictions for those that are regulated more liberally. Fatas *et al.* (2004) show the ineffectiveness of the mechanisms introduced by the European Stability and Growth Pact. Wolff and von Hagen (2006) provide evidence that EU Member States use creative accounting to circumvent the limits of the deficit size. In the United States, constitutional restrictions on state expenditure lead to a shift in spending from current to long-term investment (Strauch, 1999). The size of state budget expenditures does not seem to be reduced as a whole as a consequence of introducing restrictions on the possibility of taxing and spending (Strauch, 1999; Shadbegian, 1996). In the transforming economies taking the example of Poland Józefiak, Krajewski and Mackiewicz (2006) document immediate disregard of the expenditure rule called the "Belka anchor" by the politicians. However, in the event of breaking a fiscal rule, there seems to be a general tendency to subsequent suppression of the fiscal variable being in breach of the fiscal rule towards the benchmark introduced by the rule (Reuter 2015).

Poterba (1994) shows that numerical limitations on the size of the deficit and budget, if adhered to, can have a pro-cyclical effect and, therefore, increase the volatility of the economic cycle. Fatas and Mihov (2003) note, however, that budget rules may have a negative impact on the discretionary budgeting, which, according to the authors, should increase economic stability (this claim in the post-crisis era has, however, became controversial).

3. Methodology

The first subsection presents the main hypotheses stemming from current research. The second subsection introduces the dataset used in estimations, and the third describes Bayesian model averaging and jointness measures.

3.1. Hypotheses

Based on the review of the literature presented in section 2 of the article, one can construct several research hypotheses organized around three described categories of institutional operation (i.e. institutions of power legitimacy, of power relations and rules of the budgetary process).

H1. States with a proportional electoral system are characterized by an average higher level of public spending (institutions of power legitimacy).

H2. States with a large size of winning coalition in relation to the size of the selectorate, are characterized by a higher level of public spending (institutions of power legitimacy).

H3. There is no visible connection between the time left to the nearest elections and the volume of budget expenditures (institutions of power legitimacy).

H4. Governments with a large number of veto players are characterized by higher expenditures (institutions of internal power relations).

H5. Institutional checks and balances introducing independent institutions limiting government freedom of spending are generally effective (institutions of internal power relations).

H6. Fiscal rules, designed to stiffen the budget formation process, in practice have low effectiveness (rules of the budgetary process).

However it has to be noted that due to the specificity of the chosen methodology (BMA), the list of variables chosen for the research extends beyond those involved in testing the stated hypotheses. The approach chosen by the authors is thus a mixed one, combining confirmatory and exploratory analysis.

3.2. Data and measurement

The independent variables comprise of data on political institutions within three categories described above (institutions of power legitimacy, of power relations, of budgetary process) obtained from different sources as well as a number of control economic and social variables. Due to a large number of these variables, their detailed description can be found in the Appendix 1. However the most important variables designed to test the hypotheses posed in the subsection 3.1 are presented in table 1.

Table 1. Variables chosen to test main hypotheses of the paper

Hypothesis	Variable name	Variable description
H1	*elec_sys*	Electoral systems: 1. Majoritarian; 2. Mixed; 3. Proportional.
	closed_list	Closed list variable is a dummy constructed the following way. If voters cannot choose individual candidates and vote for entire lists - 1, otherwise - 0
	dist_house	Mean District Magnitude in House elections. Weighted average of the number of representatives elected in different size districts, if available. If not, the number of seats is divided by the number of districts (if both are known).
H2	*vot_turn*	Voter turnout in last parliamentary election (%)
H3	*yrs_elec*	Years left in current parliamentary term
H4	*gov_frac*	Government Fractionalization Index. The probability that two deputies picked at random from among the government parties will be of different parties
	no_part	Number of parties in the government
H5	*checks_bal*	The index of checks and balances equals 1, if the legislature is not chosen in competitive elections or in those in which only the executive has real power. For countries that do not meet this criterion (ie democratic states), one of the following conditions increases its value: 1. The existence of the head of state. 2. Head of state elected in competitive elections. 3. The opposition controls the legislature. Additionally, in presidential systems the value is increased by 1 when: 1. There is more than one chamber of parliament, unless the head of state has a majority in the lower house and there is a closed list system 2. There are parties recognized as affiliated with the party of the head of state, but with an ideological position similar to the opposition. In parliamentary systems, however, the value is increased by 1: 1. For each party in the ruling coalition, as long as its votes are necessary to keep the majority in the parliament. 2. For each party in a ruling coalition whose ideological position is closer to the opposition than to the prime minister's party. 3. The value is lowered by 1 when the open list is functioning
	Polcon3	Political constraints Index III. The index is composed from the following information: the number of independent branches of government with veto power over policy change, counting the executive and the presence of an elective lower and upper house in the legislature (more branches leading to more constraint); the extent of party alignment across branches of government, measured as the extent to which the same party or coalition of parties control each branch (decreasing the level of constraint); and the extent of preference heterogeneity within each legislative branch, measured as legislative fractionalization in the relevant house (increasing constraint for aligned executives, decreasing it for opposed executives).

	polcon5	Political constraints Index V. This index follows the same logic as Political Constraints Index III (h_polcon3) but also includes two additional veto points: the judiciary and sub-federal entities
H6	er_nat	Existence of an expenditure rule at a central level. Yes - 1, No - 0
	rr_nat	Existence of a revenue rule at a central level. Yes - 1, No - 0
	bbr_nat	Existence of a balance budget rule at a central level. Yes - 1, No - 0
	dr_nat	Existence of a debt rule at a central level. Yes - 1, No - 0
	dr	Existence of a debt rule at any level of government. Yes - 1, No - 0
	bbr	Existence of a balance budget rule rule at any level of government. Yes - 1, No - 0

Source: own compilation[3]

The particular dependent variable used in the analysis (*COFOG_tot*) is the sum of central government expenditures excluding social security contributions by functions of government (COFOG) as a share of GDP compiled by the IMF for the database Government Finance Statistics (see GFSM 2014)[4]. Although it slightly differs from other measures of central government spending, its advantage is completeness for the countries included in the dataset and, due to the same methodology, comparability to data on COFOG expenditures obtained from other sources (e.g. OECD, Eurostat). A variable for budgetary expenditure on the central level has been chosen deliberately. Since most of the institutions we study work at the level of the central government, they may not be well suited for explaining expenditure of local and regional governments. Therefore, the authors have decided to choose a variable which explicitly excludes these expenditures. Such an approach should result in expenditures' levels being more sensitive to changes in institutions.

The dataset includes the following 25 countries (members of OECD) for which we were able to obtain complete data over 2001-2012 years for all the variables: Australia, Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Latvia, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom, and United States. Overall, the panel comprises 300 observations. All 39 variables were tested for the common unit root using Levin, Lin and Chu test (2002) as well as for individual unit root using Im, Peseran and Shi test (2003). As confirmed by aforementioned tests, all variables used in the estimations are weakly stationary[5].

3.3 BMA – Bayesian model averaging

Theoretical literature contains a long list of potential institutional determinants of budgetary expenditures. Thus far, researchers were trying to verify the hypotheses about them, focused their inquiries only on phew variables representing the institutions they were interested in or those associated with a given strain of theory. This type of approach completely disregards uncertainty about the specification of the model being tested. This issue is amplified by the presence of open-endedness, the idea that the validity of one casual theory is not implying falsification of another one (Brock and Durlauf, 2001). With the vast theoretical and empirical literature on the subject, the assessment which of the theories are correct becomes infeasible due to the bulk of inconsistent or even conflicting results that cannot be compared.

Accordingly, in order to assess which institutions are in fact, determining budgetary expenditure, the analytical framework needs to allow the comparison of the different models

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3 Sources for the data are relegated to the table in the appendix 1.

4 COFOG expenditures are divided into the following ten functions: general public services; defense; public order and safety; economic affairs; environmental protection; housing and community amenities; health; recreation, culture and religion; education; and social protection. Data on central government expenditures by function include transfers between the different levels of government.

5 Results are not reported here for brevity and are available upon request.

as well as their assessment based on the empirical grounds. Bayesian model averaging is a method possessing all these qualities, and consequently, in the present paper, it was used to identify the robustness of the institutional determinants of budget expenditure among the candidates form the up to date research. The remainder of this subsection presents the general idea behind BMA and introduces the reader to its mains statistics. Due to the technical complexity of the method, the details with the references are described in Appendix 2.

The data comprises a panel of 25 countries over the 2001-2012 period with one dependent variable and 38 regressors. In the literature, country heterogeneity in the data is dealt with using random or fixed effects models. Those models are well fit when a single theory is tested at a time, and random and fixed effects serve as a way of covering up the ignorance about the sources of heterogeneity (Wooldridge, 2010). On the other hand, BMA deals with heterogeneity directly by finding a combination of regressors which accounts for it to the greatest extent within a conditioning set of information. Consequently, BMA appears to be ideally suited for finding robust determinants of budgetary expenditure.

