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# *Measuring the Strength of the Theories of Government Size*

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# Measuring the Strength of the Theories of Government Size

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**Abstract**

Existing theoretical and empirical evidence on the determinants of government expenditure is inconclusive. We posit that the main cause of this problem is theory uncertainty, which arises due to the fact that the different theories imply different mutually compatible and interrelated mechanisms. This paper proposes a novel model averaging method to perform model averaging in linear regression systems that allows for endogeneity. Using data for more than 90 countries we assess the evidentiary support for nine different theories. Our results suggest that the government size and its components are explained by multiple mechanisms that work simultaneously but differ in their impact and importance. In particular, for general government total expenditure we find decisive evidence for the demography theory and a strong evidence for the globalization and political institution theory. In the case of central government total expenditure, we find that income inequality and macroeconomic policy play a decisive role in addition to demography.

**Keywords:** Bayesian Model Averaging, Conditional Bayes Factors, Endogeneity, Government Expenditure, Gibbs Sampling.

**JEL Classification Codes:** C4, C11, C59, H10, H50.

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# 1 Introduction

A fundamental question in the public finance literature is what are the determinants of the size of the government. For many nations, including the most developed ones, government expenditure constitutes a large share of the GDP - world average 28%, G7 average 40%, and EU average 43% over the period of 1970 to 2010 - and thus, characteristics of such activities cannot be left unexplained. Government expenditure is also characterized by substantial heterogeneity even amongst the most developed countries. For example, for 168 countries over the period of 1970 to 2010, the expenditure of the general government ranges from 6% for Guinea-Bissau to 61% for Denmark on average. Notably, among the high income countries, Singapore, Japan and Chile average 17%, 20% and 24%, respectively while Israel, the Netherlands, and Denmark average 56%, 57% and 61%, respectively. More importantly, governments may adopt policies that either extend government expenditure because of concerns about the welfare of citizens, or limit government spending due to concerns about the unsustainability of the public debt trajectory. For instance, the central government will reduce its spending if it believes that the centralized provision of public goods such as education or healthcare is a major factor of government size. Such policies however, like the recent debate in the US on Obamacare, may have substantial implications on redistribution and inequality in the long run. Hence, uncovering the substantial factors of government expenditure is not simply a matter of characterization of the cross-country patterns of government size, but also informs policy makers about the impact of their policies.

By now, there exists a large literature that has proposed and tested a wide range of alternative theories and hypotheses that determine the long run demand and supply of government size. Shelton (2007) identifies at least 8 distinct theories of government expenditure that have been tested by several studies using various proxy variables.[1] However, both theory and empirics have not provided convincing answers about the determinants of government expenditure.

The earliest theory of the size of government, *Wagner's Law*, traces back to the late 19th century when Adolf Wagner argued that government size increases with economic development. One of the most salient theories of government expenditure, however, is based on the seminal work of Rodrik (1998), who establishes the connection between *Globalization* and government size.[2] Rodrik argues that trade openness generates demand for insurance to compensate for the risk exposure to international markets. Epifani and Gancia (2009) proposed an alternative demand channel that relies on terms-of-trade externality whereby trade decreases the cost of taxation. Openness can also have a negative impact via a supply channel. Specifically, the government has incentives to increase efficiency and competitiveness by reducing the size of the government in order to keep mobile capital within national borders (Garrett and Mitchell (2001)). An additional theory is *Income Inequality*, which is based on the work of Meltzer and Richard (1981) who hypothesize that income inequality can generate demand for more redistribution and a larger government since the median voter has less income than the mean, which creates an incentive to vote for more redistribution. In contrast, when majority voting models account for capital market imperfections, ideology or the prospect of upward mobility, inequality may negatively affect redistribution (Saint-Paul (2001), Roemer (1998), and Benabou and Ok (2001)).

Furthermore, *Country Size* can negatively affect the share of government in GDP when there are fixed costs and economies of scale linked to partial or complete non-rivalry in the

[1] In Shelton (2007) political rights, electoral rules and government type are identified as different theories. In our baseline formulation we combine those under the theory of political institutions because they all refer to institutions constraining government and elite expropriation but also consider various robustness exercises (Acemoglu and Johnson (2005)).

[2] The first evidence of a relationship between trade and government expenditure were documented by Cameron (1978).

supply of public goods (e.g., Alesina and Wacziarg (1998)). Wallis and Oates (1988) and many others emphasize the importance of *Centralization*, which implies that an increase in fiscal decentralization will lead to an increase in the size of lower-level government (state and local) and to a decrease in the size of higher-level government. Another strand of literature has developed a theory of *Political Institutions* that links the different types of representative democracy and the composition of government expenditure (Persson, Roland, and Tabellini (1998), Persson and Tabellini (1999), Milesi-Ferretti, Perotti, and Rostagno (2001)). Other theories include *Ethnic Fractionalization*, which proposes a link between ethnic fragmentation and measures of public goods (Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003));[3] *Conflict* which links increases in government size with expenditure on defense (Eterovic and Eterovic (2012)); *Demography* which suggests the relevance of population growth, urbanization and the shares of dependants; and *Macroeconomic Policy*, besides trade policies, which relates to public debt, inflation and foreign direct investment with government expenditure (Rodrik (1998), Dreher, Sturm, and Ursprung (2008)).[4]

This paper contributes to the literature of government size by assessing the strength of the empirical relevance of the aforementioned theories, by taking into account model uncertainty. We posit that a major source of model uncertainty is due to the problem of theory uncertainty.[5] By the term theory uncertainty we mean that there exist multiple channels of transmission, due to various theories, and these channels are mutually compatible, that is, the validity of one theory of government expenditure (e.g., globalization) does not logically exclude other theories (e.g., country size) from also being relevant. This implies that there is no a priori justification for including a particular set of theories and their

[3]We do not include Ethnic Fractionalization because it is measured by time invariant variables and its effect is absorbed by fixed effects.

[4]Table S1 of Supplementary Online Appendix presents a summary of the empirical literature on the determinants of government size.

[5]Brock and Durlauf (2001) coined the term theory uncertainty due to openendedness of theories in the context of economic growth.

proxies in the regression model. Put differently, if one ignores this problem, results are likely to be fragile. The estimated effects could change dramatically in magnitude, lose their statistical significance, or even switch signs depending on which other variables are included in or excluded from the regression equation. For example, while Rodrik (1998) emphasizes the importance of globalization as a determinant of government expenditure, Wallis and Oates (1988), using a different set of determinants, argue that decentralization is the main reason for differences in government size among countries. An obvious alternative is to condition on all theories and include all possible determinants, as suggested by Shelton (2007).[6] This approach is also known as the "kitchen-sink" and is often used to evaluate the relative evidentiary support of competing theories. One problem with this approach is that the largest model can potentially include many irrelevant covariates yielding a poor description of the underlying stochastic phenomenon. Another possible alternative is to consider all possible models. But this is rather infeasible and also raises the question of how to summarize information across all relevant models. Even if each theory is sufficiently described by only one variable, it means there are $2^9$ possible models. So, how should one deal with the issue of model uncertainty?

To address the issue of model uncertainty, we propose a Bayesian Model Averaging (BMA) approach (e.g., Raftery, Madigan, and Hoeting (1997)). While these methods have been widely applied in other areas of economics, especially in the area of empirical growth, they are novel to this literature. BMA constructs estimates that do not depend on a particular model specification but rather use information from all candidate models. In particular, a BMA estimate is a weighted average of model specific estimates where the weights are given by the posterior model probabilities. This implies that the BMA estimates do not depend on a particular model specification but are instead conditional on the model

[6]In addition to Shelton (2007) theories we consider *Conflict*, and *Macroeconomic Policy* theories.

space, which is generated by the set of all plausible determinants of the dependent variable.[7]

Our second contribution involves a novel BMA approach that develops an Instrumental Variable Bayesian Model Averaging (IVBMA) with priors defined in economic theory space. In particular, our method introduces BMA in linear models with endogenous regressors. Our method builds on a Gibbs sampler for the IV framework, similar to that discussed in Rossi, Allenby, and McCulloch (2006). While direct model comparisons are intractable, we introduce the notion of a conditional Bayes factor (CBF), first discussed by Dickey and Gunel (1978) and employed in a seemingly unrelated regression context by Holmes, Denison, and Mallick (2002). The CBF compares two models in a nested hierarchical system, conditional on parameters not influenced by the models under consideration. A key feature of the CBF is that for both outcome and instrumental equations, it is exceedingly straightforward to calculate and it essentially reduces to the normalizing constants of a multivariate normal distribution. This leads to a procedure in which model moves are embedded in a Gibbs sampler, which we term Markov Chain Monte Carlo Model Composition (MC3)-within-Gibbs. Based on this order of operations, IVBMA is then shown to be only trivially more difficult than a Gibbs sampler that does not incorporate model uncertainty and thus appears to have limited issues regarding mixing.

Our approach differs from the literature in several ways. Early attempts to account for endogeneity in the context of BMA were made by Durlauf, Kourtellos, and Tan (2011) who proposed a two-stage least squares Bayesian model averaging method (2SLS-BMA) for the case of just-identification and extended by Lenkoski, Eicher, and Raftery (2014) to over-identification by allowing for model uncertainty in both first and second

[7]BMA has been successfully applied to address model uncertainty in the context of growth regressions by constructing estimates conditional not on a single model, but on a model space whose elements span a range of potential determinants; for example, Brock and Durlauf (2001); Fernández, Ley, and Steel (2001);Sala-i Martin, Doppelhofer, and Miller (2004); Durlauf, Kourtellos, and Tan (2008); Masanjala and Papageorgiou (2008); Malik and Temple (2009); Magnus, Powell, and Prufer (2010); Mirestean and Tsangarides (2016); Moral-Benito (2016).

stage models and by Morales-Benito (2112) to dynamic panel data. The weights of these methods rely on an approximation of the posterior probability of each model by the exponential of the Bayesian information criterion. This approximation is justified when a unit information prior for parameters is assumed as in Kass and Wasserman (1995). Chen, Mirestean, and Tsangarides (2016) proposed a limited information BMA approach, based on a method of moments methodology which avoids strong distributional assumptions. Koop, Léon-Gonzalez, and Strachan (2012) develop a fully Bayesian methodology that does not utilize approximations to integrated likelihoods. They develop a reversible jump Markov chain Monte Carlo (RJMCMC) algorithm, which extends the methodology of Holmes, Denison, and Mallick (2002). The authors then show that the method is able to handle a variety of priors, including those of Drèze (1976), Kleibergen and van Dijk (1998) and Strachan and Inder (2004). However, as the authors note, direct application of RJMCMC leads to significant mixing difficulties and relies on a complicated model move procedure that has similarities to simulated tempering to escape local model modes. Leon-Gonzalez and Montolio (2015) extend the approach of Koop, Léon-Gonzalez, and Strachan (2012) to dynamic panel data models.

Our proposed method allows for priors defined in theory space to account for the fact that the strength of several competing theories simultaneously is assessed using multiple proxy variables. Typical model priors are likely to inflate the probability of those theories which are associated with more variables. To deal with this problem, Brock and Durlauf (2001) proposed a hierarchical prior, which was extended by Durlauf, Kourtellos, and Tan (2011), who considered a hierarchical dilution prior. More recently, Magnus and Wang (2014) proposed a hierarchical weighted least squares method to address these uncertainties. Following Durlauf, Kourtellos, and Tan (2011) we extend the idea of hierarchical priors with dilution to the context of IVBMA using a more accurate sampling strategy.

Moreover, when working with a large system of equations subject to endogeneity and instrumentation, there is a natural concern that the instrument assumptions may not hold. There are a host of frequentist-type hypotheses that have been proposed to examine the instrument conditions, the most familiar of which to applied researchers is the test of Sargan (1958). There have been, to our knowledge, no similar checks of instrument validity proposed in the Bayesian IV literature outside of the approximate method advocated in Lenkoski, Eicher, and Raftery (2014). We propose a new check of instrument validity, also based on CBFs, which appears to be the Bayesian analogue of the Sargan test. This method is able to integrate seemlessly with the IVBMA framework and offers a check of instrument validity.

The main finding of the paper is that government size and its components are explained by multiple mechanisms that work simultaneously but differ in their impact and importance. To this nuanced characterization adds the fact that the differential impact of the various theories also depends on the specific measure of government size. In particular, for general government total expenditure we find decisive evidence for the demography theory, strong evidence for the globalization and political institution theories, positive evidence for Wagner's law, centralization, income inequality and macroeconomic policy theories, and weak evidence for the country size and conflict theories. Interestingly enough, in the case of central government total expenditure, we find that income inequality and macroeconomic policy play a decisive role in addition to demography. However, the theories of globalization, political institution, and Wagner's law appear to have a weaker impact on central government compared to that on general government. The results for both total government expenditure and the components are consistent with the variance decomposition analysis. In particular, we find that almost 80% of the total variation in general government is explained by demography and political institution theories. In the case of central government, demography appears to be the only dominant theory, explaining 32% of total variation.

A similar pattern emerges in our investigation of the components of both general and central level of government. In particular, we find at least strong evidence that the components related to public goods expenditure (public order and safety, health and education expenditures) are affected by the centralization, demography, globalization, and Wagner's law theories. For the components related to social protection expenditure we find strong evidence for all theories except from the centralization, conflict, and country size theories. Finally, for the components related to the operation of the government (compensation of employees, general public services and economic affairs) we find strong evidence for the majority of the theories, with the exception of centralization, conflict, and globalization theories. In the case of the central government, we find similar results but with the following notable differences. For the components related to public goods expenditure, macroeconomic policy, and political institution theories play an important role, while centralization and globalization do not. For the components related to social protection expenditure we find strong evidence only for the demography theory.