Within the set of regressors, the research strives at the identification of the variables, whose influence on budgetary expenditures finds the most substantial support in the data. BMA assumes the following general form of the model:

$$y_j = \alpha_j + X_j\beta_j + \varepsilon_j \tag{1}$$

where $j=1, 2,..,m$ denotes the number of the model, y_j is a vector $((n*t) \times 1)$ of the values of the dependent variable, α_j is a vector of intercepts, β_j is a vector $(K \times 1)$ of unknown parameters, X_j is a matrix $((n*t) \times K)$ of explanatory variables, whereas ε_j is a vector of residuals which are assumed to be normally distributed and conditionally homoscedastic, $\varepsilon \sim N(0, \sigma^2 I)$. $n*t$ denotes the number of observations (300), and K is the total number of regressors (38). Generally, with K regressors representing different theories it is possible to construct 2^K different models:

$\binom{K}{0} = 1$ with no variables: none of the theories is correct;

$\binom{K}{1} = K$ models with one variable;

$\binom{K}{2} = \frac{(K-1)*K}{2}$ models with two variables;

$\vdots$

$\binom{K}{K-2} = \frac{(K-1)*K}{2}$ models with $K-2$ variables:;

$\binom{K}{K-1} = K$ models with $K-1$ variable;

$\binom{K}{K} = 1$ with all variables.

Assuming that all these models are estimated, in the first stage of Bayesian model averaging it is required to assess what is the probability that each of the following models is so-called "true regression model." It is achieved with the Bayes theorem, by calculating posterior model probability (PMP) for each of the models (M_j):

$$PMP_j = P(M_j|data) = \frac{L(data|M_j) * P(M_j)}{\sum_{j=1}^{2^K} L(data|M_j) * P(M_j)}. \tag{2}$$

Bayes theorem is utilized to obtain PMP – the probability that a given model j is the "true regression model" after seeing the data – by combining information from the data with the prior belief of the researcher that the model is, in fact, the correct one. $L(data|M_j)$ – model specific value of marginal likelihood function represents information from the data. It shows what is the probability that the considered model generated the data at hand. $P(M_j)$ - is the prior probability that a given model j is the true regression model. If the researcher has no prior knowledge which of the analyzed model is the correct one, the uninformative prior can be utilized. The present paper uses two different uninformative priors. The uniform model prior assumes that all 2^K are equally probable: $P(M_j) = \frac{1}{2^K}$. The binomial-beta model prior assumes that models of a given size – measured by the number of regressors – are all equally probable. The denominator of (1) adds up products of the likelihood function and prior model probability, and consequently, the PMPs can be treated as probabilities or model weights as they sum up to 1.

In the second stage, with PMPs calculated, it is possible to calculate the BMA statistics. The first is the posterior inclusion probability (PIP) – the probability of including a variable in a model after seeing the data. With prior model probability distributions used in this research, the prior inclusion probability – the probability of including a variable in the model – is equal to 0.5. Consequently, if PIP is higher than 0.5, the variable is considered robust. PIP is calculated for each regressor by adding up posterior model probabilities from the models in which the variable is present:

$$PIP_i = P(x_i|data) = \sum_{j=1}^{2^K} 1(\varphi_i = 1|M_j) * PMP_j \tag{3}$$

where $\varphi_i = 1$ signifies including the variable x_i in the model.

Posterior mean (PM) is calculated to establish the strength of the impact of a given regressor, taking into account information from all the possible models. It is accomplished by taking a weighted average of a coefficient β of a given regressor i from all the models, where posterior model probabilities are used as weights:

$$PM_i = E(\beta_i|data) = \sum_{j=1}^{2^K} P(M_j|data) * \hat{\beta}_{ij}. \tag{4}$$

If a given variable i is not in the model, the value of the coefficient β is equal to 0. Posterior standard deviation (PSD) measures the uncertainty about the value of the coefficient β. It is a broader concept than standard error used in the regression models as it collects information about uncertainty from two sources. Firstly, much like a standard error, uncertainty about the value of β in each one specific model, and secondly about the uncertainty resulting from the differences in the value of the coefficient between models. The posterior probability of positive sign, denoted by P(+) informs about the stability of the sign of a coefficient. The value close to one indicates that the coefficient consistently positive, while close to zero consistently negative. The closer the values to 0.5, the higher is the sign instability between models.

To allow the comparison of the relative impact of the institutional determinants on the central government expenditure, standardized coefficients were calculated and BMA statistics based on their values. SPM denotes the standardized posterior mean, while SPSD denotes a standardized posterior standard deviation.

The six aforementioned statistics are used to assess the robustness of the variables and their impact on government expenditure. It should be noted that three more notions associated with Bayesian model averaging were left for the appendix. Firstly, in order to account for possible multicollinearity between regressors, the dilution prior was utilized in estimations. Secondly, different specifications of g prior were used to assure the robustness of the results. Finally, with 38 regressors the number of possible models to estimate amounts to almost 275 billion, and is infeasible to estimate analytically. Consequently, the number of possible models is reduced with MC[3] (Markov Chain Monte Carlo model Composition) sampler.

Within the BMA framework, it is possible to investigate the nature of the relationships between the explanatory variables using jointness measures put forward by Doppelhofer and Week (2009) as well as Ley and Steel (2007). Both measures allow classification of the relationship between variables into three main categories. The first represent unrelated variables. The second covers substitutes – the regressors that contain the same information about the dependent variable. The third one comprises complements – the regressors that reinforce their explanatory power when they are included together.

4. Analysis of the results

The main results of the analysis are presented in Table 2[6]. The section is organized as follows. First the results for the three institutional levels (of power legitimacy, of internal relations and rules of the budgetary process) are presented subsequently. Then an analysis of supplementary and control variables is conducted to explore avenues of the further research. The section is concluded with a part describing the most robust and potent predictors of budgetary expenditures.

Table 2. Main results of the analysis

model prior	Uniform						Dillution					
g prior	Unit Information Prior						Risk Inflation Criterion					
VARIABLE	PIP	PM	PSD	SPM	SPSD	P(+)	PIP	PM	PSD	SPM	SPSD	P(+)
bbr_nat	1.000	4.051	0.596	0.293	0.043	1.000	1.000	4.098	0.598	0.297	0.043	1.000
English_LE	1.000	11.710	1.220	0.679	0.071	1.000	1.000	11.340	1.009	0.657	0.058	1.000
French_LE	1.000	12.660	1.564	0.824	0.102	1.000	1.000	12.901	1.440	0.839	0.094	1.000
Socialist_LE	1.000	11.790	1.546	0.767	0.101	1.000	1.000	11.198	1.506	0.729	0.098	1.000
elec_sys	1.000	4.119	0.601	0.449	0.065	1.000	1.000	4.145	0.629	0.451	0.068	1.000
cur_union	1.000	-8.231	0.772	-0.596	0.056	0.000	1.000	-8.415	0.769	-0.609	0.056	0.000
reg_age	1.000	0.073	0.009	0.514	0.065	1.000	1.000	0.073	0.009	0.514	0.064	1.000
checks_bal	1.000	-1.785	0.220	-0.284	0.035	0.000	1.000	-1.816	0.219	-0.289	0.035	0.000
closed_list	1.000	-5.998	0.806	-0.434	0.058	0.000	1.000	-6.217	0.826	-0.450	0.060	0.000
advanced	1.000	5.371	0.831	0.285	0.044	1.000	1.000	5.224	0.824	0.278	0.044	1.000
resour_rich	1.000	9.931	1.424	0.282	0.040	1.000	1.000	10.051	1.384	0.285	0.039	1.000
religion_frac	1.000	-10.005	1.557	-0.319	0.050	0.000	1.000	-10.453	1.430	-0.334	0.046	0.000
German_LE	1.000	14.889	1.672	0.585	0.066	1.000	1.000	14.604	1.555	0.574	0.061	1.000
fed	1.000	-5.424	1.154	-0.314	0.067	0.000	0.993	-4.627	1.277	-0.268	0.074	0.000
ethnic_frac	1.000	-17.659	2.688	-0.458	0.070	0.000	1.000	-19.496	1.805	-0.505	0.047	0.000
polcon5	1.000	-15.661	3.269	-0.168	0.035	0.000	1.000	-16.384	3.133	-0.176	0.034	0.000
er_nat	1.000	-2.475	0.498	-0.173	0.035	0.000	1.000	-2.663	0.472	-0.186	0.033	0.000
gov_frac	0.997	9.846	1.964	0.364	0.073	1.000	0.992	10.371	1.558	0.383	0.058	1.000
pub_bal	0.935	-0.576	0.176	-0.413	0.126	0.000	0.931	-0.599	0.173	-0.429	0.124	0.000
vot_turn	0.875	0.063	0.033	0.111	0.059	1.000	0.492	0.032	0.036	0.057	0.064	1.000
dr_nat	0.813	-1.349	0.822	-0.082	0.050	0.000	0.764	-1.434	0.918	-0.087	0.056	0.000

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[6] Results for combination of RIC and binomial-beta priors, as well as for dilution and UIP prior are shown in Appendix 3. Jointness measure are relegated to Appendix 4.

debt_pub	0.592	0.017	0.017	0.071	0.070	1.000	0.336	0.011	0.017	0.045	0.068	1.000
language_frac	0.276	-1.724	3.321	-0.049	0.094	0.014	0.015	-0.096	0.879	-0.003	0.025	0.008
polcon3	0.263	0.998	1.954	0.017	0.034	1.000	0.062	0.231	1.023	0.004	0.018	1.000
no_part	0.164	0.097	0.274	0.017	0.049	1.000	0.024	0.027	0.197	0.005	0.035	1.000
bud_bal	0.146	-0.058	0.177	-0.040	0.121	0.000	0.070	-0.047	0.174	-0.032	0.119	0.000
gdpgr	0.124	-0.010	0.034	-0.005	0.017	0.000	0.044	-0.003	0.020	-0.002	0.010	0.000
yrs_elec	0.111	-0.018	0.068	-0.003	0.012	0.000	0.048	-0.008	0.045	-0.001	0.008	0.000
dist_house	0.109	-0.002	0.008	-0.006	0.027	0.135	0.010	0.000	0.002	0.000	0.007	0.023
unemployment	0.106	-0.009	0.038	-0.005	0.020	0.014	0.023	-0.002	0.019	-0.001	0.010	0.006
rr_nat	0.090	0.074	0.344	0.004	0.017	1.000	0.014	0.008	0.122	0.000	0.006	0.994
dr	0.086	0.056	0.291	0.003	0.016	0.978	0.016	0.012	0.132	0.001	0.007	0.995
x2009	0.075	-0.041	0.257	-0.002	0.010	0.011	0.025	-0.009	0.123	0.000	0.005	0.013
e_union	0.061	-0.025	0.272	-0.001	0.015	0.267	0.006	0.001	0.076	0.000	0.004	0.461
elec_year	0.061	0.009	0.096	0.001	0.006	0.907	0.027	0.004	0.062	0.000	0.004	0.971
bbr	0.060	0.014	0.212	0.001	0.009	0.892	0.012	0.004	0.092	0.000	0.004	0.984
inflation	0.057	0.001	0.026	0.000	0.007	0.795	0.020	0.001	0.015	0.000	0.004	0.973
x2010	0.056	-0.009	0.146	0.000	0.006	0.010	0.023	-0.004	0.093	0.000	0.004	0.007
Burn-ins	100000											
Itertions	1m											
Cor PMP	0.9987						0.9998					

Source: own compilation

4.1. Institutions of power legitimacy

The nominal variable (*elec_sys*) responsible for the electoral system (majoritarian, mixed or proportional) is robust with PIP equal to 1, and PM 4.12. In other words in line with established research to date in the vein of the "tragedy of the fiscal commons" tradition, the more proportional the electoral system, the higher government expenditures (Persson and Tabellini, 1999; Milesi-Ferretti, Perotti and Rostagno, 2002).

Conversely a dummy variable for closed list (*closed_list*) is characterized by PIP equal to 1 and posterior mean -6. In other words, the existence of closed list in a particular political regime is associated with 6 percentage points lower government expenditures on average. This lends credibility to the view that closed electoral lists cause more party discipline outside majoritarian systems, so it is easier to control spending by party leadership in a top-down manner, without taking into account the preferences of all candidates (Pfeil, 2016).

Voter turnout in parliamentary elections (*vot_turn*) was classified as robust with 0.88 posterior inclusion probability. PM is equal to 0.06 indicating that ten percentage point higher turnout is related to 6 per mil points increase in expenditures, which can be explained in the vein of selectorate theory, by the decision to increase the burden on the system for the provision of general public goods and increasing fiscal transfers. This is, however, inconsistent with some other studies which find negative (Hodler *et al*., 2015; Godefroy and Henry, 2016) or insignificant influence (Hoffman, León and Lombardi, 2017). We favor the explanation that increased electoral participation can be associated with amplified pressure on politicians to generate more inclusive budgets, especially towards lower income population strata, which is consistent with some other research (Stratmann and Okolski, 2010). Attesting to some mentioned disagreement in the literature, the variable appears fragile in the dilut-RIC specification.

Interestingly, district magnitude (*dist_house*) does not to be a strong determinant of government expenditure either. This may explain a disagreement in the literature on the relation between the variables (Milesi-Ferretti, Perotti and Rostagno, 2002; Persson and Tabellini, 2001). The *yrs_elec* and *elec_year* also obtain low PIPs (0.111 and 0.061) which

suggest that the political budget cycle in advanced economies is at most weak, confirming established results for developed countries (Drazen, 2000; Philips, 2016).

4.2. Institutions of internal power relations

Government Fractionalization (*gov_frac*) as the approximation of the weighted number of political veto players (parties) in the central government is robust, and in line with the prediction resulting from the concept of the tragedy of the fiscal commons increases government expenditures (Roubini and Sachs, 1989; Volkerink and de Haan, 2001; Bräuninger, 2005), as indicated by PM of 9.85. Moreover, the variable strongly complements the impact of electoral system on expenditures (JLS=5.67), suggesting that government fractionalization is more of a problem for proportional systems than majoritarian ones. A similar direction of impact is assumed for the variable *no_part* (number of parties in the government), i.e. the unweighted index of government fractionalization, although the variable is characterized by PIP far below the threshold for robust variables. Additionally, since in line

Figure 1. Electoral system, government fractionalization and the number of parties
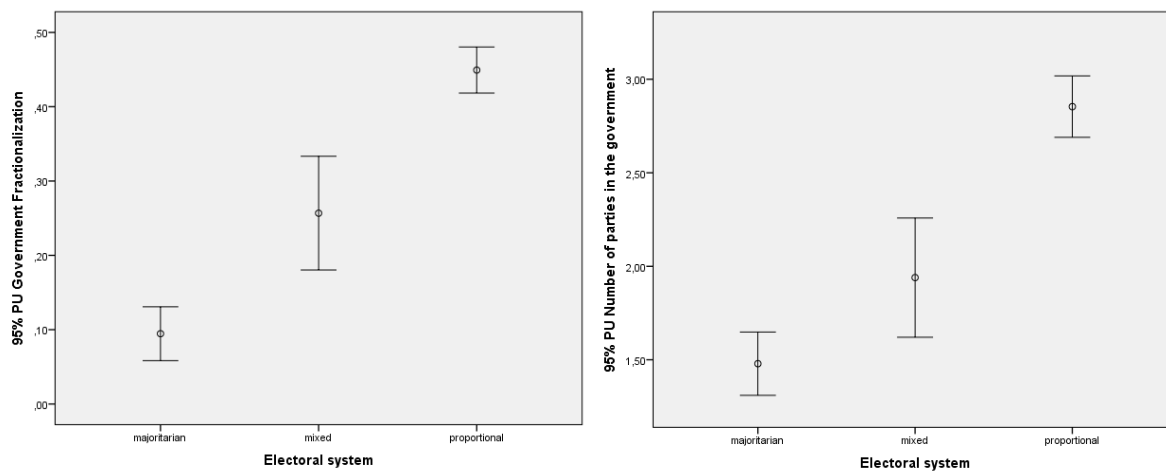
with the Duverger's law electoral system is a strong predictor of both government fractionalization and the number of parties (as confirmed in Figure 1), it is sensible to look for jointness measures. Government fractionalization is a strong complement of electoral system variable with JLS measure of 5.67. This means that more proportional systems are more affected by government fractionalization in terms of the influence on central government expenditures. Conversely, the number of parties is a significant substitute of electoral system variable (JLS = -1,63). Together this may mean that the systems which generate governments with a large number of equally strong parties in the coalition (high fractionalization index) suffer most from the tragedy of the fiscal commons.

Whiskers 95 confidence interval and dots mean values.

Source: own compilation

Also, lending credibility to the concept of the tragedy of the fiscal commons, all institutional restrictions imposed on actors in the public sphere in the form exemplified by the highly complementary *polcon5* and *checks_bal* variables negatively affect the ability to generate high government expenditures (Keefer and Knack, 2007). *Polcon5* is characterized by PIP of 1, while the posterior probability of a positive sign is 0. The same situation occurs with *checks_bal* variable.

Polcon3 variable is below the threshold, but the sign is positive (contrary to *polcon5*). In this context, one should observe that *polcon3* is more biased towards partisan veto-points just like government fractionalization and the number of parties), while *polcon5* includes more

institutional veto-points (federal structure and independent judiciary), which makes it more similar to *checks_bal* variable. This makes for a more detailed explanation which can be summed up using the following logic: in political systems with a stable, well-established institutional structure based on a well-developed structure of systemic checks and balances, provided that it exists for at least a few terms and is respected, a relatively stable expenditure balance should emerge, which may be low and very difficult to change due to the highly diverging interests of various branches of power, while in systems with a labyrinthine political structure the veto players need to implement government action which enforces political compromises involving exchange, trades and negotiations (log-rolling system) also in terms of expenditure. This results in a relative increase in the volume of public spending.

4.3. Rules of the budgetary process

An expenditure rule introduced at the national level (*er_nat*), in accordance with its function, clearly reduces the amount of government expenditures (on average by 2.5 percentage points, with PIP of 1). The debt rule at the national level (*dr_nat*) has a negative impact on the amount of expenditures (PIP of 0.81 and PM of -1.35), which is a natural consequence of the positive impact of the size of public debt on the size of government expenditures provided it is effective[7]. The balanced budget rule at the national level (*bbr_nat*), in turn, positively influences the amount of expenditures (PIP of 1 and PM of 4.05), which is puzzling. If this rule is effective, and there are reasons to believe this is the case[8], it should be able to reduce the deficit and, consequently, public expenditure. Overall, this interesting result may suggest that when balanced budget rule is introduced in countries which experience large deficits and large expenditures simultaneously, they try to narrow the deficit by rising taxes instead of reducing expenditures. Moreover, the strong complementarity of *bbr_nat* and *pub_bal* variables (JLS of 2.8) is worth noting, which suggests in turn that countries which violate their commitment to balance the budget by running large deficits to finance increased expenditure are penalized by more stringent interest rate which increases expenditure even further.

4.4. Other institutional variables and controls

As the BMA framework allows for testing many variables concurrently, authors have decided, based on an analysis of research to date, to include variables traditionally deemed important for the fiscal policy in the literature.