The paper is organized as follows. Section 2 proposes our econometric methodology, Instrumental Variable Bayesian Model Averaging (IVBMA) approach. We start by describing the standard instrumental variable model in the context of the Bayesian approach. Then, we incorporate model uncertainty and assess the validity of the instruments. Section 3 describes our data and the variables we use to measure the various theories. In Section 4, we present the main results of the paper, the variance decomposition analysis, the channel of transmission analysis, and other investigations. Finally, Section 5 presents our conclusions.

# 2 Methodology: IVBMA

We investigate the drivers of government expenditure using the linear instrumental variables (IV) model. For each country $j$, government expenditure over the time interval $t-1$ to $t$ is assumed to follow

$$gov_{jt} = \boldsymbol{Y}_{1jt}^{'}\boldsymbol{\beta}_1 + u_j + v_t + \epsilon_{jt} \tag{2.1}$$

where $j = 1, 2, ..., n_t$, $t = 1, 2, ..., T$, $\boldsymbol{Y}_{1jt}$ is a $(R-1) \times 1$ vector of endogenous variables, and instrumental variables given by the lagged values of the endogenous variables, $E(\boldsymbol{Y}_{1jt-1}'\epsilon_{jt}) = 0$. $u_i$ and $v_t$ denote the fixed and time effects, respectively. We assume that $\epsilon_{jt}$ is $i.i.d$ across countries and time, and that $u_i$, $v_t$, and $e_{jt}$ are mutually orthogonal. Let $u_j = \boldsymbol{d}_j'\boldsymbol{u}$ be the country fixed effect with $\boldsymbol{d}_j = (\boldsymbol{d}_{j1}, ..., \boldsymbol{d}_{jn_t})'$, $\boldsymbol{u} = (u_1, ..., u_{n_t})'$, where $d_{ji} = 1$ if $j = i$ and 0 otherwise. Similarly, we can define the time effects $v_t = \breve{\boldsymbol{d}}_t'\boldsymbol{v}$, with $d_{ts} = 1$ if $t = s$ and 0 otherwise. Let $\boldsymbol{W}_{jt} = (\boldsymbol{d}_j', \breve{\boldsymbol{d}}_t')'$ and $\boldsymbol{X}_{i1} = (\boldsymbol{Y}_{1jt}, \boldsymbol{W}_{jt}')'$. By pooling time and countries we can also express the above model (2.1) as

$$gov_i = \boldsymbol{X}_{i1}^{'}\boldsymbol{\beta}_1 + \epsilon_{i1} \tag{2.2}$$

## 2.1 The Instrumental Variable Model

Following Chao and Phillips (1998), we express the linear IV model in Equation (2.1) using the limited information formulation of the R-equation simultaneous equations model.

$$Y_{ir} = \boldsymbol{X}_{ir}^{'}\boldsymbol{\beta}_r + \epsilon_{ir} \tag{2.3}$$

where $r \in \{1, \ldots, R\}$ denotes the $R$ equations in the system and $i \in \{1, \ldots, n\}$ a set of *i.i.d.* observations. Thus, each covariate vector $\boldsymbol{X}_{ir}$ has length $p_r$ and is formed such that $\boldsymbol{X}_{i1} = (Y_{i2}, \ \ldots \ Y_{iR}, \ W_{i1}, \ \ldots \ W_{iq})'$ while $\boldsymbol{X}_{ir} = (Z_{i1}, \ \ldots \ , Z_{is}, \ W_{i1}, \ \ldots \ W_{iq})'$ for $r > 1$. $W_{iq}$, where $q \in \{1, \ldots, Q\}$, denotes the included exogenous variables, $E(W'_{iq}\epsilon_{ir}) = 0$ while $Z_{is}$, where $s \in \{1, \ldots, S\}$, denotes the excluded instrumental variables, $E(Z'_{is}\epsilon_{is}) = 0$. In our context, $R = 20$, $Y_{i1} = gov_i$ denotes the government expenditure, $Y_{ir}$ for $r \in \{2, \ldots, R\}$ consists of all the time varying determinants of government expenditure, $Z_{is}$ consists of the one-period lag of the endogenous variables such that the system is just identified equation-by-equation, $s = R - 1$, and $W_{iq}$ consists time and country fixed effects.

Letting $\boldsymbol{\epsilon}_i = (\epsilon_{i1}, \ldots, \epsilon_{iR})'$, we assume[8]

$$\boldsymbol{\epsilon}_i \sim \mathcal{N}_R(0, \boldsymbol{K}^{-1}). \tag{2.4}$$

### 2.1.1 Bayesian Estimation Under Standard Conjugate Priors

Accordingly, with each parameter vector, we assume $\boldsymbol{\beta}_r \sim \mathcal{N}(0, \mathbb{I}_{p_r})$ and $\boldsymbol{K} \sim \mathcal{W}(3, \mathbb{I}_R)$ where $\boldsymbol{K} \sim \mathcal{W}(\delta, \boldsymbol{D})$ represents a Wishart distribution with density

$$pr(\boldsymbol{K}|\delta, \boldsymbol{D}) \propto |\boldsymbol{K}|^{(\delta-2)/2} \exp\left(-\frac{1}{2}tr(\boldsymbol{K}\boldsymbol{D})\right)\mathbf{1}_{K\in\mathbb{P}_R}$$

where $\mathbb{P}_R$ is the cone of $R \times R$ symmetric positive definite matrices.

Let $\boldsymbol{\theta} = \{\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_R, \boldsymbol{K}\}$ represent the collection of parameters to be estimated. Denote the data $\mathcal{D} = \{\boldsymbol{Y}, \boldsymbol{X}_1, \ldots, \boldsymbol{X}_R\}$, where $\boldsymbol{Y}$ is the $n \times R$ matrix of responses and endogenous

[8]When $K_{1r} \neq 0$ for a given $r > 1$, this implies a lack of conditional independence between the residuals for the response and the associated endogenous variable. This contaminates inference on $\boldsymbol{\beta}_1$ if unaccounted for, necessitating the existence of instruments $\boldsymbol{Z}_i$ that do not appear in $\boldsymbol{X}_{i1}$ and a joint estimation of the parameters in Equations (2.3) and (2.4).

variables and each $\boldsymbol{X}_{(r)}$ is an $n \times p_r$ matrix. Our goal is to then determine the posterior distribution $pr(\boldsymbol{\theta}|\mathcal{D})$. Rossi, Allenby, and McCulloch (2006) discuss estimation of this model for the case when $R = 2$ and note that it is not possible to directly evaluate this posterior. However, approximate inference may be performed via Gibbs sampling.

Fix $r$ and suppose that $\boldsymbol{K}$ and all $\boldsymbol{\beta}_t$ for $t \neq r$ are given. Note, by properties of standard normal variates that $\epsilon_{ir}|\boldsymbol{K}, \{\boldsymbol{\beta}_t\}_{t\neq r} \sim \mathcal{N}\left(\mu_{ir}, K_{rr}^{-1}\right)$ where $\mu_{ir} = -\sum_{t\neq r} \frac{K_{rt}}{K_{rr}} \left(Y_{it} - \boldsymbol{X}_{it}\boldsymbol{\beta}_t\right)$. Set $\tilde{Y}_{ir} = Y_{ir} - \mu_{ir}$ and thus note that $\tilde{Y}_{ir} \sim \mathcal{N}(\boldsymbol{U}_{ir}\boldsymbol{\beta}_r, K_{rr}^{-1})$.

The act of conditioning, therefore, turns the original system into a simple linear regression problem and via standard results (see e.g. Rossi, Allenby, and McCulloch (2006) we have that

$$\boldsymbol{\beta}_r|\boldsymbol{K}, \{\boldsymbol{\beta}_t\}_{t\neq r} \sim \mathcal{N}\left(\hat{\boldsymbol{\beta}}_r, \boldsymbol{\Omega}_r^{-1}\right) \tag{2.5}$$

where $\boldsymbol{\Omega}_r = K_{rr}\boldsymbol{X}_r'\boldsymbol{X}_r + \mathbb{I}_{p_r}$ and $\hat{\boldsymbol{\beta}}_r = K_{rr}\boldsymbol{\Omega}_r^{-1}\boldsymbol{X}_r'\tilde{\boldsymbol{Y}}_r$.

Finally, suppose that all $\boldsymbol{\beta}_r$ are given, then

$$\boldsymbol{K} \sim \mathcal{W}(\delta + n, \boldsymbol{E} + \mathbb{I}_R) \tag{2.6}$$

where $\boldsymbol{E} = \sum_{i=1}^{n} \boldsymbol{\epsilon}_i\boldsymbol{\epsilon}_i'$, with each $\boldsymbol{\epsilon}_i$ computed relative to the current state of $\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_R$.

Equations (2.5) and (2.6) thereby give the full conditionals necessary for the Gibbs sampler. We note that our approach differs slightly from that of Rossi, Allenby, and McCulloch (2006), in that their Gibbs sampler features a more involved manner of updating the instrumental covariates $\boldsymbol{\beta}_2$. However, the two approaches evaluate the same posterior distribution. We find that the approach above leads to easier implementation and description and therefore we prefer it to extending that of Rossi, Allenby, and McCulloch (2006) to multiple endogenous variables.

There are a host of alternative prior specifications for both $\boldsymbol{\beta}_r$ and $\boldsymbol{K}$ which could have been entertained. However we note that the majority of these choices could be incorporated into our model averaging framework without affecting the overall approach. For instance, it is occassionally typical to place an uninformative prior on the precision matrix of the form $pr(\boldsymbol{K}) \propto |K|^{1/2}$, (see the discussion in Kleibergen and Zivot (2003)). This is related to the prior used in the seminal work of Drèze (1976). The informative prior we have chosen for $\boldsymbol{K}$ is similarly popular, (see e.g. Rossi, Allenby, and McCulloch (2006)) and has the advantage of being integrable. It is important to note that the difference between our Wishart prior and the uninformative prior is likely to have minimal impact on our posterior distributions. Indeed, both yield a Wishart posterior, but with slightly different parameters. Furthermore, the approach to handling model averaging computationally would be unaffected by this difference.

The prior on $\boldsymbol{\beta}_r$ could also have been specified differently. In particular, the $\mathcal{N}(\mathbf{0}, \mathbb{I}_{p_r})$ could be replaced with $\mathcal{N}(\boldsymbol{\mu}, \Sigma)$ for arbitrary $\boldsymbol{\mu}$ and $\Sigma$. We chose $\boldsymbol{\mu} = \mathbf{0}$ and $\mathbb{I}_{p_r}$ in keeping with some of the seminal work on BMA (Hoeting, Madigan, Raftery, and Volinsky (1999)). An alternative that is often used is to set $\boldsymbol{\mu}$ and $\boldsymbol{\Sigma}$ to the MLE given $\boldsymbol{X}$ and $\boldsymbol{Y}$ (Eicher, Papageorgiou, and Raftery (2011), Raftery (1995). This Unit Information Prior (UIP) is most often chosen because of its relation to the Bayes Information Criteria (BIC) and is the standard choice when BIC is used to score models. The extension of this prior to IV estimation problems was detailed in Lenkoski, Eicher, and Raftery (2014). While the UIP has enjoyed substantial use in practice, we have avoided it here. This is for two reasons. First, the UIP is ultimately not a prior distribution, since it uses the observed data to center to prior. This violation of the Bayesian paradigm is often justified on the grounds of expediency (the BIC is easy to calculate), but our purpose was to show that more theoretically rigorous approaches are possible.

More importantly, from a practical perspective, the use of a UIP leads to difficulties when considering the nested nature of our multiple endogenous variable model. In particular the "centering at the MLE" no longer has the same easy interpretation that it does in the single variable regression model. Lenkoski, Eicher, and Raftery (2014) avoided this problem by making an analogy to 2SLS and running the first stage regressions independently and then crossing the results of these regressions in the second stage, using UIPs in each stage. However, their example was confined to a model scenario with two endogenous variables. The combinatorial explosion of model crossings necessary to handle the twenty-equation model we consider here renders such an approach completely infeasible.

There has been additional research on using other distributions for $\boldsymbol{\beta}_r$ than Gaussian. For instance, Conley, Hansen, McCulloch, and Rossi (2008) use a Dirichlet process prior mixing representation to achieve heavier tails than offered by a normal distribution. We have not considered these extensions in this work. However, we note that the strategies discussed in this work would be readily amendable to incorporation into any prior framework where, conditioned on a set of hyper and mixing paramters, there is a form Gaussianity to the prior of $\boldsymbol{\beta}_r$.

## 2.2 Incorporating Model Uncertainty

We describe our method for incorporating model uncertainty in Equations (2.3) and (2.4). We show how the concept of Bayes Factors can be usefully embedded in a Gibbs sampler yielding CBFs. These CBFs are then shown to yield straightforward calculations.[9]

We now consider the incorporation of model uncertainty into the system (2.3). This involves considering a separate model space $\mathcal{M}_r$ for each equation in the system. A given

[9] In Appendix A1 we review some basic results from classic model selection problems.

model $M_r \in \mathcal{M}_r$ thus restricts certain elements of $\boldsymbol{\beta}_r$ to zero and we write $\boldsymbol{\beta}_{M_r}$ to indicate the non-zero elements of $\boldsymbol{\beta}_r$ according to $M_r$. Furthermore, we let $\Lambda_{M_r}$ be the subspace of $\mathbb{R}^{p_r}$ spanned by $\boldsymbol{\beta}_{M_r}$.