Federal states distribute significantly less public resources at the central level, which results both from the basic features of such a form of the decentralization of public activities and from the specificity of this kind of institutional arrangement which favors limited expenditures (Brennan and Buchanan, 2000; Tiebout, 1956; Weingast, Shepsle and Johnsen, 1981). This notion is confirmed in the results, with the *fed* variable being robust with posterior mean of -5.42. Simply put government expenditures in federal states are on average 5.4 percentage points lower than in unitary states.

As a rule, older democracies are characterized by higher government expenditure. The PIP for the variable *reg_age* equals 1, while posterior mean suggests that one additional year of democracy is connected with 0.07 percentage points increase in expenditures. This is consistent with the path dependence hypotheses posed by e.g. Parkinson (1957), Baumol and Bowen (1965), Wagner (1958), and others which state that the longer period of regime

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[7] In the analyzed group of countries, the average debt of states that introduced the rule is lower by over 25 percentage points. compared to countries that do not use such a rule.
[8] Again in the analyzed group of countries, the average deficits of countries that have introduced the balanced budget rule, we can observe public deficits lower by more than 2.8 percentage points.

stability one faces the more resources are redirected through public sphere. This also suggests that in the absence of forces opposing the expansion of public spending, democratic processes are naturally biased in favor of replacing private sector activities with public action in the long term (Persson and Tabellini, 2003) and corresponds well with the Peacock-Wiseman hypothesis of long-run changes in the intensity of state activity in response to short-run disturbances such as crises, natural disasters and wars (Peacock and Wiseman, 1961).

As a control, dummy variables for German, French, English, and Socialist legal origins were included in the analysis. Interestingly, all of these variables assume PIP of 1 and, consistently, have positive signs with a posterior mean ranging from 11.71 for English legal origin to 14.89 for German legal origins. Conversely, this means that the countries of the Scandinavian legal origins have smaller expenditures than other developed countries. This is a very interesting result that demands deeper explanation. Traditionally, Scandinavian countries (Finland, Denmark, Norway, and Sweden in our database), have been associated with higher levels of public (and government) expenditures due to their emphasis on equality and social spending (Esping-Andersen, 1990). This approach to public intervention has been dubbed the "Nordic model" (Iqbal and Todi, 2015). When we look at the data gathered for discussed research at "face value" we may reach similar conclusions. The average government expenditures in Scandinavian countries in our database are 30.39% (relative to GDP), compared to 25.88% in the rest of the countries. This significant difference, similar to other research to date does not take into account the mediating effect of political institutions on public spending. Based on our results, one can hypothesize that the specificity of Scandinavian countries has more to do with their institutional landscape than with significantly higher nominal spending. Scandinavian countries all use proportional representation systems, have traditionally highest electoral turnout, highest government fractionalization (and the number of parties in the government) and a significantly lower index of institutional constraints (*polcon5*) than other developed countries and are relatively old democracies. This interesting result makes it possible to argue, that the exceptionalism of Scandinavian countries is basically defined by the political institutions that they tend to choose compared to other developed democracies. The negative impact of the "Scandinavian legal origins" seems to be driven by other, possibly cultural factors. This seems to be an interesting avenue of further research.

Similarly, highly developed (*advanced*) countries and Norway as a resource-rich state are characterized by a higher level of government expenditure. PIP and P(+) in case of both dummy variables (*advanced*, *res_rich*) is 1. In the first case, this situation can be again explained by Wagner's law or by the increased capacity to mobilize resources (in the form of taxes and loans) by such countries. The second case is consistent with explanations indicating a stronger position of the public sphere in countries rich in natural resources through their total or partial monopolization (Ossowski and Halland, 2016). In our sample, only Norway is classified as resource rich, which is a special case due to its very prudent management of oil windfalls, which, however, does not preclude some "expenditure bias" among its politicians aware of the fact that a large sovereign fund is waiting to be tapped into. The PM of the variable is 9.93 which means that after controlling for other institutional characteristics Norway government expenditure is 9.93 percentage points higher than in other countries. This goes some way towards explaining the unexpected (implied) negative impact of the Scandinavian legal origins on expenditures.

Countries of the Eurozone, after taking into account all other institutional conditions, are consistently characterized by lower public spending than other countries (EU and outside the EU). Currency union dummy variable (*cur_union*) has PIP of 1 and posterior mean of -8.23, which means that entering the Eurozone is associated with reduction of expenditure by more

than 8 percentage points on average[9]. This lends itself as a justification for the effectiveness of public finance management instruments of the Stability and Growth Pact or the auto-selection of countries entering the Eurozone, which are forced to meet the Maastricht criteria. In the latter case, the influence of the path dependence mechanism can be expected (Pierson, 2000). The difference between expenditures of countries in the Eurozone and outside it are pronounced even after controlling for the effects of the 2008 crisis (see Table 3), after which the former increased spending more visibly than the latter.

Table 3 - Government expenditure relative to GDP of countries in the currency union (CU - i.e. Eurozone) and outside it (NON-CU) before and after the crisis

	NON-CU	CU
2001-2007	30.37%	26.43%
2008-2012	31.57%	29.39%
Change	3.96%	11.18%

Source: own compilation

In accordance with the results of previous research, both ethnic and religious fractionalization negatively affects the amount of expenditures (PIP and P(+) in case of both variables *ethnic_frac* and *religious_frac* equals 1). This can be a result both of the lack of consensus on the direction of expenditure in society (especially limiting expenditure on the needs of minorities - see Alesina and Glaeser, 2004; Stichnoth and Van der Straeten, 2013) and from the interaction between social fragmentation and the probability of adopting the federal regime implying a positive relationship (Anderson, 2013). In our sample, federal states are characterized by higher indexes of fractionalization. in addition, both indicators of social fractionalization are strong compliments to the federal variable (JLS equals 8.7 and 9.2 for ethnic and religious fractionalization respectively).

Countries with higher public debt are characterized by slightly higher government expenditures (PIP of *debt_pub* variable is 0.59 and PM equals 0.02), which can be justified by acknowledging, that higher public debt means higher servicing costs (the PM of 0.02 suggests on average a lowly 2% interest on the public debt). Another explanation can be made by the adoption of a reverse causality, in which states with higher government expenditures accumulate higher public debts. This is consistent with a model developed by Le *et al.* (2016) in which both expenditure level and public debt level are positively linked to the tax rate. However in the context of the growing consensus that high debt reduces social spending (Lora and Olivera, 2007), we may assume that increased spending in the higher-debt countries comes from a change in the structure of expenditures in favor of functions different than social spending or that the interest rate is generally higher than 2%, with a reduction in social spending providing a counteracting force. Overall, this result encourages a more thorough analysis, especially that the relationship proves fragile in the dilut-RIC and dilut-UIP specifications, which means that it is possible that the public debt does not influence central government expenditure, which could mean that the interest rate and social spending channels cancel each other out.

In the case of public fiscal balance (and budget balance, although here the dependence is weaker and fragile), we observe an intuitive relationship – the higher the public deficit (lower the balance), the higher the government expenditure. PIP of *pub_bal* variable is 0.94 and PM

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[9] However, and this comment refers to most of the independent variables, especially dummies, one has to bear in mind that there are probably shared institutional characteristics that distinguish Eurozone members from other countries. In other words there is a potential problem of endogeneity, where other variables may cause e.g. both higher expenditures and higher probability of country being (entering the currency union). This is a risk not controlled for in the modelling strategy chosen here.

equals -0,58. The explanation for this direction of influence is that deficit financing of expenditures may be more desirable for politicians than non-repayable funding; therefore, as a consequence of possibility of deficit financing, expenditures are raised to a more extent than when it is possible to finance them only with tax-related instruments. This lends credibility to the fiscal myopia argument, where politicians, together with citizens, discount future obligations highly enough to increase expenditure in the face of increased deficit (Pasten and Cover, 2010).

Other variables introduced into the model proved to be fragile with PIP for every one of them lower than 0.28. The PIP of language fractionalization (*language_frac*) variable also puts it below the threshold, but the P(+) of 0.014 suggests it as a negative correlate of government expenditure similarly to ethnic and religious fractionalization. It is worth noting that the variable is significantly correlated with ethnic fractionalization (with Pearson r of 0.78) and can be treated as a substitute for it with JLS = -0.95. Budgetary deficit seems to be "insignificant" in the highest weighted models, but the *bud_bal* retains the same sign as *pub_bal. Gdpgr* variable is also not included, which suggests, that the relationship is ambiguous at most, and probably needs a more sophisticated analysis, comparing economic growth to various components of public expenditure (see Brașoveanu, 2012). Unemployment and inflation, as well as revenue rule at the national level, debt rule, balanced budget rule, membership of EU do not seem to affect government expenditures in perceivable way either, once other institutional features are taken into account. Interestingly, dummies for 2009 and 2010 do not seem to be robust determinants of expenditures as well, despite an increase in expenditures in all countries, which may mean that institutional features of particular countries robustly determine their responses to the financial crisis. Detailed analysis of the data suggests that oversized response of public expenditure to the crisis may be part of explanation of positive relationship between *English_LE* and *COFOG_tot* (average expenditure in these countries rose in the period under consideration by 18%, while in the rest it increased by 8%).

4.5. Results in aggregate

The analysis of standardized posterior means for the variables with PIP above the threshold attests to a very strong influence of particular legal origins on government expenditures (PSM between 0.59 to 0.82). Ethnic and linguistic fractionalization also strongly affect expenditures with SPM of -0.46 and -0.32 respectively. Established institutional features such as being a member of currency union, stability of the political regime, electoral systems and being a federation moderately influence expenditures, similarly to government fractionalization and fiscal balance. Some country features which operationalize power relations such as checks and balances and *polcon5* seem to be weaker determinants of expenditures, similarly to fiscal rules. Relatively weak PSM for *advanced* variable suggests that there is a visible variability among the developed countries in terms of their public expenditure bias. Voter turnout does not seem to be influencing expenditure significantly, which, in connection with traditional political economy arguments, may suggest that the position of the median voter does change, but not significantly, when preferences of a bigger number of voters are taken into account (Downs, 1957). This may also be considered in light of the argument put by Wagner (2007) that political actors are only loosely and conditionally constrained by the will of their constituencies. A very low PSM by the *debt_pub* variable seems to be connected with the complex nature of the influence of public debt on expenditures which operates on at least two levels: as the matter of pure accounting debt levels increase expenditure, while they may compel politicians to somewhat reduce current spending (especially on social programmes) in order to minimize the risk of default.

Qualitatively and quantitatively, similar results were obtained under a different prior structure i.e. a combination of unit information g prior and uniform model prior. With the combination of risk inflation criterion g prior and binomial-beta model prior, the same variables were classified as robust, and posterior means were of basically the same values as in the main results. Slightly different results were obtained with the dilution prior, which accounts for the presence of multicollinearity in the conditioning set of information. Under the combination with unit information prior, results were also similar with the exception of public debt which turned out fragile. Finally, the combination with risk inflation criterion g prior, two variables turned out fragile in comparison with the main results. Those variables are public debt and voter turnout. Consequently, all changes in prior structure show that the main results are very robust. Moreover, 0.5 critical point for dilution prior is a very strong criterion of robustness, as previously mentioned in methodological part.

5. Summary/discussion

The paper, based on a mix of confirmatory and exploratory analysis allowed to test the hypotheses put forth in the subsection 3.1 and make an attempt to discriminate among the theories presented in the introduction. Table 4 summarizes the results in terms of the posed hypotheses.

Table 4. The results of hypotheses testing

Hypothesis	Verdict
H1. States with a proportional electoral system are characterized by an average higher level of public spending (institutions of power legitimacy).	Not rejected
H2. States with a large size of winning coalition in relation to the size of the selectorate, are characterized by a higher level of public spending (institutions of power legitimacy).	Not rejected, but based on the value of PSM the link is very weak
H3. There is no visible connection between the time left to the nearest elections and the volume of budget expenditures (institutions of power legitimacy).	Not rejected
H4. Governments with a large number of veto players are characterized by higher expenditures (institutions of internal power relations).	Not rejected
H5. Institutional checks and balances introducing independent counteracting forces to the institutions limiting government freedom of spending are generally effective (institutions of internal power relations).	Not rejected, but based on the value of PSM the link is not very strong
H6. Fiscal rules, designed to stiffen the budget formation process, in practice have low effectiveness (rules of the budgetary process).	Analysis points towards rejection of H6. expenditure rule and debt rule at the national level seem to suppress budget expenditures, but their influence, based on the value of PSM remains limited.

Source: own compilation

Overall, the presented results unambiguously confirm the well-established strain of research on the tragedy of fiscal commons, both in its first approximation (the number of actors with the power to influence expenditures positively affects them) and its institutional correlates (institutions which are designed to limit political power of the elected politicians work as intended by reducing the expenditure bias of democratic systems). At a more detailed level, it seems that political systems, together with some very fundamental institutional/cultural features (such as legal origins), are the most robust and strong determinants of central government expenditures, followed by institutions structuring power relations and fiscal rules, which, again, work as intended. Several other interesting issues are worth pointing out. The old path dependence arguments suggesting that democracies incrementally increase their expenditures on the development path are also positively verified, with older democracies and

richer countries characterized with increased government expenditure. Despite some worries concerning the ability of the EU to discipline public finance in the Euro area countries (Fatas *et al.*, 2004; Baskaran and Hessami, 2016) it seems that the Stability and Growth Pact as well as other solutions aimed at fiscal consolidation (promoting more austere policies) are relatively highly effective.

Moreover from the perspective of veto player theories, the analysis suggests that in terms of public expenditure, explanations based on this tradition should not avoid nuance as to the type of veto player being analyzed. Based on the results, one can argue that institutional veto points which are weakly bound by the will of the voters decrease (and probably stabilize) public expenditures, while adding veto players of partisan nature increases expenditures.

This is yet another analysis which suggests weak explanatory power of the political business/budget cycle theories, at least among developed countries.

A very interesting (and worthy of pursuing) result is connected to the lower expenditures of countries of Scandinavian legal origins. This is a very unusual and unintuitive result, but authors offer an explanation taking into account the problem of institutional endogeneity together with acknowledging that one of the countries in the database (Norway) is rich in oil.

Overall, the analysis suggests that in terms of factors influencing government expenditures institutions matter, and they matter a lot. Many of the standard control variables (unemployment, inflation, dummies for post-crisis years, GDP growth) have proven to be unsatisfactory in explaining the levels of expenditure when institutional features of OECD countries are accounted for. Table 5 synthesizes the main conclusions of the paper with respect to four frameworks (or theoretical families).

Table 5 - Synthesis of the main conclusions of the paper

Framework	Fundamental claim	Evaluation
Tragedy of the fiscal commons	The more actors with differing political bases are engaged in the budgetary process, the higher the public expenditures (and deficit) are	This claim is positively verified
Path dependence	Public expenditures rise incrementally in the long run	This claim is positively verified
Veto Players	The more veto players with different ideologies are engaged in the budgetary process, the more difficult it is to change expenditures	Institutional veto players which are weakly bound by the will of the voters decrease (and probably stabilize) public expenditures, while adding veto players of partisan nature increases expenditures.
Political Budget Cycle	Expenditures (and deficits) rise before important political elections	This claim is verified negatively

Source: own compilation

In conclusion, the authors would like to discuss two potential doubts as to the particular methodological choices made in the article. Firstly, it may be argued that general government expenditure constitutes a better dependent variable in this kind of analysis compared to central government expenditure because it is a better proxy for the activities within the whole public sector. The authors acknowledge the fact that a large part of activities in the public sector is happening below the central government level. However in decentralized countries, the relationship between political institutions designed as constraints on the central government and overall expenditure is much more complex, and needs to take into account a lot more variables and interdependencies between them. We plan to undertake this problem in future investigations. Secondly, country heterogeneity in the data is traditionally dealt with using random or fixed effects models, unlike in this paper, where the problem was resolved with the

usage of BMA. However, as already argued in the methodological section, traditional models are well fit when one given theory is tested at a time, and random and fixed effects serve as a way of covering up the ignorance about the sources of heterogeneity (Wooldridge, 2010). From this point of view the study aims at overcoming the problem of the lack of prior knowledge with the help of methodology dealing with heterogeneity on empirical grounds.

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Appendix 1 - list of variables with explanation

Short name	Explanation	Source
er_nat	Explained in table 1 in the main text	Fiscal Rules Dataset (IMF, 2017)
rr_nat	Explained in table 1 in the main text	
bbr_nat	Explained in table 1 in the main text	
dr_nat	Explained in table 1 in the main text	
dr	Explained in table 1 in the main text	
bbr	Explained in table 1 in the main text	
cur_union	Dummy answering the question: Is country a member of currency union? 1 - yes, 0 - no	
advanced	Dummy answering the question: Country is on IMF the list of Advanced Economies - 1, no - 0	
resour_rich	Dummy answering the question: Is the economy rich in natural resources? 1 - yes, 0 - no	
fed	Dummy answering the question: Is country a federation - 1, otherwise - 0	
e_union	Dummy for EU members Yes - 1, No - 0	
English_LE	According to „*legal origins*" concept one of possible legal systems: English Common Law,	La Porta, Lopez-de-Silanes and Shleifer, 1999
French_LE	According to „*legal origins*" concept: French Commercial Code,	
Socialist_LE	According to „*legal origins*" concept: Socialist/Communist Laws,	
German_LE	According to „*legal origins*" concept: German Commercial Code,	
elec_sys	Explained in table 1 in the main text	Bormann and Golder, 2013
reg_age	Current political regime durability in years (averages)	Polity IV
checks_bal	Explained in table 1 in the main text	Beck *et al.,* 2001
closed_list	Explained in table 1 in the main text	
gov_frac	Explained in table 1 in the main text	
no_part	Explained in table 1 in the main text	
yrs_elec	Explained in table 1 in the main text	
dist_house	Explained in table 1 in the main text	
elec_year	Dummy for parliamentary election year. Yes - 1, No - 0	
ethnic_frac	Ethnic fractionalization. The variable reflect the probability that two randomly selected people from a given country will not share ethnicity, the higher the number the less probability of the two sharing that characteristic.	Alesina *et al.,* 2003
language_frac	Linguistic fractionalization. The variable reflect the probability that two randomly selected people from a given country will not share language, the higher the number the less probability of the two sharing that characteristic.	
religion_frac	Religious fractionalization. The variable reflect the probability that two randomly selected people from a given country will not share religion, the higher the number the less probability of the two sharing that characteristic.	
polcon3	Explained in table 1 in the main text	Henisz, 2002
polcon5	Explained in table 1 in the main text	
vot_turn	Explained in table 1 in the main text	Reynolds *et al.,* 2005
pub_bal	Public fiscal net balance. Surplus (+)/Deficit (-)	IMF
bud_bal	Budgetary balance. Surplus (+)/Deficit (-)	
debt_pub	Gross General Government Debt % GDP	
gdpgr	GDP growth (%)	
unemployment	Official unemployment rate (%)	
inflation	Control for the inflation rate (%)	
COFOG_tot	Total central government expenditures (%GDP) - dependent variable	
x2009	Control for first year after the financial crisis	Own
x2010	Control for second year after the financial crisis	