Ideally, we would be able to incorporate model uncertainty into this system in a manner analogous to Equation (A2). Unfortunately,

$$pr(\mathcal{D}|M_1, \ldots M_R) = \int_{\mathbb{P}_R} \int_{\Lambda_{M_1}} \cdots \int_{\Lambda_{M_R}} pr(\mathcal{D}|\{\boldsymbol{\beta}_{M_r}\}_{r=1}^{R}, \boldsymbol{K}) pr(\boldsymbol{K}) \prod_{r=1}^{R} pr(\boldsymbol{\beta}_{M_r}) d\boldsymbol{\beta}_{M_1} \cdots d\boldsymbol{\beta}_{M_R} d\boldsymbol{K}$$

cannot be directly calculated in any obvious manner. Therefore, an implementation of MC3 on the product space of $\mathcal{M}_1 \times \cdots \times \mathcal{M}_R$ is infeasible. What we show below, however, is that embedding MC3 within the Gibbs sampler, and therefore calculation using CBFs to move between models, offers an extremely efficient solution. CBFs were originally discussed in Dickey and Gunel (1978) in an unrelated context.

Given the system (2.3), fix $r$ and suppose that $\boldsymbol{\theta}_{-r} = \{\boldsymbol{K}, \{\boldsymbol{\beta}_t\}_{t \neq r}\}$ is given. Now consider comparing two models $M_r, L_r \in \mathcal{M}_r$. Finally, suppose that the prior over models $\mathcal{M}_r$ is set independently of $\boldsymbol{\theta}_{-r}$. We thus have

$$\frac{pr(M_r|\mathcal{D}, \boldsymbol{\theta}_{-r})}{pr(L_r|\mathcal{D}, \boldsymbol{\theta}_{-r})} = \frac{pr(\mathcal{D}|M_r, \boldsymbol{\theta}_{-r})}{pr(\mathcal{D}|L_r, \boldsymbol{\theta}_{-r})} \times \frac{pr(M_r)}{pr(L_r)} \tag{2.7}$$

and thus the conditional posterior odds depends on calculating a Bayes factor conditional on the current state of $\boldsymbol{\theta}_{-r}$.

Calculating the relevant terms in (2.7) is straightforward. We note, in particular that $pr(\mathcal{D}|M_r, \boldsymbol{\theta}_{-r}) = \int_{\Lambda_{M_r}} pr(\mathcal{D}|\boldsymbol{\beta}_{M_r}, \boldsymbol{\theta}_{-r}) pr(\boldsymbol{\beta}_{M_r}|M_r) d\boldsymbol{\beta}_{M_r}$ which is, in essence, an integrated likelihood for model $M_r$ conditional on fixed values of $\boldsymbol{\theta}_{-r}$. In Appendix A2 we show that

$$\int_{\Lambda_{M_r}} pr(\mathcal{D}|\boldsymbol{\beta}_{M_r}, \boldsymbol{\theta}_{-r}) d\beta_{M_r} \propto |\boldsymbol{\Omega}_{M_r}|^{-1/2} \exp\left(\frac{1}{2}\hat{\boldsymbol{\beta}}'_{M_r}\boldsymbol{\Omega}_{M_r}\hat{\boldsymbol{\beta}}_{M_r}\right) \tag{2.8}$$

where $\hat{\boldsymbol{\beta}}_{M_r}$ and $\boldsymbol{\Omega}_{M_r}$ are defined in Appendix A2, but are exactly analogous to the $\hat{\boldsymbol{\beta}}_r$ and $\boldsymbol{\Omega}_r$ discussed in Section 2.1, relative to the subspace $\Lambda_{M_r}$.

The power of this result is that the model $M_r$ and the associated parameter $\boldsymbol{\beta}_{M_r}$ may then be updated in a block. In particular, we note that

$$pr(\boldsymbol{\beta}_r, M_r|\boldsymbol{\theta}_{-r}, \mathcal{D}) = pr(\boldsymbol{\beta}_r|M_r, \boldsymbol{\theta}_{-r}, \mathcal{D}) \times pr(M_r|\boldsymbol{\theta}_{-r}, \mathcal{D}). \tag{2.9}$$

Since MC3 constitutes a valid MCMC transition in the model space $\boldsymbol{\mathcal{M}}_r$, we may first attempt to update $M_r$ via (2.7) and then subsequently resample $\beta_{M_r}$ via (2.5). By cycling through all $R$ equations in (2.3) in this manner, and then subsequently updating $\boldsymbol{K}$ we have proposed a computationally efficient estimation strategy for incorporating model uncertainty in IV frameworks.

We note that the general form of $pr(M_r)$ has not been developed yet and many different possibilities exist (see Ley and Steel (2009) and Eicher, Papageorgiou, and Raftery (2011) for a review of popular choices in the econometrics literature). In general, our methodology is amenable to all possible choices of model prior. In practice it is common, absent other information, to place a prior on the model space which has the form

$$pr(M_r) = \gamma^{|M_r|}(1-\gamma)^{p_r - |M_r|} \tag{2.10}$$

for $\gamma \in (0, 1]$. Note (2.10) covers the uniform prior ($\gamma = 0.5$) as well as priors that either penalize complexity ($\gamma < 0.5$) or encourages it ($\gamma > 0.5$) (see Ley and Steel (2009) for a discussion of these features).

The key factor that a majority of priors considered in the literature share is their treatment of each covariate as an independent unit, meaning that each affects the prior probability independently. Without additional knowledge about the covariate set, this assumption is a reasonable one, and we note that the IVBMA methodology discussed here can incorporate all potential model priors of this form. However, as we discuss below, in the context of many economic studies, the independent manner in which each variable enters the model prior can have substantial negative consequences when variable inclusion probabilities are used to assess the degree to which various theories are pertinent.

### 2.3 Priors in Theory Space

The critical issue of priors of the form (2.10) is their separability with regard to individual covariates. As noted above, the prior (2.10) places an independent prior probability $\gamma$ of inclusion on each variable under consideration. However, in economic applications of model uncertainty, variables are often meant to proxy theories. As they are proxies, they are naturally imperfect and thus it is common to collect a number of different potential proxies. Using posterior inclusion probabilies of these proxies to judge the relative strength of two competing theories is then contaminated by the fact that differing numbers of proxies may have been collected for each theory. Furthermore, the strong degree to which these proxies are likely correlated with one another must be accounted for.

Model space priors which do not account for these multiplicity issues are liable to overestimate the probability of those theories which are associated with the largest number of variables. This occurs because the collection of models, including at least one constituent, is greater than the set of models with few variables (see Durlauf, Kourtellos, and Tan (2011) for a discussion). Therefore, economic studies utilizing model uncertainty to assess theory relevance need to have model a prior which incorporate this structure.

In equation $r$ of (2.3) suppose that there are $T_r$ different theories. Let $t \in \{1, \ldots, T_r = 9\}$ denote one such theory with $p_{tr}$ potential variables included. $\mathcal{M}_{tr}$ is the model space defined by theory $t$ where $M_{tr} \in \mathcal{M}_{tr}$ when $M_{tr} \subset \{1, \ldots, p_{tr}\}$ with the restriction that $M_{tr} \neq \emptyset$. Finally, let $\boldsymbol{X}_{r,M_{tr}}$ be those columns of $\boldsymbol{X}_r$ associated with the model $M_{tr}$.

Setting priors in theory space is then performed hierarchically. Let $\gamma_{tr} \in \{0, 1\}$ be a binary indicator denoting whether theory $t$ is relevant for equation $r$. We first set a probability $pr(\gamma_{tr} = 1)$ dictating our prior belief that theory $t$ is relevant, which in practice is typically chosen to be 0.5.

Subsequent to setting the prior overall probability that theory $t$ holds, we then set individual model-level probabilities inside each theory. The simplest prior that corrects for multiplicity issues simply divides each theory by its size. But in practice, multiple measurements that represent the same theory are likely to be highly correlated and various priors have been proposed which account for this feature. The dilution prior of Durlauf, Kourtellos, and Tan (2011) is a notable example but complicates the straightforward implementation of the IVBMA algorithm discussed in Section 2.2. Both priors are discussed in Appendix A3.

To alleviate this complication of the dilution prior, we instead use the auxiliary variable $\gamma_{rt}$ directly in each step of the sampler. Rewriting (2.3) we have

$$Y_{ir} = \sum_{t=1}^{T_r} \gamma_{rt}(\boldsymbol{X}'_{r,M_{rt}} \boldsymbol{\theta}_{rt}) + \epsilon_{ir} \tag{2.11}$$

where $\gamma_{rt} \in \{0, 1\}$, $\theta_{rt} \in \Theta_{M_{rt}}$, $M_{rt} \in \mathcal{M}_{rt}$, $\boldsymbol{\epsilon}_i \sim \mathcal{N}(0, \boldsymbol{K}^{-1})$ and $\theta_{rt} \in \Theta_{M_{rt}} \subset \mathbb{R}^{p_{rt}}$ has zeros according to the model $M_{rt}$. Let $\boldsymbol{M}_r = \{M_{1r}, \ldots, M_{T_r r}\}$ be the collection of theory level models for theory $r$ write $\boldsymbol{\theta}_r \in \Theta_{\boldsymbol{M}_r} \subset \mathbb{R}^{p_r}$ to be the concatenation of parameter vectors where each subset associated with a given theory $t$ has the appropriate zeros according to $M_{tr}$. Posterior inference can then proceed by sampling, in turn, the pair

$$pr(\gamma_{rt}, M_{rt}|\cdot) = pr(\gamma_{rt}|M_{rt}, \cdot)pr(M_{rt}|\cdot) \tag{2.12}$$

for $t = 1, \ldots, T_r$, and $r = 1, \ldots, R$ instead of the original sampling of $M_r$ in Section 2.2. Since any potential $M_{rt}$ has the same denominator in Equation (A3), this term drops out of pairwise comparisons.

In practice, resampling $M_{rt}$ is performed by first forming

$$\tilde{\boldsymbol{Y}}_{tr} = \boldsymbol{Y}_r - \sum_{s \neq t} \boldsymbol{U}_{M_{sr}}^{(r)\prime} \boldsymbol{\theta}_{rs} + \sum_{q \neq r} \frac{K_{qr}}{K_{rr}} (\boldsymbol{Y}_q - \boldsymbol{U}^{(q)\prime} \boldsymbol{\theta}_q).$$

A neighboring $M'_{rt}$ is then proposed, following the logic of (2.12), $\hat{\boldsymbol{\beta}}_{\boldsymbol{M_{rt}}}$ and $\boldsymbol{\Omega}_{M_{rt}}$ are caculated using $\tilde{\boldsymbol{Y}}_{tr}$ and $\boldsymbol{X}_r$, which is combined with the prior probability $pr(M_{rt})$ to move between the two competing models.

After resampling the $M_{rt}$ term, $\gamma_{rt}$ is updated via $pr(\gamma_{rt} = 1|M_{rt}, \cdot) = \frac{u_1 pr(\gamma_{rt}=1)}{u_1 pr(\gamma_{rt}=1) + pr(\gamma_{rt}=0)}$ where $u_1$ is calculated as in (2.8). If $\gamma_{rt}$ is sampled to be 1, a parameter vector $\boldsymbol{\theta}_{rt} \in \Theta_{M_{rt}}$ is resampled according to $\hat{\boldsymbol{\beta}}_{M_{rt}}$ and $\boldsymbol{\Omega}_{M_{rt}}$.

This sampling strategy, which relies heavily on the auxiliary variables $\gamma_{rt}$, allows for complicated priors to be elicited inside a theory, without concern for the missing prior denominator that would be necessary to directly compare a model $M_{rt} \in \mathcal{M}_{rt}$ to the null model $\emptyset$ associated with the theory being invalid. Instead, by consistently updating which model $M_{rt} \in \mathcal{M}_{rt}$ is to be compared to $\emptyset$ through the use of $\gamma_{rt}$ we are able to move both inside theory space and to turn off theories using roughly the same CBF machinery as above.

## 2.4 Assessing Instrument Validity

A critical assumption for the estimates of $\boldsymbol{\beta}_1$ to have appropriate inferential properties is that the instrumental variables $\boldsymbol{Z}$ must be valid. In other words, $E[\boldsymbol{Z}_i'\epsilon_{i1}|\epsilon_{i2},\ldots,\epsilon_{iR}] = \mathbf{0}$. Many tools exist for evaluating the validity of this assumption in frequentist settings, the most popular of which in the applied community is the test of Sargan (1958). To our knowledge, consideration of similar assessments in a Bayesian setting have not been explored, beyond the approximate test proposed in Lenkoski, Eicher, and Raftery (2014). In Appendix A4 we propose a Bayesian assessment of instrument validity, borrowing many of the ideas above and merging these with the spirit of the Sargan test.

Suppose that all residuals and $\boldsymbol{K}$ were known. Let $\boldsymbol{\varsigma}$ be such that $\varsigma_i = \epsilon_{i1} + \sum_{r=2}^{R} \frac{K_{1r}}{K_{11}}\epsilon_{ir}$. The essential notion of the Sargan test is to consider the model $\varsigma_i = \boldsymbol{Z}_i'\boldsymbol{\xi} + \eta_i, \quad \eta_i \sim \mathcal{N}(0,\tau^{-1})$ and test whether $\boldsymbol{\xi} \neq \mathbf{0}$. The mechanics of the Sargan test ultimately rely on assymptotic theory and Lenkoski, Eicher, and Raftery (2014) discusses its poor performance in low sample size environments.