Appendix 2: Bayesian Model Averaging

For the space of all models that can be estimated with the 38 regressors at hand, unconditional posterior distribution of coefficient β is given by:

$$P(\beta|y) = \sum_{j=1}^{2^K} P(\beta|M_j, y) * P(M_j|y) \tag{A1}$$

where: y denotes data, j ($j=1, 2,...,m$) signify the number of the model, K being the total number of potential regressors, $P(\beta|M_j, y)$ is the conditional distribution of coefficient β for a given model M_j, and $P(M_j|y)$ is the posterior probability of the model. Using the Bayes' theorem, the posterior probability of the model (PMP – Posterior Model Probability) $P(M_j|y)$ can be rendered as:

$$PMP = P(M_j|y) = \frac{L(y|M_j) * P(M_j)}{P(y)}, \tag{A2}$$

where PMP is proportional to the product of $L(y|M_j)$ – model specific marginal likelihood – and $P(M_j)$ – model specific prior probability – which can be written down as $P(M_j|y) \propto L(y|M_j) * P(M_j)$. Moreover, because: $P(y) = \sum_{j=1}^{2^K} L(y|M_j) * P(M_j)$, weights of individual models can be transformed into probabilities through the normalization in relation to the space of all 2^K models:

$$P(M_j|y) = \frac{L(y|M_j) * P(M_j)}{\sum_{j=1}^{2^K} L(y|M_j) * P(M_j)}. \tag{A3}$$

The likelihood function is given by:

$$L(y|M_j) = (n * t)^{-\frac{k_j}{2}} * \left[(y - X_j\beta)'(y - X_j\beta)\right]^{-\frac{(n*t)}{2}}. \tag{A4}$$

Applying BMA requires specifying the prior structure of the model. The value of the coefficients β is characterized by normal distribution with zero mean and variance $\sigma^2 V_{oj}$, hence:

$$P(\beta|\sigma^2, M_j) \sim N(0, \sigma^2 V_{oj}). \tag{A5}$$

It is assumed that the prior variance matrix V_{oj} is proportional to the covariance in the sample: $(gX'_j X_j)^{-1}$, where g is the proportionality coefficient. The g prior parameter was put forward by Zellner (1986) and is widely used in BMA applications. In their seminal work on the subject of choosing the g prior Fernández, *et al.* (2001) put forward the following rule, to choose the best g prior:

$$g = \frac{1}{\max(n*t, K^2)},$$
(A6)

where n denotes the number of observations. $\frac{1}{n}$ is known as UIP – unit information prior (Kass and Wasserman, 1995), whereas $\frac{1}{k^2}$ is convergent to RIC – risk inflation criterion (Foster and George, 1994). For further discussion on the subject of g priors see: Ley and Steel (2009, 2012), Feldkircher and Zeugner (2009), and Eicher, *et al.* (2011).

While applying BMA, besides the specification of g prior, it is necessary to determine the prior model distribution. For binomial model prior (Sala-I-Martin *et al.*, 2004):

$$P(M_j) \propto \left(\frac{Em}{K}\right)^{k_j} * \left(1 - \frac{Em}{K}\right)^{K-k_j},$$
(A7)

where Em denotes expected model size, while k_j the number of covariates in a given model. When $Em = \frac{K}{2}$, it turns into a uniform model prior – priors on all the models are all equal $(P(M_j) \propto 1)$. Under uniform model prior, the prior probability of including a variable in a model amounts to 0.5.

The main estimation results presented in this paper are based on a combination of uniform model prior and unit information g prior. This combination of priors is recommended by Eicher *et al.* (2011). To assure robustness of the results, other prior structures have been utilized as well. First of all risk inflation prior dictated by the rule given in equation (A6) for the data set under consideration[10] was combined with binomial-beta model prior given by the following formula (Ley and Steel, 2009):

$$P(M_j) \propto \Gamma(1 + k_j) * \Gamma\left(\frac{K - Em}{Em} + K - k_j\right).$$
(A8)

In the case of binomial-beta distribution with expected model size *K/2*, the probability of a model of each size is the same $\left(\frac{1}{K+1}\right)$. Thus, the prior probability of including the variable in the model amounts to 0.5, for both binomial and binomial-beta prior with $Em = K/2$. In order to account for potential multicollinearity between regressors, dilution prior was utilized. Accordingly, a uniform model prior is supplemented with a function accounting for multicollinearity (George, 2010) to obtain prior model probabilities:

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[10] *n*t=300* and *k²=1444*.

$$P(M_j) \propto |R_j|^{0.5} \left(\frac{1}{2}\right)^K, \tag{A9}$$

where $K = (38)$ is the number of covariates, while $|R_j|$ is the determinant of the correlation matrix for all the regressors in the model j. The uniform model prior implies equal probabilities assigned to all the models, so the $|R_j|$ component of (A9) decides about the distribution of the prior probability mass. The higher the multicollinearity between the variables, the closer the value of $|R_j|$ to 0 and the lower the prior ascribed to a given model.

In case of 38 covariates the entire model space consists of around 275 billion possible models, which is a number infeasible to assess analytically. Accordingly, the model space is reduced with MC[3] (Markov Chain Monte Carlo model Composition) sampler (Madigan *et al.*, 1995). The convergence of the chain is assessed by the correlation coefficient between the analytical and MC[3] posterior model probabilities for the best 10000 models.

Using the posterior probabilities of the models in the role of weights allows to calculate the unconditional posterior mean and standard deviation of the coefficient β_i. Posterior mean (PM) of the coefficient β_i, independent of the space of the models, is then given with the following formula:

$$PM = E(\beta_i|y) = \sum_{j=1}^{2^K} P(M_j|y) * \hat{\beta}_{ij}, \tag{A10}$$

where $\hat{\beta}_{ij} = E(\beta_i|y, M_j)$ is the value of the coefficient β_i estimated for the model M_j. The posterior standard deviation (PSD) is equal to:

$$PSD = \sqrt{\sum_{j=1}^{2^K} P(M_j|y) * V(\beta_j|y, M_j) + \sum_{j=1}^{2^K} P(M_j|y) * [\hat{\beta}_{ij} - E(\beta_i|y, M_j)]^2}, \tag{A11}$$

where $V(\beta_j|y, M_j)$ signifies the conditional variance of the parameter for the model M_j. To better capture the relative impact of the determinants on the government expenditure, standardized coefficients were calculated and BMA statistics based on their values. SPM denotes the standardized posterior mean, while SPSD denotes a standardized posterior standard deviation[11].

The most important statistic for BMA is posterior inclusion probability (PIP). PIP for the regressor x_i equals:

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[11] See Doppelhofer and Weeks (2009) for elaboration.

$$PIP = P(x_i|y) = \sum_{j=1}^{2^K} 1(\varphi_i = 1|y, M_j) * P(M_j|y) \tag{A12}$$

where $\varphi_i = 1$ signifies including the variable x_i in the model. As for uniform and beta-binomial prior model distributions prior inclusion probability equal to 0.5 is implied, the variable characterized by PIP higher than 0.5 is classified as robust and accordingly should be included in the model explaining the size of central government expenditures. In the case of dilution prior, there is a problem with setting the exact value of prior inclusion probability. As the method combines a uniform model prior with a function penalizing for multicollinearity, the exact prior distribution is not known before calculations. As explained above, the entire model space as well as all the values of $|R_j|$ are infeasible to calculate with a large number of regressors and, consequently, the same is true for prior inclusion probability. On the other hand, $|R_j|$ takes lower values for bigger models by virtue of its construction and, consequently, the expected model size is lower than for uniform distribution, and prior inclusion probability is lower than 0.5^{12}. In this setting, the critical value of PIP of 0.5 can serve as a very strict criterion of asserting robustness of the variables under consideration.

Additionally, the researcher can be interested in the sign of the estimated parameter, if it is included in the model. The posterior probability of positive sign of the coefficient in the model [P(+)] is calculated in the following way:

$$P(+) = P[sign(x_i)|y] = \begin{cases} \sum_{j=1}^{2^K} P(M_j|y) * CDF(t_{ij}|M_j), & if\ sign[E(\beta_i|y)] = 1 \\ 1 - \sum_{j=1}^{2^K} P(M_j|y) * CDF(t_{ij}|M_j), & if\ sign[E(\beta_i|y)] = -1 \end{cases} \tag{A13}$$

where CDF signifies a cumulative distribution function, while $t_{ij} \equiv (\hat{\beta}_i/\widehat{SD}_i|M_j)$.

Within BMA, it is possible to assess the nature of the relationships between regressors using jointness measures. Doppelhofer and Week (2009) define their jointness measure as:

$$JDW_{(ih)} = ln\left[\frac{P(i \cap h|y)}{P(i \cap \bar{h}|y)} * \frac{P(\bar{i} \cap \bar{h}|y)}{P(\bar{i} \cap h|y)}\right] = ln\left[\frac{P(i|h,y)}{P(\bar{i}|h,y)} * \frac{P(\bar{i}|\bar{h},y)}{P(i|\bar{h},y)}\right], \tag{A14}$$

where i and h represent two regressors in the model. One of the biggest drawbacks of *JDW* is that, by construction, there are circumstances in which it cannot be calculated[13]. Accordingly, in order to obtain more reliable information about jointness, Ley and Steel (2007) measure is calculated as:

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[12] Moreover, prior inclusion probabilities are lower for the variables characterized by a higher degree of multicollinearity.

[13] For example, when a given variable is characterized by PIP very close to 0 computation of JDW will require division of 0/0, which gives undefined symbol, or nan – not a number.

$$JLS_{(ih)} = ln\left[\frac{P(i \cap h|y)}{P(i \cap \bar{h}|y) + P(\bar{i} \cap h|y)}\right] = ln\left[\frac{P(i \cap h|y)}{P(i|y) + P(h|y) - 2P(i \cap h|y)}\right]. \qquad (A15)$$

For both jointness measures (J) the same critical values can be applied. When $J > 2$, two variables are referred to as strong complements, $2 > J > 1$ as significant complements, $1 > J > -1$ as unrelated, $-1 > J > -2$ as significant substitutes, while $-2 > J$ signifies strong substitutes (Błażejowski and Kwiatkowski, 2015). As demonstrated in Beck (2017), JLS generally outperforms JDW. Accordingly, interpretations of jointness measures in the results are mainly based on JLS[14].

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[14] More on jointness measures can be found in Hofmarcher *et al.* (2018).

Appendix 3 – result for the RIC and binomial-beta, as well as UIP and dilution prior

model prior	Beta-binomial						Dillution					
g prior	Risk Inflation Criterion						Unit Information Prior					
VARIABLE	PIP	PM	PSD	SPM	SPSD	P(+)	PIP	PM	PSD	SPM	SPSD	P(+)
er_nat	1,000	-2,519	0,493	-0,176	0,034	0,000	1,000	-2,620	0,477	-0,183	0,033	0,000
bbr_nat	1,000	4,054	0,593	0,294	0,043	1,000	1,000	4,052	0,604	0,293	0,044	1,000
English_LE	1,000	11,639	1,187	0,675	0,069	1,000	1,000	11,372	1,044	0,659	0,061	1,000
French_LE	1,000	12,685	1,534	0,825	0,100	1,000	1,000	12,623	1,456	0,821	0,095	1,000
Socialist_LE	1,000	11,695	1,544	0,761	0,100	1,000	1,000	11,373	1,520	0,740	0,099	1,000
elec_sys	1,000	4,125	0,607	0,449	0,066	1,000	1,000	4,065	0,629	0,443	0,069	1,000
cur_union	1,000	-8,260	0,766	-0,598	0,055	0,000	1,000	-8,264	0,772	-0,598	0,056	0,000
reg_age	1,000	0,073	0,009	0,515	0,065	1,000	1,000	0,073	0,009	0,515	0,065	1,000
checks_bal	1,000	-1,793	0,219	-0,286	0,035	0,000	1,000	-1,807	0,221	-0,288	0,035	0,000
closed_list	1,000	-6,046	0,814	-0,438	0,059	0,000	1,000	-6,092	0,827	-0,441	0,060	0,000
advanced	1,000	5,356	0,828	0,285	0,044	1,000	1,000	5,219	0,828	0,277	0,044	1,000
resour_rich	1,000	9,990	1,401	0,284	0,040	1,000	1,000	10,002	1,403	0,284	0,040	1,000
religion_frac	1,000	-10,079	1,533	-0,322	0,049	0,000	1,000	-10,405	1,448	-0,332	0,046	0,000
German_LE	1,000	14,844	1,634	0,584	0,064	1,000	1,000	14,599	1,569	0,574	0,062	1,000
ethnic_frac	1,000	-18,058	2,573	-0,468	0,067	0,000	1,000	-19,108	1,915	-0,495	0,050	0,000
polcon5	1,000	-15,752	3,224	-0,169	0,035	0,000	1,000	-16,092	3,181	-0,173	0,034	0,000
fed	1,000	-5,309	1,187	-0,308	0,069	0,000	0,997	-4,919	1,250	-0,285	0,072	0,000
gov_frac	0,995	9,971	1,914	0,368	0,071	1,000	0,991	10,114	1,668	0,374	0,062	1,000
pub_bal	0,933	-0,582	0,176	-0,417	0,126	0,000	0,907	-0,579	0,195	-0,415	0,140	0,000
vot_turn	0,823	0,058	0,035	0,103	0,062	1,000	0,672	0,044	0,036	0,078	0,063	1,000
dr_nat	0,779	-1,330	0,863	-0,081	0,053	0,000	0,791	-1,439	0,889	-0,088	0,054	0,000
debt_pub	0,555	0,017	0,017	0,068	0,071	1,000	0,427	0,013	0,017	0,054	0,070	1,000
language_frac	0,220	-1,379	3,047	-0,039	0,087	0,014	0,032	-0,207	1,289	-0,006	0,037	0,010
polcon3	0,204	0,774	1,769	0,013	0,031	1,000	0,126	0,473	1,431	0,008	0,025	1,000
no_part	0,129	0,082	0,262	0,015	0,047	1,000	0,038	0,035	0,208	0,006	0,037	1,000
bud_bal	0,125	-0,056	0,178	-0,038	0,122	0,000	0,096	-0,064	0,198	-0,044	0,135	0,000
gdpgr	0,087	-0,006	0,028	-0,003	0,014	0,000	0,085	-0,007	0,028	-0,003	0,014	0,000
yrs_elec	0,082	-0,014	0,059	-0,002	0,010	0,000	0,096	-0,015	0,062	-0,003	0,011	0,000
unemployment	0,082	-0,007	0,034	-0,004	0,018	0,010	0,042	-0,004	0,025	-0,002	0,013	0,007
dist_house	0,077	-0,001	0,007	-0,004	0,022	0,121	0,023	0,000	0,003	-0,001	0,011	0,029
rr_nat	0,062	0,050	0,284	0,003	0,014	1,000	0,026	0,016	0,167	0,001	0,008	0,995
dr	0,060	0,040	0,244	0,002	0,013	0,984	0,035	0,026	0,191	0,001	0,010	0,993
x2009	0,050	-0,025	0,200	-0,001	0,008	0,019	0,061	-0,027	0,209	-0,001	0,008	0,023
e_union	0,045	-0,015	0,224	-0,001	0,012	0,292	0,013	0,000	0,104	0,000	0,006	0,430
elec_year	0,043	0,006	0,080	0,000	0,005	0,913	0,056	0,008	0,091	0,000	0,006	0,934
x2010	0,042	-0,007	0,125	0,000	0,005	0,010	0,051	-0,009	0,140	0,000	0,006	0,017
inflation	0,040	0,001	0,022	0,000	0,006	0,807	0,040	0,001	0,022	0,000	0,006	0,936
bbr	0,039	0,010	0,167	0,000	0,007	0,914	0,028	0,008	0,139	0,000	0,006	0,968
Burn-ins	100000											
Itertions	1m											
Cor PMP	0.9995						0.9996					