Our approach is to model this in a Bayesian context. In particular, we consider two models: $J_0$, which states that $\boldsymbol{\xi} = \mathbf{0}$, and $J_1$, which puts $\boldsymbol{\xi} \in \mathbb{R}^q$. We then aim to determine whether $pr(J_0|\mathcal{D})$ is large, indicating instrument validity. Note that this can be represented as the following marginalization

$$pr(J_0|\mathcal{D}) = \int pr(J_0|\boldsymbol{\varsigma},\mathcal{D})pr(\boldsymbol{\varsigma}|\mathcal{D})d\boldsymbol{\varsigma} \tag{2.13}$$

This approach offers similar performance to the test of Sargan (1958) and has the desirable features that it is a fully Bayesian approach (as opposed to the approximate test of Lenkoski, Eicher, and Raftery (2014)), which can be directly embedded in the Gibbs sampling procedures outlined above. Much work can still be done on this diagnostic.

## 2.5 Inference

We are interested in three posterior statistics of each coefficient, namely the posterior inclusion probability $pr(\beta_r \neq 0|\mathcal{D})$, the posterior mean $E(\beta_r|\mathcal{D})$ and the posterior standard deviation $sd(\beta_r|\mathcal{D})$. IVBMA returns a MCMC sample of size $S$ which can be used to approximate these posterior summaries. In particular

$$
\begin{aligned}
pr(\beta_r \neq 0|\mathcal{D}) &= S^{-1}\sum_{s=1}^{S} 1\{r \in \mathcal{M}^{(s)})\\
E(\beta_r|\mathcal{D}) &= S^{-1}\beta_r^{(s)}\\
sd(\beta_r|\mathcal{D}) &= \left(S^{-1}\sum_{s=1}^{S}(\beta_r^{(s)} - E(\beta_r|\mathcal{D}))^2\right)^{1/2}
\end{aligned}
$$

Using the notation of Section 2.3, suppose that $\gamma_t^{(s)}$ is the binary indicator where $\gamma_t^{(s)} = 1$ implies that theory $t$ is present in model $M^{(s)}$, then the PIP of theory $t$ is

$$
pr(\gamma_t = 1|\mathcal{D}) = S^{-1}\sum_{s=1}^{S}\gamma_t^{(s)}
$$

The larger the probability of the non-zero effect, the larger the evidence in favor of the covariate $r$ being part of the true theory. Following Kass and Raftery (1995) and Eicher, Henn, and Papageorgiou (2012) we interpret the values of PIP as follows: $PIP < 50\%$ indicates lack of evidence for an effect, $50\% \leq PIP < 75\%$ indicates weak evidence for an effect, $75\% \leq PIP < 95\%$ indicates positive evidence for an effect, $95\% \leq PIP < 99\%$ indicates strong evidence for an effect, and $PIP \geq 99\%$ indicates decisive evidence for an effect.

# 3 Measurement Issues

We employ a 5-year period unbalanced panel of 91 countries from 1971 to 2010.[10] The data are averaged over 5 years to avoid business cycle effects. To form five year panels from annual data, we took the arithmetic averages of the available annual values for each variable. The countries and observations vary by the category of expenditure used. For the total government expenditures we have information on 91 countries, while for the various components we have information on 80 countries. Details about the countries can be found in Table S2 of Supplementary Online Appendix.

## 3.1 Government Expenditure

We measure government size in complementary ways, one by general expenditure and the other by central government expenditure. Government expenditure is further classified by economic or functional classification. For the economic classification of expenditure, we use expenses for "Compensation of employees" and "Use of goods". For the functional classification of expenses we use expenses for "General public services", "Defence", "Public order and safety", "Economic affairs", "Health", "Education" and "Social protection".[11] The source for the share of government expenditure to GDP is the IMF's Government Financial Statistics database (GFS). Information on total government expenditure and its components can be found in Table S3 of Supplementary Online Appendix, and the summary statistics in Table S5 of Supplementary Online Appendix.

[10] We extend Shelton (2007) in two dimensions, time and determinants. Shelton (2007) uses a 5-year period unbalanced panel of a similar set of countries from 1971 to 2000. We use the same set of government expenditure components, but we use a much broader set of determinants.

[11] Following Persson and Tabellini (1999) and Shelton (2007), expenditure of public good is the sum of public order and safety, health and education expenditures.

## 3.2 Determinants

The determinants of government expenditure are organized into nine different theories: *Centralization*, *Conflict*, *Country Size*, *Demography*, *Globalization*, *Income Inequality*, *Macroeconomic Policy*, *Political Institution* and *Wagner's Law*, as discussed in the introduction. Measuring these theories results in 19 proxies from several databases.[12] Additionally, in every model we include a constant, time, and country fixed effects.

For *Centralization* we use the ratio of central to general total government expenditure from GFS. We proxy *Conflict* using the warfare score. We use the natural logarithm of the population and the natural logarithm of the country's land area in square kilometers to proxy *Country Size*. For *Demography* we use the share of people younger than 15 years old and older than 64 years old to the working age population, the share of urban population to total population and population growth. We proxy *Globalization* with trade openness and *Income Inequality* with the Gini coefficient for gross inequality. *Macroeconomic Policy* is proxied by the share of central government debt to GDP, the natural logarithm of FDI liabilities stock, and inflation. For *Political Institution* we use the combined polity score, the political competition index, the political rights index, the presidential system dummy, and the plurality dummy. Finally, for *Wagner's Law* we use the natural logarithm GDP per capita. Information on all the determinants can be found in Table S4 of Supplementary Online Appendix, the summary statistics in Table S6 of Supplementary Online Appendix, and correlations in Table S7 of Supplementary Online Appendix.

[12]The Database of Political Institutions (DPI), the Freedom House (FH) database, the Historical Public Debt Database (HPDD), the IMF's Government Financial Statistics database (GFS),Lane and Milesi-Ferretti (2007), the Major Episodes of Political Violence database (MEPV), Penn World Table 8 (PWT), Political Regime Characteristics and Transitions, the 1800-2013 database of the Polity IV Project (PRCT), the Polity IV Project (PIV), Solt (2009) and the World Development Indicators database (WDI).

# 4 Results

In this section we present the results for our baseline results as well as a number of additional investigations that aim at providing a sensitive and in-depth analysis. First, we present the posterior inclusion probability (PIP) of the theories and the determinants, the posterior mean, and posterior standard deviation of the determinants, for both general and central government expenditures.

Second, in order to identify the contribution of each theory and determinant to the variation of total expenditure (and in its components), we construct a variance decomposition analysis. Third, we present results for the channels of transmission, in order to cast more light on the importance and the magnitude of the various theories. This analysis can also serve as a robustness for our theory priors. Last but not least, we provide a deeper investigation on the effect of globalization, and income inequality.

## 4.1 Total Government Expenditure and Components

The PIPs of the theories and determinants are presented in Tables 1 and 2, respectively. Tables 3 and 4 present the posterior means and the posterior standard deviations of the determinants, for the general and central government expenditures, respectively. The first column of the tables shows the theories; the second column presents results for total expenditure; and the remaining columns present results for the components.

### 4.1.1 General Government

Results suggest that the theory of demography has a decisive impact on general government total expenditure and strong evidence for the theories of globalization and political institution. We also find positive evidence for Wagner's law, centralization, income inequality and macroeconomic policy theories and some weak evidence for the country size and conflict theories.

In particular, the posterior inclusion probability of the demography theory is 0.998. As seen from Table 2, column 2, and Table 3 this is due to the decisive effect, with a positive posterior mean, of the ratio of the population older than 64 ($PIP = 0.998$), the ratio of the population younger than 15 years old ($PIP = 0.957$), and the population growth ($PIP = 0.848$). The effect of demography on total government expenditure pertains to its effects on the components. More precisely, demography theory has a decisive role for public goods expenditure (health and education) through the share of the population younger than 15 and older than 64. This is consistent with the explanation of Cassette and Paty (2010), that the share of the population over 65 constitutes an interest group with high political power, voting for social benefits programs, such as health. Population growth has a negative effect on the use of goods and services, social protection and public goods expenditure. Given the fixed cost (establishing a set of institutions) and the economies of scale linked to partial or complete non-rivalry in the supply of public goods, the population growth decreases the expenditure as a % of GDP.

Results suggest that globalization plays a strong role for the total expenditure with PIP equal to 0.956. This evidence pertains to decisive evidence, with positive posterior mean, of globalization, with positive posterior mean, on the public goods expenditure (through education), strong evidence, with positive posterior mean, on the use of goods and services expenditure and positive evidence on the social protection expenditure. Our results are generally consistent to those of Rodrik (1998) who finds that globalization increases inequality and economic insecurity, which from the demand side of the political market create incentives for government to compensate the losers, mainly through income transfer programs and economic policy activism. Our results are generally consistent with these findings, since we find a positive effect on both the direct (social protection) and indirect (public goods) form of transfer. A more detailed analysis will be delayed until Section 4.4.1, using a smaller sample.

We also find strong evidence for the political institution theory, with $PIP = 0.953$. Specifically, we find positive evidence for the political competition index, the political right index, and the democracy index. The positive effect of the democracy index on total expenditure (through the general public services and education expenditures) is consistent with Alesina and Wacziarg (1998). They find that democracies have higher government size due to the fixed cost in building democratic institutions, and the existence of social and redistribution policies. In contrast, we find a negative effect on the social protection expenditure, which is a direct form of redistribution. This can be explained by the presence of many pressure groups in democracies, which may lead to greater heterogeneity of preferences and thus, lower levels of redistribution. Instead, our results seem to support the political competition theory by Eterovic and Eterovic (2012) that the increase in political competition is likely to decrease government expenditure, which is found in our results for the general public services expenditure.[13] Shelton (2007) argues that as political rights become more open, more social and redistribution policies that take place. Again our results are consistent with this.

Furthermore, we find positive evidence for Wagner's law, centralization, income inequality and macroeconomic policy theories, and weak evidence for the country size and conflict theories. Our results are consistent with Wagner's Law theory, as suggested by the

[13] As Eterovic and Eterovic (2012) state there are at least four reasons why enhanced political competition is likely to decrease government expenditure: (1) the theory of fiscal illusion, (2) enhanced political competition allows more pressure groups to be catered to in the political calculus, (3) political competition enhances political accountability, and (4) in societies with severe restrictions on political competition (dictatorship) political leaders need to spend substantial public funds on securing and maintaining power.

positive posterior mean for total expenditure and the public goods and the social protection expenditures.[14] The positive posterior mean of the centralization theory is consistent with the Brennan and Buchanan (1980) hypothesis.[15]

Finally, the negative posterior mean of the Gini coefficient is in contrast to the majority voting hypothesis (Meltzer and Richard (1981)). The literature suggests that inequality may negatively affect redistribution, if we take into account capital market imperfections (e.g., Roemer (1998), Benabou (1996) and Benabou (2000)), in the presence of high intergenerational mobility (Benabou and Ok (2001)) or if redistribution is accomplished by a public provision of goods and services rather than by transfers (Grossmann (2003)). In particular, we find strong evidence for the effect of Gini on social protection expenditure. This result suggest that a deeper investigation of the mechanism that drives this is needed. This is done in Section 4.4.2. Additionally, we find strong evidence for the effect of inequality on economic affairs expenditure. Note that economic affairs can be viewed as a form of public goods that contain among other, expenses on labor affairs, fuel and energy, manufacturing, transport and communication.

### 4.1.2 Central Government

As in the case of the general government, we find that the majority of the proposed theories provide us with at least positive evidence on the central government expenditure. Compared with the general government we find decisive evidence for the theories of macroeconomic

[14]Wagner's law suggests that as states grow wealthier they simultaneously grow more complex, increasing the need for public regulatory and protective action to ensure the smooth operation of a modern, specialized economy. Additionally, it postulates that certain public goods, such as education and health, are luxury goods, which means that the demand for those goods increases more than proportionally as income rises. Finally, Shelton (2007) indicate that richer countries have a bigger fraction of people over 64 years old, who demand more social protection.

[15]Brennan and Buchanan (1980) suggest that an increase in fiscal centralization will lead to more total government spending.

policy and income inequality on central government total expenditure, in addition to demography. Central government includes expenditures of political authority that extends over the entire territory of the country.

Macroeconomic policy theory decisively affects total government with PIP equal to 1, through inflation ($PIP = 1$) and FDI liabilities ($PIP = 0.971$). Consistent with Zakaria and Shakoor (2011), we find a negative effect of inflation on total expenditure. This can be explained by the shrinking size of the formal sector or the reductions of the real value of government revenues, which limit the government's ability to spend. Importantly, our results do not support the hypothesis of the reduction of government size in order to increase competitiveness to attract FDI, given that we find a positive effect on central government total expenditure. This comes through an increase in general public services and public order and safety, which includes expenditure on executive and legislative organs, financial, fiscal and external affairs and expenditure on police protection services and law courts, which are the main mechanism in attracting and preserving foreign direct investments. The weak evidence of FDI on general government expenditure suggest that FDI related policies are adopted in the central government and lower levels (state or local).

We also find decisive evidence, with positive posterior mean, for the income inequality theory, with $PIP = 1$, indicating that as inequality increases, so does the government size. Interestingly, we only find weak evidence of the effect of income inequality on the components. As in the case of general government, the Meltzer and Richard (1981) hypothesis is not supported, since we do not find any effect on neither social protection nor public goods expenditure. Given that total expenditure is the summation of the various components, we can conclude that the summation of the weak evidence of the effect of income inequality on the components provide the decisive evidence of the effect on total expenditure. In particular we get a small positive effect on the components (use of goods and services, economic affairs, public order and safety, health, and education expenditures), which summing those we end up with the positive effect on total expenditure. Given that general government is the summation of central and local government then the effect of inequality on general government economic affairs and social protection expenditures, comes from the local level, since in the central level we do not find any effect.

For the rest of the theories, results are similar to those relating to the general government. Specifically, we find decisive evidence for the demography theory, positive evidence for the centralization, political institution, globalization, and country size theories, and weak evidence for Wagner's law and conflict theories. Finally, we find notable differences between general and central government on the effect of urbanization and the presidential dummy. For the former, we find a positive posterior mean on public goods and social protection expenditure, which support the Ferris, Park, and Winer (2008) hypothesis.[16] Additionally, the negative effect on both general public services and economic affairs expenditure, can be explained by economies of scales, since government expenditure on administration, regulation, and operation are gathered in urban regions. The negative posterior mean of the presidential dummy on the use of goods and services, general public services and public goods expenditure (similar results with the general government) is consistent with Baraldi (2008).[17]

#### 4.1.3 Instrument Validity

Reliability of inference requires instrument validity. Hence, in this section we employ the diagnostic test proposed in Section 2.4 to evaluate the validity of the instrument.

[16] They suggest that as urbanization increases, a greater demand for government services is expected if education and health are mainly public responsibilities.

[17] He suggest that in presidential regimes government tends to be more efficient due to the competition between the policy makers.

In the bottom part of Tables 3 and 4 we present the p-value of our test statistic, under the null of no validity of the instruments, for general and central government, respectively. For both the general and the central government total expenditures and its components we reject the null hypothesis that the instruments are not valid. This result provides strong evidence that the instruments we use are valid across all cases.

#### 4.1.4 Summary of the Main Findings

The main finding is that the effect of the proposed theories on government expenditure is multidimensional. We find substantial evidence that total expenditure and its components are explained by different theories. However, the effect of the various theories differs in terms of its significance, size and the specific measure of government size. On the one hand, for general government total expenditure we find decisive evidence for the demography theory and strong evidence for the theories of globalization and political institution. On the other hand, for the central government total expenditure we find decisive evidence for the demography, macroeconomic policy, and income inequality theories.

In the next section, we present the results for the variance decomposition analysis.

### 4.2 Variance Decomposition

In this section, we develop a variance decomposition analysis, in order to determine the contribution of each theory in explaining the variation of total expenditure and its components. Firstly, we compute the posterior mean of each theory $t$: $\hat{T}_t = X_{t,1}\hat{\beta}_{t,1} + X_{t,2}\hat{\beta}_{t,2} + ... + X_{t,p}\hat{\beta}_{t,p}$, where $\hat{\beta}_{t,j}$ is the set of estimates for the coefficients of the determinants for theory $t$. Following Klenow and Rodriguez-Clare (1997), we decompose the variance of each theory:

$$1 = \sum_{i=t}^{T_r} \frac{Cov(gov_j, \hat{T}_t)}{Var(gov_j)} + \frac{Cov(gov_j, \hat{e}_t)}{Var(gov_j)}, t = ., \ldots, T_r$$

The results from the Balanced Variance Share (BVS) are presented in Table 5. Additionally, we provide robustness analysis in Table S8 of Supplementary Online Appendix, using Correlated Variance Share (CVS) as an alternative decomposition method, finding similar results.[18]

The variation of general government total expenditure is mainly explained by the demography theory (40.3%), the political institution theory (38.3%), the centralization theory (22.6%), and the income inequality theory (6.7%). Furthermore, the globalization (3.4%) and Wagner's law theory (3%), seem to explain only a small part of the total expenditure variation. For the central government total expenditure, only the demography theory explains a large fraction of the variation (32%). One notable difference is that while the macroeconomic policy and income inequality theories exhibited a decisive role in terms of PIP, their impact in terms of their ability to explain the variation of expenditure is small, suggesting that the effect is significant but small in magnitude. With the exception of the conflict and the country size theories, all others explain a fraction between 3% and 9% of the variation of central government total expenditure. Importantly, our results show that country and time heterogeneity do not explain the variation of total expenditure, neither on the general nor the central level.

In sum, our results are in agreement with the results from the posterior inclusion probability. The determinants that have a high PIP explain more than 5% of the various expenditures components variation.

[18] BVS is calculated as the share of the covariance between the posterior mean of theory $t$ and of expenditure category $j$, to the variance of expenditure category $j$: $BVS = \frac{cov(\hat{T}_{rt}, gov_j)}{var(gov_j)}$. CVS is calculated as the share of the posterior mean of theory $t$ to the variance of expenditure category $j$: $CVS = \frac{var(\hat{T}_{rt})}{var(gov_j)}$. See Gibbons, Overman, and Pelkonen (2014).

## 4.3 Channels of Transmission Analysis

In this section we consider two complementary investigations to identify and explain the mechanisms that underlie the estimated relationships between the various theories and government expenditure. First, we exclude a theory from the model space one at a time in a similar fashion as the mediation analysis, but rather than focusing on individual variables, here, the unit of analysis are the theories and their proxies. In such an analysis, the hypothesis is that an underlying theory transmits its effect to government expenditure directly as well as indirectly via a mediator theory. For example, political institutions can affect government expenditure directly or indirectly via their effect on globalization. By excluding the globalization theory from the model space we can assess its mediation role vis-a-vis the other theories of the government expenditure using a posterior odds ratio analysis. For any two given theories $i$ and $j$, $i \neq j$ we estimate

$$\frac{PIP^i}{PIP^{i,-j}} + \frac{\Delta PIP^{i,-j}}{PIP^{i,-j}} = 1, \tag{4.14}$$

where $PIP^i$ is the posterior inclusion probability of theory $i$ in the baseline model, which gives us the direct effect of theory $i$ on government expenditure, $PIP^{i,-j}$ is the posterior inclusion probability of theory $i$ after we exclude the theory $j$ and $\Delta PIP^{i,-j} = PIP^{i,-j} - PIP^i$ is the difference of the two, which gives us the mediation effect.

The posterior inclusion probabilities of the theories and the decomposition into direct and mediation effects are presented in Table 6. Additionally, in Tables S9 and S10 of Supplementary Online Appendix we present the direct and the mediation effect of the posterior inclusion probabilities and the posterior mean of the determinants, respectively. As described in the basic model analysis, for the general government total expenditure, only the demography theory has a PIP higher than 99%. This effect is mainly driven by the share of the population younger than 15 and older than 64. When we exclude any other theory, we always find the same decisive evidence for the effect, indicating a very small mediation effect. Examining the individual variable, we find that the mediation effect is much higher both in terms of PIP and posterior mean. For example, excluding the macroeconomic policy theory, we find that the PIP for the share of the population younger than 15 drops from 0.957 to 0.027 and the share of the population older than 64 drops from 0.998 to 0.051. In addition, the posterior mean becomes almost zero, from 0.183 and 1.588 for share of population younger than 15 and older than 64, respectively.

For the theories with a PIP higher than 95% (globalization, and political institution) in the baseline model, we find that with the exception of centralization and political institution theories, excluding any theory causes a decrease of the PIP in globalization to less than 75% and a sharp decrease of its posterior mean (in some cases the effect of trade openness becomes negative). In contrast, the exclusion of any theory causes a small positive mediation effect on the political institution theory, meaning that the PIP, increases. This is true for all cases with the exception of the case which we exclude demography theory and find that PIP decreases from 0.953 to 0.804. The mediation effect on the PIP of the determinants is relatively higher than the mediation effect on the PIP of the theories.

The results for the central government total expenditures and its components are generally similar. In the baseline model we find decisive evidence for the effect of demography, income inequality, and macroeconomic policy theories. The mediation effect of the PIP of the macroeconomic policy theory is big only for the cases in which we exclude either the centralization or the demography theory. This is mainly due to the sharp decrease of PIP and posterior mean of FDI and inflation. For the demography and income inequality the mediation effects in PIP are relatively large, in the sense that the initial PIP of the theories change substantially with the exclusion of the majority of the theories.

In sum, this analysis shows that most of the theories affect government expenditure directly as well as indirectly. In particular, while globalization theory has a big effect on general government expenditure, in terms of PIP and posterior mean, it also has a big indirect effect through the majority of the other theories. This is also true for the overall effect of the demography and income inequality theories on central government expenditure. Finally, we find that the indirect effect of macroeconomic policy theory comes from the centralization and the demography theories.

Second, we undertake an alternative investigation that conditions on a treatment theory to be always present in all models and then ask the question of how model uncertainty with respect to the remaining theories, which are viewed as controls, influence the effect of the treatment theory. Results for the PIP of the theories are presented in Table 7. In Tables S11 and S12 of Supplementary Online Appendix we present the direct and the mediation effect of the posterior inclusion probabilities and the posterior mean of the determinants. For both general and central government total expenditure we find that the impact of conditioning on a theory to always be included in the model space is quite substantial. For example, in the case of the general government total expenditure, when we condition Wagner's law theory to be included in the model space we find that while the PIP of the demography theory drops from 0.998 to 0.703 ($\Delta PIP^{i,-j} = -0.295$), the PIP of the macroeconomic policy theory rises from 0.796 to 0.995 ($\Delta PIP^{i,-j} = 0.199$).

Overall, this analysis highlights the presence of model uncertainty and the vital role of BMA in order to obtain valid inference. This analysis also illustrates that while the BMA does not depend on individual models, it does depend on the model space. Thus, to ensure correct specification of the model space we included in the analysis all the relevant theories to the best of our knowledge.

## 4.4 Further Results

In this section we provide an in-depth analysis of globalization using a smaller sample and a deeper look in the relationship between government size and inequality by allowing for heterogeneity in the effect of income inequality.

### 4.4.1 Globalization

As argued by Rodrik (1998) the exposure to risk of the more open to trade economies can be mitigated by increasing the "safe" government sector. Following Rodrik (1998) we use the terms of trade variability as proxy of risk. The interaction term of trade openness and terms of trade variability measure the external risk for an open economy.[19] The inclusion of these additional terms limit our sample substantially (85 countries and 219 observations), which explains the reason we opted not to consider this in the baseline sample.

In Table 8 and Table S13 of Supplementary Online Appendix we present the PIP of the theories and the variables, respectively. We find a decisive effect with PIP equal to 1 for the globalization theory on the general government total expenditure. While the PIP of the interaction term is equal to 1, indicating decisive evidence for the effect, the posterior mean is negative. Additionally, the PIP of the interaction term on both social protection and public goods expenditures indicates that neither matters (PIP is 0.003 and 0.038, respectively). In the case of central government level, we find decisive evidence for the effect of globalization on public goods expenditure. The PIP of the interaction term is 1, but the posterior mean is negative. These results do not support the explanation of Rodrik (1998), who finds a positive effect.

[19] Rodrik (1998) finds a positive and statistically significant coefficient for the interaction terms.

### 4.4.2 Income Inequality

Both the theoretical and the empirical evidence for the effect of income inequality theory on government size is inconclusive. On the one hand, Meltzer and Richard (1981) hypothesis suggests that income inequality can generate demand for more redistribution and a larger government. On the other hand, there are theories suggesting that inequality may negatively affect redistribution, in the presence of capital market imperfections (e.g., Roemer (1998), Benabou (1996) and Benabou (2000)), in the presence of high intergenerational mobility (Benabou and Ok (2001)) or if redistribution is accomplished by a public provision of goods and services rather than by transfers (Grossmann (2003)). We find a negative strong evidence for the effect of Gini on general government social protection expenditure and a positive decisive evidence on central government total expenditure, but only weak evidence of the effect of income inequality on the various components. As a next step we allow for heterogeneity in income inequality, by replacing the Gini variable with interactions of the Gini with income group dummy variables as reported by the World Bank.

In Table 9 and Table S14 of Supplementary Online Appendix we present the PIP of the theories and the variables, respectively. We find a decisive effect ($PIP = 1$) for the income inequality theory on general government total expenditure and a positive evidence ($PIP = 0.853$) on central government total expenditure. The effect on general government comes from social protection expenditure and on central government comes from public goods expenditures. In both case we find a decisive evidence for the effect with PIP equal to 1. The rest of the theories are consistent with the baseline model.

In particular for general government social protection expenditure we find a positive effect of income inequality in lower income countries ($PIP = 0.893$), a negative effect in lower middle income countries ($PIP = 1$) and an insignificant effect in upper middle income, and in high income countries ($PIP = 0.006$ and $PIP = 0.004$ respectively). This results are closer to the Prospect of Upward Mobility (POUM) hypothesis of Benabou and Ok (2001). In low income countries, intergenerational income elasticity is higher than in lower middle income countries.[20] In the lower middle countries, individuals may choose not to support high tax rates because of the prospect that they, or their children, may move up in the income distribution ladder and therefore be hurt by such policies.

For the central government public goods expenditure we find a positive effect of inequality only for high income countries, while for the rest of the countries we find a negative effect. For example this is consistent with Benabou (2000) who examines the role of the presence of capital market imperfections. In the presence of credit constrains, redistribution will command less political support in an unequal society than in a more homogeneous one. Additionally, Grossmann (2003) shows that if redistribution is accomplished by a public provision of goods and services rather than by transfers.

## 4.5 Robustness

### 4.5.1 Parameter Heterogeneity

We generalize the analysis we undertaken in Section 4.4.2 for all theories. We investigate parameter heterogeneity, with respect to the income group of each country, as reported by World Bank. We replace each theory with four new theories, based on income group. We use the interaction of the variable with the income group dummies (high income, upper middle income, lower middle income, and low income), which they add up to the original variable.