Appendix 4 – Jointness measures under UIP and uniform priors

JDW \ JLS	dr_nat	er_nat	rr_nat	bbr_nat	English_LE	French_LE	Socialist_LE	no_part	polcon3	polcon5	gdpgr	unemployment	dist_house	elec_sys	e_union	fed	cur_union	bud_bal	pub_bal	debt_pub	reg_age	checks_bal	inflation	yrs_elec	closed_list	advanced	resour_rich	vot_turn	gov_frac	religion_frac	ethnic_frac	language_frac	Germana_LE	elec_year	bbr	DR	x2009	x2010
dr_nat	x	1,1	-3,3	1,1	1,1	1,1	1,1	-2,2	-1,9	1,1	-2,9	-3,4	-3,1	1,1	-3,4	1,1	1,1	-2,2	1,0	-1,0	1,1	1,1	-3,6	-2,9	1,1	1,1	1,1	0,6	1,1	1,1	1,1	-1,5	1,1	-3,6	-3,6	-3,0	-3,3	-3,6
er_nat	-0,8	x	-3,1	8,3	8,3	8,3	8,3	-2,2	-1,8	7,7	-2,9	-2,8	-3,0	8,3	-3,4	7,2	8,3	-2,0	2,5	0,0	8,3	8,3	-3,5	-2,8	8,3	8,3	8,3	1,2	5,6	8,2	7,3	-1,6	8,3	-3,6	-3,5	-3,1	-3,4	-3,6
rr_nat	-0,6	+inf	x	-3,1	-3,1	-3,1	-3,1	-3,3	-3,3	-3,1	-3,6	-3,1	-3,6	-3,1	-4,0	-3,1	-3,1	-3,4	-3,1	-3,0	-3,1	-3,1	-4,3	-3,6	-3,1	-3,1	-3,1	-3,2	-3,1	-3,1	-3,1	-3,0	-3,1	-4,2	-3,8	-3,8	-3,6	-4,0
bbr_nat	nan	nan	nan	x	0,0	0,0	0,0	-2,2	-1,8	8,5	-2,9	-2,8	-3,0	0,0	-3,4	7,6	0,0	-2,0	2,5	0,0	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
English_LE	nan	nan	nan	nan	x	0,0	0,0	-2,2	-1,8	8,5	-2,9	-2,8	-3,0	0,0	-3,4	7,6	0,0	-2,0	2,5	0,0	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
French_LE	nan	nan	nan	nan	nan	x	0,0	-2,2	-1,8	8,5	-2,9	-2,8	-3,0	0,0	-3,4	7,6	0,0	-2,0	2,5	0,0	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
Socialist_LE	nan	nan	nan	nan	nan	nan	x	-2,2	-1,8	8,5	-2,9	-2,8	-3,0	0,0	-3,4	7,6	0,0	-2,0	2,5	0,0	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
no_part	0,1	2,1	0,0	nan	nan	nan	nan	x	-3,0	-2,2	-3,4	-3,5	-3,2	-2,2	-3,6	-2,2	-2,2	-2,9	-2,2	-2,6	-2,2	-2,2	-3,7	-3,3	-2,2	-2,2	-2,2	-2,4	-2,2	-2,2	-2,2	-2,9	-2,2	-3,6	-4,2	-3,6	-3,9	-3,8
polcon3	0,0	-1,3	0,2	nan	nan	nan	nan	-0,3	x	-1,8	-3,0	-3,4	-3,4	-1,8	-3,5	-1,8	-1,8	-2,9	-1,8	-1,8	-1,8	-1,8	-3,6	-3,3	-1,8	-1,8	-1,8	-1,8	-1,8	-1,8	-1,8	-2,5	-1,8	-4,0	-3,7	-3,3	-3,6	-3,7
polcon5	-0,3	nan	+inf	nan	nan	nan	nan	0,0	+inf	x	-2,9	-2,8	-3,0	8,5	-3,4	7,2	8,5	-2,0	2,5	0,0	8,5	8,5	-3,5	-2,8	8,5	8,5	8,5	1,2	5,6	8,3	7,4	-1,6	8,5	-3,6	-3,5	-3,1	-3,4	-3,6
gdpgr	0,0	-1,7	0,1	nan	nan	nan	nan	0,0	0,3	+inf	x	-3,5	-3,7	-2,9	-4,1	-2,9	-2,9	-2,7	-3,0	-2,9	-2,9	-2,9	-3,9	-3,3	-2,9	-2,9	-2,9	-3,0	-2,9	-2,9	-3,2	-2,9	-3,8	-4,0	-3,6	-2,7	-4,1
unemployment	-1,2	-0,6	0,5	nan	nan	nan	nan	-0,3	-0,3	-0,8	0,1	x	-3,0	-2,8	-3,8	-2,8	-2,8	-3,4	-2,8	-2,4	-2,8	-2,8	-4,1	-3,6	-2,8	-2,8	-2,8	-3,0	-2,8	-2,8	-2,8	-3,7	-2,8	-4,1	-3,8	-3,7	-3,9	-3,9
dist_house	-0,3	-0,9	0,3	nan	nan	nan	nan	0,4	0,1	+inf	0,0	0,5	x	-3,0	-3,6	-3,0	-3,0	-3,2	-3,0	-2,7	-3,0	-3,0	-4,1	-3,5	-3,0	-3,0	-3,0	-3,1	-3,0	-3,0	-3,0	-3,5	-3,0	-4,1	-3,8	-4,2	-4,2	-4,0
elec_sys	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	-3,4	7,6	0,0	-2,0	2,5	0,0	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
e_union	0,1	0,1	0,0	nan	nan	nan	nan	0,0	0,0	+inf	-0,3	-0,1	0,3	nan	x	-3,4	-3,4	-3,6	-3,4	-3,6	-3,4	-3,4	-4,2	-4,0	-3,4	-3,4	-3,4	-3,4	-3,4	-3,4	-3,4	-3,3	-3,4	-4,1	-4,1	-3,8	-4,6	-3,9
fed	0,6	-inf	-0,3	nan	nan	nan	nan	+inf	-0,2	-inf	0,1	+inf	-0,4	nan	-1,2	x	7,6	-2,0	2,5	0,0	7,6	7,6	-3,5	-2,8	7,6	7,6	7,6	1,2	5,5	7,5	7,0	-1,6	7,6	-3,6	-3,5	-3,1	-3,4	-3,6
cur_union	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	-2,0	2,5	0,0	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
bud_bal	-0,4	1,3	-0,2	nan	nan	nan	nan	0,1	-0,3	+inf	0,4	-0,3	0,1	nan	0,3	-2,8	nan	x	-3,1	-1,9	-2,0	-2,0	-3,8	-3,2	-2,0	-2,0	-2,0	-2,3	-2,0	-2,0	-2,0	-2,8	-2,0	-3,9	-3,9	-3,6	-3,5	-3,8
pub_bal	0,6	-0,8	0,3	nan	nan	nan	nan	-0,2	0,3	nan	-0,5	0,5	-0,3	nan	-0,3	3,2	nan	nan	x	-0,1	2,5	2,5	-3,5	-2,8	2,5	2,5	2,5	1,1	2,5	2,5	2,5	-1,6	2,5	-3,6	-3,5	-3,1	-3,4	-3,6
debt_pub	-3,9	0,9	0,5	nan	nan	nan	nan	-0,6	0,3	1,5	-0,1	1,0	0,8	nan	-0,1	0,2	nan	0,4	-0,7	x	0,0	0,0	-3,5	-2,8	0,0	0,0	0,0	-0,2	0,0	0,0	0,0	-2,7	0,0	-3,7	-3,4	-3,2	-3,5	-3,6
reg_age	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	0,0	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
checks_bal	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	-3,5	-2,8	0,0	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
inflation	-0,1	+inf	0,3	nan	nan	nan	nan	0,0	0,0	+inf	0,5	0,0	0,1	nan	0,1	+inf	nan	0,2	-0,2	0,1	nan	nan	x	-3,6	-3,5	-3,5	-3,5	-3,5	-3,5	-3,5	-3,5	-3,7	-3,5	-4,1	-4,4	-4,1	-4,0	-4,1
yrs_elec	-0,3	+inf	0,2	nan	nan	nan	nan	-0,1	-0,4	+inf	0,2	0,5	0,2	nan	0,2	+inf	nan	-0,1	0,0	0,3	nan	nan	-0,1	x	-2,8	-2,8	-2,8	-2,9	-2,8	-2,8	-2,8	-3,1	-2,8	-4,2	-4,1	-3,8	-3,5	-3,9
closed_list	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	0,0	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
advanced	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	0,0	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
resour_rich	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	1,2	5,7	10,2	7,8	-1,6	0,0	-3,6	-3,5	-3,1	-3,4	-3,6
vot_turn	0,5	-0,7	-0,2	nan	nan	nan	nan	-0,5	0,2	-inf	-0,2	-0,6	-0,3	nan	0,1	+inf	nan	-0,6	0,8	0,0	nan	nan	0,0	0,0	nan	nan	nan	x	1,2	1,2	1,2	-1,3	1,2	-3,6	-3,5	-3,3	-3,4	-3,6
gov_frac	1,3	-inf	-0,7	nan	nan	nan	nan	-33,3	-1,3	-inf	-0,3	0,2	0,0	nan	-0,5	-inf	nan	-1,4	1,8	0,2	nan	nan	-0,2	0,7	nan	nan	nan	1,1	x	5,7	5,6	-1,6	5,7	-3,6	-3,5	-3,1	-3,4	-3,6
religion_frac	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	7,7	-1,6	10,2	-3,6	-3,5	-3,1	-3,4	-3,6
ethnic_frac	2,1	-inf	-30,3	nan	nan	nan	nan	+inf	0,7	-inf	+inf	-7,0	-3,4	nan	+inf	-inf	nan	+inf	-inf	+inf	nan	nan	+inf	+inf	nan	nan	nan	-26,0	-21,6	nan	x	-1,6	7,8	-3,6	-3,5	-3,1	-3,4	-3,6
language_frac	0,8	-3,5	0,3	nan	nan	nan	nan	-0,4	-0,1	-2,1	-0,1	-0,6	-0,4	nan	0,4	1,6	nan	-0,5	0,8	-1,5	nan	nan	0,0	0,0	nan	nan	nan	2,2	1,7	nan	-inf	x	-1,6	-3,6	-3,6	-3,6	-3,5	-3,6
Germana_LE	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	nan	x	-3,6	-3,5	-3,1	-3,4	-3,6
elec_year	0,0	+inf	0,1	nan	nan	nan	nan	0,3	-0,1	+inf	-0,1	-0,1	-0,1	nan	-0,1	1,9	nan	0,1	-0,2	-0,1	nan	nan	0,3	-0,1	nan	nan	nan	0,0	-0,3	nan	+inf	0,1	nan	x	-4,7	-3,9	-4,5	-4,2
bbr	-0,1	+inf	0,2	nan	nan	nan	nan	-0,2	0,1	-2,7	-0,2	-0,1	-0,3	nan	0,2	+inf	nan	-0,2	0,3	0,0	nan	nan	-0,3	-0,2	nan	nan	nan	0,1	-0,3	nan	+inf	0,1	nan	0,1	x	-4,0	-4,3	-4,1
DR	0,4	+inf	-0,1	nan	nan	nan	nan	-0,1	0,2	+inf	0,0	0,1	0,0	nan	0,2	1,9	nan	-0,2	0,1	0,1	nan	nan	-0,2	0,0	nan	nan	nan	-0,4	0,4	nan	+inf	-0,3	nan	0,1	0,1	x	-4,0	-4,1
x2009	0,2	+inf	0,0	nan	nan	nan	nan	0,0	0,2	+inf	1,2	-0,2	-0,3	nan	0,1	-1,0	nan	0,2	-0,3	-0,2	nan	nan	-0,1	0,0	nan	nan	nan	0,0	0,0	nan	+inf	0,1	nan	0,0	-0,2	0,3	x	-4,0
x2010	0,2	0,0	-0,1	nan	nan	nan	nan	0,1	-0,1	+inf	-0,3	-0,1	0,0	nan	-0,2	+inf	nan	-0,2	0,3	-0,1	nan	nan	-0,3	0,2	nan	nan	nan	0,1	1,8	nan	+inf	0,0	nan	0,5	-0,5	-0,1	0,0	x

LS (above diagonal) and DW (below diagonal) measures