[20]Some evidence are provided in Hertz, Jayasundera, Piraino, Selcuk, Smith, and Verashchagina (2007). For example, for low income countries they find a coefficient of 0.75 and 0.94 for Ethiopia has and Nepal, respectively. For lower middle countries they find a coefficient of 0.41 and 0.61 for Philippines has and Sri Lanka, respectively.

Then each variable is included in the relevant theory. The results for the PIP for the theories and variables are presented in Table 10 and Table S15 of Supplementary Online Appendix, respectively.

For general government we find decisive evidence for the demography theory. Splitting the theory into the 4 income groups we find a strong evidence only for the high income countries. This is consistent with the fact that in those countries both the percentage of people older than 64 and the percentage of urban population is higher, than in lower income countries. For globalization and political institution theories, that we find a strong evidence, parameter heterogeneity plays an important role. The PIP of the globalization theory is higher than 95% only for high income countries (this is reasonable given that those countries are more open to international trade). The strong evidence of the political institution theory is not found in any of the four income groups (we find a positive evidence only for upper middle income countries). Our baseline results suggest a decisive evidence for the macroeconomic policy, income inequality, and demography theories. As in the case of general government total expenditures the PIP for those theories is much higher for the high income countries.

From the whole set of results we can conclude that parameter heterogeneity affects the formation of both general and central government total expenditures. More importantly, the evidence of parameter heterogeneity does not invalidate our previous results but simple provides a deeper understanding of the effect of the various theories.

#### 4.5.2 Theory Prior

Our proposed method, discussed in Section 2.3, overcomes the multiplicity issues due to the fact that several competing theories are simultaneously tested and each theory has a number of variables which serve as potential proxies. Here we consider a robustness exercise that sets flat weights on each theory. We consider two cases. First for each theory we include only a single variable.[21] Second we set that each determinant is a theory by its own. Results are presented in Table 11.

In the case of including a single variable, in terms of theory PIP we find that for general government globalization, income inequality and political institution theories lose their significance while now we find a decisive effect for the Wagner's law theory. For central government we find that globalization, income inequality and macroeconomic theory lose their significance while country size PIP increase to 1.

In the second case, when we treat each variable as a single theory. We find positive evidence for both variables of the country size theory, in contrast with our baseline results. As expected the PIP and posterior mean of the variables are consistent with the baseline model. The results suggest that our proposed theory priors overcomes the issue of the overestimation of the probability of those theories which are associated with the largest number of variables and also alleviate the complication of the dilution priors.

#### 4.5.3 Alternative Specifications of Theories

In this section we consider a sensitivity analysis of the baseline specification of theories. Results are presented in Table 12. In particular, we do two things.

First, we merge the globalization and macroeconomic theories, as suggested by a large

[21] For centralization theory we use the percentage of central to general total government expenditure, for conflict theory we use the magnitude score of episode(s) of warfare involving that state in that year, for country size theory we use population, for demographic theory we use the percentage of people older than 64 to the working-age population, for globalization theory we use trade openness, for income inequality theory we use gross income gini inequality, for macroeconomic theory we use total central government debt, for political institution theory we use the combined polity democracy score, and for the Wagner's law theory we use GDP per capita.

body of the literature. In order to be consistent with this we add trade openness into macroeconomic theory. We find a decisive effect of the macroeconomic theory on general government total expenditure, in contrast with the positive effect of the baseline model. This is driven by trade openness, as suggested by the PIP of the included variable. The effect of the macroeconomic theory on the central government expenditures remains decisive and the inference of the variables remain consistent with our baseline model. For the rest of the theories and variables, both the PIP, the posterior mean, and the posterior SD are substantially the same with our baseline results. Our finding suggest that we get more information by splitting globalization and macroeconomic theories without changing the results of the rest theories.

Second, following Shelton (2007) we consider each component of the political institution theory as its own theory. We let democracy score, political competition index, presidential and plurality dummy, and political rights index to be theories on its own. In the baseline model we find a strong effect of the political institution theory on general government total expenditure and a positive effect on central government expenditure. Now, we find a strong effect of democracy score and a positive effect of political rights on general government total expenditure while we find a positive effect of political rights on central government total expenditure. The results are consistent with Shelton (2007), but combining all variables under one theory we additionally get the significant of the theory as a whole.

#### 4.5.4 BMA and Classical Analysis

In addition to our IVBMA results, we present the top three models of IVBMA as well as the largest model. We do so to provide the reader with the ability to compare results if one were to engage in model selection. For completeness we also present least square BMA results that do not take into account for endogeneity of the determinants.[22] Results are presented in Tables S16 and S17 of Supplementary Online Appendix.

The top three models yields posterior probability 0.031, 0.031 and 0.029 for the general government total expenditure and 0.074, 0.068 and 0.041 for the central government total expenditure, suggesting that r model space is not dominated by few models. Furthermore, the largest model also known as "kitchen-sink" model, for both the general and the central government expenditures, yields very different determinants for the government expenditure. Nevertheless, given that the posterior model probability is approximately zero, this implies that this model is not reliable for inference. Last but not least, there is a big difference between our IVBMA results and the least squares BMA results, suggesting that ignoring the endogeneity of the regressors can lead us to incorrect conclusions.

# 5 Conclusion

By now there exists a large literature on the size of government that proposed and tested a wide range of alternative theories and hypotheses that determine the long run demand and supply of government size. Yet, both theory and empirics have not provided convincing answers about the determinants of government expenditure. This paper contributes to the literature of government size by assessing the strength of the empirical relevance of those theories by taking into account model uncertainty.

To address the issue of model uncertainty, we propose a novel BMA approach that develops an Instrumental Variable Bayesian Model Averaging with priors defined in economic theory space to account for the fact that the strength of several competing theories is

[22]For more information on the BMA estimation see Kass and Raftery (1995) and Raftery, Madigan, and Hoeting (1997).

simultaneously assessed using multiple proxy variables. In particular, our method introduces BMA in linear models with endogenous regressors.

For general government we find decisive evidence for the demography theory, strong evidence for the globalization and political institution theories, positive evidence for Wagner's law, centralization, income inequality and macroeconomic policy theories and weak evidence for the country size and conflict theories. For the central government we find decisive evidence for the macroeconomic policy, income inequality, and demography theories, positive evidence for the centralization, political institution, globalization, and country size theories, and weak evidence for Wagner's law and conflict theories. These results are robust with the variance decomposition and the channels of transmission analyses. Finally, we do not find evidence for the explanation of Rodrik (1998), who suggests that the link between government expenditure and globalization is based on the exposure to risk of the country.

Finally, the investigation of the formation of the components of government expenditure suggests that different categories are affected by different theory. Hence, focusing only on total expenditures can lead us to incomplete and misleading results. That said, there is a a number of theories that affect both total and the various components. Particularly, the demography theory affects both total and the various components of general government and the demography, macroeconomic policy, and political institution theories affects both total and the various components of central government.

## Table 1: Posterior Probability of the Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures and components. Time and country fixed effects (unreported) are included in each model.

| | **Total Expenditure** | **Compensation of Employees** | **Use of Goods and Services** | **General Public Services** | **Defense** | **Public Order and Safety** | **Economic Affairs** | **Health** | **Education** | **Social Protection** | **Public Goods** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: General Government** | | | | | | | | | | | |
| Centralization | 0.805 | 0.032 | 0.207 | 0.021 | 0.011 | 0.006 | 0.032 | 1.000 | 1.000 | 0.421 | 0.994 |
| Conflict | 0.607 | 0.285 | 0.147 | 0.485 | 0.787 | 0.159 | 0.137 | 0.345 | 0.139 | 0.437 | 0.378 |
| Country Size | 0.654 | 0.398 | 0.971 | 0.924 | 0.241 | 0.488 | 0.307 | 0.410 | 0.995 | 0.355 | 0.221 |
| Demography | 0.998 | 0.665 | 0.999 | 0.747 | 0.710 | 0.148 | 0.827 | 0.954 | 0.942 | 0.833 | 1.000 |
| Globalization | 0.956 | 0.369 | 0.984 | 0.205 | 0.159 | 0.304 | 0.486 | 0.047 | 0.946 | 0.815 | 1.000 |
| Income Inequality | 0.796 | 0.372 | 0.737 | 0.348 | 0.240 | 0.034 | 0.977 | 0.335 | 0.173 | 0.929 | 0.150 |
| Macroeconomic Policy | 0.796 | 0.940 | 0.690 | 0.997 | 0.954 | 0.176 | 0.132 | 0.098 | 0.203 | 1.000 | 0.333 |
| Political Institution | 0.953 | 0.557 | 0.354 | 1.000 | 0.703 | 0.175 | 0.192 | 0.164 | 0.882 | 0.858 | 0.499 |
| Wagner's Law | 0.863 | 0.913 | 0.767 | 0.802 | 0.438 | 0.217 | 0.502 | 1.000 | 1.000 | 0.846 | 1.000 |
| **Panel B: Central Government** | | | | | | | | | | | |
| Centralization | 0.899 | 0.980 | 1.000 | 0.578 | 0.020 | 0.388 | 0.036 | 0.095 | 0.824 | 0.023 | 0.561 |
| Conflict | 0.617 | 0.422 | 0.228 | 0.257 | 0.863 | 0.143 | 0.105 | 0.103 | 0.103 | 0.382 | 0.418 |
| Country Size | 0.764 | 0.897 | 0.429 | 0.236 | 0.118 | 0.344 | 0.872 | 0.272 | 1.000 | 0.108 | 0.630 |
| Demography | 0.996 | 0.762 | 0.580 | 0.985 | 0.918 | 0.034 | 0.940 | 0.933 | 0.997 | 1.000 | 0.910 |
| Globalization | 0.813 | 0.541 | 0.391 | 0.067 | 0.207 | 0.038 | 0.938 | 0.459 | 0.593 | 0.142 | 0.317 |
| Income Inequality | 1.000 | 0.675 | 0.253 | 0.170 | 0.854 | 0.376 | 0.582 | 0.699 | 0.119 | 0.574 | 0.550 |
| Macroeconomic Policy | 1.000 | 1.000 | 0.045 | 1.000 | 0.925 | 0.835 | 0.952 | 0.003 | 0.350 | 0.226 | 0.789 |
| Political Institution | 0.853 | 0.831 | 0.999 | 1.000 | 0.488 | 0.828 | 0.538 | 0.511 | 0.894 | 0.654 | 1.000 |
| Wagner's Law | 0.717 | 0.870 | 0.591 | 0.874 | 0.526 | 0.371 | 0.817 | 0.503 | 0.758 | 0.470 | 0.983 |

## Table 2: Posterior Probability of the Determinants

The table provides the IVBMA posterior inclusion probability for the different determinants for general and central government total expenditures and components. Time and country fixed effects (unreported) are included in each model.

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: General Government** | | | | | | | | | | | |
| Centralization | 0.806 | 0.032 | 0.206 | 0.022 | 0.010 | 0.005 | 0.033 | 1.000 | 1.000 | 0.422 | 0.994 |
| Warfare Score | 0.601 | 0.292 | 0.143 | 0.476 | 0.784 | 0.160 | 0.137 | 0.346 | 0.140 | 0.433 | 0.379 |
| Land Area | 0.525 | 0.400 | 0.971 | 0.923 | 0.238 | 0.487 | 0.072 | 0.012 | 0.988 | 0.024 | 0.223 |
| Population | 0.504 | 0.097 | 0.143 | 0.051 | 0.006 | 0.008 | 0.311 | 0.413 | 0.994 | 0.356 | 0.038 |
| Dependency Share $< 15$ | 0.957 | 0.637 | 0.021 | 0.736 | 0.704 | 0.002 | 0.015 | 0.929 | 0.942 | 0.007 | 1.000 |
| Dependency Share $> 64$ | 0.998 | 0.658 | 0.998 | 0.660 | 0.002 | 0.002 | 0.021 | 0.004 | 0.003 | 0.009 | 0.913 |
| Urbanization | 0.014 | 0.557 | 0.022 | 0.646 | 0.704 | 0.002 | 0.810 | 0.003 | 0.867 | 0.007 | 0.010 |
| Population Growth | 0.848 | 0.537 | 0.920 | 0.051 | 0.012 | 0.145 | 0.798 | 0.954 | 0.030 | 0.834 | 1.000 |
| Trade Openness | 0.958 | 0.366 | 0.985 | 0.199 | 0.161 | 0.305 | 0.487 | 0.046 | 0.947 | 0.813 | 1.000 |
| Gross Inequality | 0.798 | 0.369 | 0.741 | 0.347 | 0.243 | 0.034 | 0.976 | 0.337 | 0.171 | 0.929 | 0.148 |
| Central Government Debt | 0.602 | 0.688 | 0.006 | 0.997 | 0.004 | 0.163 | 0.102 | 0.077 | 0.141 | 0.903 | 0.282 |
| FDI Liabilities | 0.736 | 0.930 | 0.691 | 0.041 | 0.008 | 0.169 | 0.004 | 0.094 | 0.196 | 0.977 | 0.320 |
| Inflation | 0.793 | 0.001 | 0.002 | 0.002 | 0.954 | 0.001 | 0.131 | 0.086 | 0.000 | 1.000 | 0.003 |
| Democracy Score | 0.887 | 0.018 | 0.294 | 0.999 | 0.001 | 0.164 | 0.004 | 0.169 | 0.764 | 0.833 | 0.007 |
| Political Competition Index | 0.924 | 0.513 | 0.018 | 0.996 | 0.691 | 0.168 | 0.151 | 0.004 | 0.805 | 0.006 | 0.009 |
| Presidential Systems | 0.132 | 0.072 | 0.056 | 0.190 | 0.653 | 0.159 | 0.018 | 0.009 | 0.877 | 0.744 | 0.035 |
| Plurality Systems | 0.137 | 0.469 | 0.341 | 0.869 | 0.619 | 0.004 | 0.170 | 0.008 | 0.754 | 0.806 | 0.502 |
| Political Rights Index | 0.896 | 0.520 | 0.019 | 0.017 | 0.700 | 0.001 | 0.005 | 0.004 | 0.856 | 0.820 | 0.015 |
| GDP per Capita | 0.868 | 0.910 | 0.766 | 0.808 | 0.437 | 0.217 | 0.499 | 1.000 | 0.999 | 0.847 | 1.000 |
| **Panel B: Central Government** | | | | | | | | | | | |
| Centralization | 0.899 | 0.981 | 1.000 | 0.577 | 0.020 | 0.388 | 0.036 | 0.096 | 0.824 | 0.025 | 0.561 |
| Warfare Score | 0.616 | 0.426 | 0.227 | 0.262 | 0.859 | 0.140 | 0.108 | 0.105 | 0.105 | 0.383 | 0.414 |
| Land Area | 0.550 | 0.055 | 0.427 | 0.018 | 0.074 | 0.007 | 0.856 | 0.008 | 0.949 | 0.109 | 0.633 |
| Population | 0.696 | 0.897 | 0.074 | 0.234 | 0.079 | 0.342 | 0.584 | 0.272 | 1.000 | 0.007 | 0.095 |
| Dependency Share $< 15$ | 0.028 | 0.011 | 0.010 | 0.981 | 0.004 | 0.035 | 0.022 | 0.887 | 0.996 | 0.001 | 0.018 |
| Dependency Share $> 64$ | 0.993 | 0.010 | 0.529 | 0.008 | 0.882 | 0.001 | 0.029 | 0.898 | 0.005 | 1.000 | 0.906 |
| Urbanization | 0.978 | 0.763 | 0.011 | 0.944 | 0.003 | 0.001 | 0.928 | 0.767 | 0.911 | 0.891 | 0.906 |
| Population Growth | 0.073 | 0.040 | 0.545 | 0.062 | 0.917 | 0.001 | 0.904 | 0.018 | 0.997 | 0.902 | 0.039 |
| Trade Openness | 0.814 | 0.542 | 0.392 | 0.065 | 0.210 | 0.039 | 0.938 | 0.464 | 0.592 | 0.134 | 0.315 |
| Gross Inequality | 1.000 | 0.673 | 0.253 | 0.167 | 0.853 | 0.376 | 0.583 | 0.696 | 0.119 | 0.575 | 0.554 |
| Central Government Debt | 0.804 | 1.000 | 0.044 | 0.999 | 0.924 | 0.002 | 0.007 | 0.002 | 0.001 | 0.191 | 0.015 |
| FDI Liabilities | 0.971 | 0.944 | 0.004 | 0.994 | 0.834 | 0.825 | 0.951 | 0.003 | 0.344 | 0.209 | 0.788 |
| Inflation | 1.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.828 | 0.001 | 0.002 | 0.300 | 0.000 | 0.003 |
| Democracy Score | 0.008 | 0.734 | 0.006 | 0.003 | 0.001 | 0.798 | 0.002 | 0.501 | 0.864 | 0.008 | 0.019 |
| Political Competition Index | 0.821 | 0.799 | 0.010 | 0.944 | 0.471 | 0.002 | 0.509 | 0.507 | 0.004 | 0.009 | 1.000 |
| Presidential Systems | 0.777 | 0.061 | 0.999 | 1.000 | 0.020 | 0.756 | 0.035 | 0.468 | 0.888 | 0.040 | 0.983 |
| Plurality Systems | 0.090 | 0.769 | 0.078 | 0.184 | 0.017 | 0.827 | 0.447 | 0.450 | 0.031 | 0.651 | 0.081 |
| Political Rights Index | 0.018 | 0.764 | 0.887 | 0.965 | 0.472 | 0.813 | 0.524 | 0.003 | 0.005 | 0.015 | 0.025 |
| GDP per Capita | 0.719 | 0.868 | 0.595 | 0.873 | 0.525 | 0.367 | 0.822 | 0.508 | 0.759 | 0.474 | 0.983 |

## Table 3: Posterior Mean and Posterior Standard Deviation - General Government

The table provides the IVBMA posterior mean and posterior standard deviation (in parenthesis) for the different determinants for general government total expenditure and components. Time and country fixed effects (unreported) are included in each model. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

| | **Total Expenditure** | **Compensation of Employees** | **Use of Goods and Services** | **General Public Services** | **Defense** | **Public Order and Safety** | **Economic Affairs** | **Health** | **Education** | **Social Protection** | **Public Goods** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Centralization | 0.407 | 0.000 | -0.007 | 0.000 | 0.000 | 0.000 | -0.001 | -0.050*** | -0.047*** | 0.162 | -0.089*** |
| | (0.638) | (0.005) | (0.015) | (0.003) | (0.001) | (0.000) | (0.004) | (0.008) | (0.010) | (0.296) | (0.018) |
| Warfare Score | 0.297 | -0.046 | 0.003 | -0.120 | 0.310 | 0.009 | 0.009 | -0.044 | 0.010 | -0.027 | -0.086 |
| | (0.696) | (0.123) | (0.047) | (0.171) | (0.263) | (0.024) | (0.044) | (0.073) | (0.037) | (0.303) | (0.155) |
| Land Area | 0.343 | -0.078 | 0.510*** | 0.353** | 0.043 | 0.065 | 0.031 | 0.001 | 0.372*** | 0.004 | 0.028 |
| | (0.644) | (0.198) | (0.186) | (0.165) | (0.111) | (0.079) | (0.119) | (0.014) | (0.118) | (0.044) | (0.114) |
| Population | -0.219 | -0.061 | -0.053 | 0.006 | 0.000 | -0.002 | 0.018 | -0.064 | -0.480*** | 0.043 | -0.024 |
| | (0.525) | (0.191) | (0.141) | (0.049) | (0.010) | (0.019) | (0.090) | (0.092) | (0.134) | (0.289) | (0.128) |
| Dependency Share $< 15$ | 0.183 | 0.048 | 0.000 | 0.040 | 0.028 | 0.000 | 0.000 | 0.028 | 0.038*** | 0.000 | 0.159*** |
| | (0.147) | (0.055) | (0.003) | (0.033) | (0.024) | (0.000) | (0.004) | (0.017) | (0.014) | (0.002) | (0.022) |
| Dependency Share $> 64$ | 1.588** | 0.205 | 0.279*** | 0.067 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.031 |
| | (0.767) | (0.185) | (0.085) | (0.076) | (0.002) | (0.001) | (0.012) | (0.003) | (0.002) | (0.007) | (0.069) |
| Urbanization | 0.000 | 0.012 | 0.000 | -0.004 | 0.015 | 0.000 | -0.023 | 0.000 | -0.008 | 0.000 | 0.000 |
| | (0.004) | (0.018) | (0.002) | (0.035) | (0.012) | (0.000) | (0.016) | (0.001) | (0.009) | (0.001) | (0.003) |
| Population Growth | 0.080 | -0.058 | -0.174 | -0.021 | 0.001 | -0.003 | -0.383 | -0.752*** | -0.006 | -0.838 | -3.176*** |
| | (0.993) | (0.369) | (0.408) | (0.130) | (0.018) | (0.042) | (0.319) | (0.266) | (0.048) | (0.625) | (0.555) |
| Trade Openness | 0.399 | 0.006 | 0.025*** | 0.001 | -0.001 | 0.002 | 0.005 | 0.000 | 0.011*** | 0.305* | 0.023*** |
| | (0.459) | (0.009) | (0.007) | (0.004) | (0.006) | (0.002) | (0.007) | (0.001) | (0.004) | (0.184) | (0.005) |
| Gross Inequality | -2.816 | 0.016 | 0.041 | -0.014 | 0.011 | 0.000 | 0.069*** | 0.013 | 0.004 | -0.995** | 0.004 |
| | (1.839) | (0.034) | (0.032) | (0.029) | (0.039) | (0.001) | (0.025) | (0.022) | (0.013) | (0.487) | (0.016) |
| Central Government Debt | 0.008 | -0.005 | 0.000 | 0.042*** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.181 | -0.003 |
| | (0.014) | (0.008) | (0.000) | (0.008) | (0.000) | (0.001) | (0.002) | (0.001) | (0.001) | (0.208) | (0.013) |
| FDI Liabilities | 0.163 | -0.544* | -0.234 | 0.006 | 0.000 | 0.002 | -0.001 | 0.015 | -0.045 | -0.504 | -0.050 |
| | (0.628) | (0.295) | (0.209) | (0.051) | (0.007) | (0.034) | (0.011) | (0.057) | (0.112) | (0.388) | (0.134) |
| Inflation | 1.482 | 0.000 | 0.000 | 0.000 | -0.109* | 0.000 | -0.005 | 0.000 | 0.000 | 1.243*** | 0.000 |
| | (1.084) | (0.000) | (0.000) | (0.000) | (0.057) | (0.000) | (0.014) | (0.002) | (0.000) | (0.304) | (0.000) |

Table continued on next page ...

# Table 3 continued

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Democracy Score | 1.445 | -0.006 | -0.008 | 0.607*** | 0.000 | -0.007 | 0.000 | 0.009 | 0.053 | -0.115 | 0.000 |
| | (1.429) | (0.050) | (0.033) | (0.177) | (0.004) | (0.023) | (0.006) | (0.030) | (0.099) | (0.342) | (0.005) |
| Political Competition Index | 1.620 | 0.021 | -0.005 | -0.908** | 0.085 | 0.015 | 0.006 | 0.001 | 0.136 | 0.001 | 0.001 |
| | (1.110) | (0.150) | (0.045) | (0.377) | (0.098) | (0.048) | (0.036) | (0.014) | (0.169) | (0.023) | (0.014) |
| Presidential Systems | -0.116 | -0.051 | -0.075 | -0.329 | -0.259 | -0.009 | -0.011 | -0.001 | -0.840* | -0.130 | -0.017 |
| | (0.432) | (0.249) | (0.315) | (0.718) | (0.327) | (0.092) | (0.105) | (0.024) | (0.447) | (0.539) | (0.119) |
| Plurality Systems | -0.085 | 0.127 | 0.144 | -0.451 | -0.101 | -0.001 | -0.009 | -0.001 | -0.075 | -0.678 | -0.144 |
| | (0.338) | (0.346) | (0.289) | (0.455) | (0.241) | (0.020) | (0.135) | (0.025) | (0.243) | (0.662) | (0.335) |
| Political Rights Index | 0.977 | 0.181 | -0.003 | 0.001 | 0.298 | 0.000 | 0.000 | 0.000 | 0.444 | 0.453 | -0.002 |
| | (0.883) | (0.328) | (0.037) | (0.045) | (0.250) | (0.003) | (0.015) | (0.009) | (0.348) | (0.510) | (0.028) |
| GDP per Capita | 0.408 | 1.131 | -0.385 | 0.287 | 0.048 | 0.000 | 0.126 | 0.805*** | 0.765*** | 0.808 | 1.541*** |
| | (1.260) | (0.702) | (0.399) | (0.421) | (0.166) | (0.043) | (0.188) | (0.149) | (0.198) | (0.744) | (0.265) |
| Sargan p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 414 | 398 | 398 | 356 | 347 | 281 | 354 | 358 | 358 | 346 | 281 |

## Table 4: Posterior Mean and Posterior Standard Deviation - Central Government

The table provides the IVBMA posterior mean and posterior standard deviation (in parenthesis) for the different determinants for general government total expenditure and components. Time and country fixed effects (unreported) are included in each model. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Centralization | -0.993 | -0.749*** | 0.054*** | 0.030 | 0.000 | 0.006 | 0.001 | 0.002 | 0.040* | 0.000 | 0.040 |
| | (0.738) | (0.242) | (0.011) | (0.029) | (0.002) | (0.008) | (0.004) | (0.006) | (0.022) | (0.002) | (0.039) |
| Warfare Score | -0.190 | 0.158 | -0.027 | -0.039 | 0.155* | 0.008 | 0.002 | -0.006 | 0.002 | -0.070 | -0.200 |
| | (0.615) | (0.351) | (0.070) | (0.105) | (0.086) | (0.025) | (0.032) | (0.026) | (0.029) | (0.116) | (0.367) |
| Land Area | 0.115 | 0.001 | 0.116 | 0.004 | 0.000 | 0.002 | 0.344* | -0.001 | 0.295** | -0.003 | -0.181 |
| | (0.545) | (0.056) | (0.181) | (0.034) | (0.030) | (0.017) | (0.183) | (0.009) | (0.142) | (0.034) | (0.220) |
| Population | -0.660 | -0.664* | -0.031 | -0.037 | -0.003 | -0.053 | -0.065 | -0.033 | -0.672*** | -0.001 | -0.061 |
| | (0.785) | (0.352) | (0.122) | (0.107) | (0.031) | (0.087) | (0.126) | (0.067) | (0.138) | (0.019) | (0.207) |
| Dependency Share $< 15$ | 0.000 | 0.000 | 0.000 | 0.066*** | 0.000 | 0.000 | 0.001 | -0.014 | 0.085*** | 0.000 | 0.000 |
| | (0.006) | (0.002) | (0.002) | (0.024) | (0.001) | (0.001) | (0.004) | (0.020) | (0.032) | (0.001) | (0.002) |
| Dependency Share $> 64$ | 0.519*** | 0.000 | 0.039 | 0.000 | 0.040 | 0.000 | 0.003 | 0.079 | 0.000 | 0.702*** | -0.647 |
| | (0.179) | (0.007) | (0.075) | (0.008) | (0.039) | (0.001) | (0.018) | (0.066) | (0.004) | (0.063) | (0.402) |
| Urbanization | 0.536 | -0.204 | 0.000 | -0.032 | 0.000 | 0.000 | -0.037* | -0.002 | 0.005 | 0.019 | 0.204 |
| | (0.442) | (0.209) | (0.001) | (0.069) | (0.000) | (0.000) | (0.020) | (0.007) | (0.011) | (0.013) | (0.129) |
| Population Growth | -0.002 | 0.000 | 0.181 | -0.023 | 0.653** | 0.000 | -0.428 | -0.002 | -1.374*** | -0.282 | 0.000 |
| | (0.099) | (0.054) | (0.290) | (0.125) | (0.316) | (0.002) | (0.304) | (0.023) | (0.346) | (0.337) | (0.056) |
| Trade Openness | -0.672 | -0.057 | 0.006 | 0.000 | 0.001 | 0.000 | 0.020*** | 0.002 | 0.006 | 0.000 | 0.003 |
| | (0.581) | (0.097) | (0.008) | (0.002) | (0.003) | (0.001) | (0.007) | (0.003) | (0.006) | (0.002) | (0.014) |
| Gross Inequality | 4.225*** | -0.368 | 0.007 | -0.003 | -0.036* | 0.018 | 0.022 | 0.023 | 0.000 | -0.026 | 0.034 |
| | (0.537) | (0.496) | (0.017) | (0.017) | (0.020) | (0.028) | (0.024) | (0.020) | (0.012) | (0.028) | (0.057) |
| Central Government Debt | 0.014 | 1.773*** | 0.000 | 0.032*** | 0.012*** | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 |
| | (0.020) | (0.219) | (0.003) | (0.007) | (0.005) | (0.000) | (0.000) | (0.000) | (0.000) | (0.005) | (0.001) |
| FDI Liabilities | 0.781 | -0.258 | -0.001 | 0.517** | 0.023 | 0.091 | -0.375** | 0.000 | 0.071 | -0.034 | 0.419 |
| | (0.622) | (0.271) | (0.025) | (0.217) | (0.082) | (0.078) | (0.154) | (0.006) | (0.126) | (0.091) | (0.325) |
| Inflation | -2.407*** | 0.000 | 0.000 | 0.000 | 0.000 | -0.015 | 0.000 | 0.000 | -0.001 | 0.000 | 0.000 |
| | (0.549) | (0.000) | (0.000) | (0.000) | (0.000) | (0.013) | (0.000) | (0.000) | (0.003) | (0.000) | (0.000) |

Table continued on next page ...

# Table 4 continued

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Democracy Score | -0.001 | -0.073 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | -0.086 | -0.093 | 0.000 | 0.003 |
| | (0.022) | (0.275) | (0.004) | (0.009) | (0.000) | (0.046) | (0.004) | (0.107) | (0.127) | (0.005) | (0.022) |
| Political Competition Index | 0.469 | 0.563 | 0.000 | -0.005 | 0.057 | 0.000 | 0.052 | 0.176 | 0.000 | 0.000 | 1.524*** |
| | (0.676) | (0.548) | (0.010) | (0.229) | (0.086) | (0.001) | (0.094) | (0.209) | (0.008) | (0.006) | (0.470) |
| Presidential Systems | -0.596 | -0.012 | -1.713*** | -2.921*** | -0.007 | 0.042 | -0.013 | -0.133 | -0.816* | -0.009 | -1.128** |
| | (0.865) | (0.144) | (0.413) | (0.537) | (0.063) | (0.177) | (0.094) | (0.253) | (0.452) | (0.098) | (0.551) |
| Plurality Systems | -0.011 | 0.576 | 0.034 | -0.212 | -0.002 | -0.450* | -0.044 | -0.063 | -0.005 | -0.325 | -0.036 |
| | (0.205) | (0.609) | (0.156) | (0.478) | (0.036) | (0.269) | (0.213) | (0.179) | (0.059) | (0.363) | (0.155) |
| Political Rights Index | 0.003 | 0.236 | -0.006 | -0.618 | 0.118 | 0.136 | 0.206 | 0.000 | 0.000 | 0.001 | -0.009 |
| | (0.068) | (0.534) | (0.158) | (0.484) | (0.174) | (0.111) | (0.256) | (0.006) | (0.010) | (0.018) | (0.066) |
| GDP per Capita | 0.447 | 0.665 | -0.233 | -0.014 | 0.104 | -0.027 | 0.366 | 0.065 | 0.421 | -0.127 | -1.545** |
| | (0.847) | (0.715) | (0.355) | (0.827) | (0.159) | (0.085) | (0.268) | (0.175) | (0.367) | (0.232) | (0.643) |
| Sargan p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 414 | 398 | 398 | 356 | 347 | 281 | 354 | 358 | 358 | 346 | 281 |

## Table 5: Variance Decomposition

The table presents the role of each theory in explaining the variation of the general and central government total expenditures and components, using the Balanced Variance Share (BVS) described in section 4.2.

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: General Government** | | | | | | | | | | | |
| Centralization | 22.63 | 0.00 | 0.91 | 0.01 | 0.00 | 0.01 | 0.05 | 14.16 | 12.42 | 18.92 | 14.47 |
| Conflict | 0.70 | 0.13 | 0.01 | 0.18 | 7.64 | 0.24 | 0.07 | 0.90 | 0.15 | 0.15 | 0.70 |
| Country Size | 0.04 | 1.32 | 0.09 | 1.55 | 0.34 | 1.93 | 0.21 | 0.56 | 7.45 | 0.00 | 0.14 |
| Demography | 40.32 | 6.39 | 21.66 | 0.93 | 5.18 | 4.58 | 4.61 | 1.79 | 14.87 | 8.01 | 3.10 |
| Globalization | 3.36 | 0.83 | 4.37 | 0.10 | 0.22 | 7.53 | 0.76 | 0.03 | 5.27 | 4.60 | 3.42 |
| Income Inequality | 6.67 | 0.15 | 0.30 | 0.22 | 0.62 | 10.03 | 1.07 | 0.37 | 0.04 | 21.82 | 0.01 |
| Macroeconomic Policy | 0.28 | 2.31 | 2.90 | 12.18 | 0.52 | 0.93 | 1.23 | 0.90 | 1.43 | 3.00 | 1.09 |
| Political Institution | 38.33 | 1.00 | 0.36 | 7.52 | 2.38 | 0.49 | 0.02 | 1.27 | 4.67 | 9.75 | 0.47 |
| Wagner's Law | 2.96 | 11.26 | 5.41 | 0.95 | 0.05 | 3.14 | 0.50 | 35.87 | 23.55 | 12.38 | 34.02 |
| Time Fixed Effects | 0.02 | 1.00 | 1.99 | 1.48 | 3.41 | 20.87 | 5.27 | 1.69 | 2.43 | 0.01 | 2.41 |
| Country Fixed Effects | 1.23 | 13.05 | 27.40 | 11.59 | 47.34 | 36.11 | 29.35 | 25.57 | 32.05 | 3.62 | 13.71 |
| **Panel B: Central Government** | | | | | | | | | | | |
| Centralization | 4.66 | 36.91 | 4.24 | 0.30 | 0.01 | 4.68 | 0.09 | 0.01 | 11.75 | 0.04 | 4.38 |
| Conflict | 0.56 | 0.16 | 0.07 | 0.06 | 3.97 | 0.08 | 0.02 | 0.13 | 0.02 | 0.48 | 1.10 |
| Country Size | 1.88 | 8.28 | 0.64 | 0.01 | 0.00 | 4.19 | 3.86 | 0.45 | 13.13 | 0.00 | 3.98 |
| Demography | 32.03 | 3.03 | 0.36 | 3.08 | 4.87 | 0.03 | 10.07 | 22.27 | 7.59 | 82.53 | 4.46 |
| Globalization | 5.71 | 10.44 | 1.56 | 0.00 | 0.54 | 0.32 | 6.46 | 0.94 | 4.92 | 0.02 | 1.27 |
| Income Inequality | 2.87 | 6.45 | 0.16 | 0.03 | 2.05 | 3.67 | 0.94 | 0.12 | 0.04 | 0.83 | 1.05 |
| Macroeconomic Policy | 8.81 | 5.17 | 0.10 | 13.28 | 8.08 | 2.19 | 13.25 | 0.01 | 0.60 | 0.83 | 1.78 |
| Political Institution | 5.94 | 1.45 | 6.24 | 14.26 | 0.41 | 4.69 | 1.69 | 1.95 | 1.46 | 0.88 | 9.60 |
| Wagner's Law | 3.36 | 2.98 | 0.85 | 0.03 | 0.20 | 0.77 | 6.83 | 2.65 | 0.95 | 2.51 | 11.85 |
| Time Fixed Effects | 0.03 | 0.90 | 6.45 | 0.84 | 3.06 | 3.57 | 4.16 | 1.87 | 2.55 | 0.32 | 0.42 |
| Country Fixed Effects | 1.75 | 6.20 | 27.74 | 14.51 | 46.70 | 69.00 | 24.40 | 53.50 | 33.42 | 7.75 | 19.02 |

## Table 6: Channels of Transmission Analysis - Posterior Probability of Theories - Dropping Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures when we exclude the various theories one-by-one. Time and country fixed effects (unreported) are included in each model.

| | $PIP^i$ | $PIP^{i,-j}$ | | | | | | | | | $\Delta PIP^{i,-j}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Theory Drop** | | | | | | | | | **Theory Drop** | | | | | | | | |
| | **Baseline** | **Centralization** | **Conflict** | **Country Size** | **Demography** | **Globalization** | **Income Inequality** | **Macroeconomic Policy** | **Political Institution** | **Wagner's Law** | **Centralization** | **Conflict** | **Country Size** | **Demography** | **Globalization** | **Income Inequality** | **Macroeconomic Policy** | **Political Institution** | **Wagner's Law** |
| **Panel A: General Government** | | | | | | | | | | | | | | | | | | | |
| Centralization | 0.805 | | 1.000 | 0.273 | 0.970 | 0.986 | 0.843 | 0.998 | 1.000 | 0.082 | | 0.195 | -0.532 | 0.164 | 0.181 | 0.038 | 0.192 | 0.195 | -0.723 |
| Conflict | 0.607 | 0.627 | | 0.792 | 0.826 | 0.542 | 0.751 | 0.543 | 0.814 | 0.599 | 0.020 | | 0.185 | 0.219 | -0.065 | 0.144 | -0.064 | 0.207 | -0.008 |
| Country Size | 0.654 | 0.746 | 0.478 | | 0.450 | 0.454 | 0.750 | 0.436 | 0.932 | 0.834 | 0.092 | -0.176 | | -0.204 | -0.200 | 0.096 | -0.218 | 0.278 | 0.180 |
| Demography | 0.998 | 0.996 | 0.974 | 0.975 | | 0.981 | 0.955 | 1.000 | 0.999 | 0.997 | -0.002 | -0.024 | -0.023 | | -0.017 | -0.043 | 0.002 | 0.001 | -0.001 |
| Globalization | 0.956 | 0.981 | 0.701 | 0.359 | 0.173 | | 0.387 | 0.176 | 0.933 | 0.233 | 0.025 | -0.255 | -0.597 | -0.784 | | -0.569 | -0.780 | -0.023 | -0.724 |
| Income Inequality | 0.796 | 1.000 | 1.000 | 0.978 | 0.519 | 0.990 | | 0.415 | 0.958 | 0.995 | 0.204 | 0.204 | 0.182 | -0.277 | 0.194 | | -0.382 | 0.162 | 0.199 |
| Macroeconomic Policy | 0.796 | 1.000 | 1.000 | 0.875 | 0.583 | 1.000 | 1.000 | | 0.793 | 0.999 | 0.204 | 0.204 | 0.079 | -0.213 | 0.204 | 0.203 | | -0.003 | 0.203 |
| Political Institution | 0.953 | 0.991 | 1.000 | 1.000 | 0.804 | 0.963 | 0.956 | 1.000 | | 0.972 | 0.039 | 0.047 | 0.047 | -0.148 | 0.010 | 0.003 | 0.047 | | 0.019 |
| Wagner's Law | 0.863 | 0.817 | 0.888 | 0.917 | 0.985 | 0.865 | 1.000 | 0.809 | 0.709 | | -0.046 | 0.025 | 0.054 | 0.122 | 0.002 | 0.137 | -0.054 | -0.154 | |
| **Panel B: Central Government** | | | | | | | | | | | | | | | | | | | |
| Centralization | 0.899 | | 0.930 | 0.990 | 0.350 | 1.000 | 1.000 | 0.999 | 0.970 | 1.000 | | 0.031 | 0.091 | -0.549 | 0.101 | 0.101 | 0.100 | 0.071 | 0.101 |
| Conflict | 0.617 | 0.982 | | 0.928 | 0.428 | 0.749 | 0.557 | 0.532 | 0.633 | 0.926 | 0.364 | | 0.311 | -0.189 | 0.131 | -0.060 | -0.086 | 0.016 | 0.309 |
| Country Size | 0.764 | 0.219 | 0.565 | | 1.000 | 0.384 | 0.627 | 0.495 | 0.757 | 0.998 | -0.545 | -0.199 | | 0.236 | -0.380 | -0.138 | -0.270 | -0.007 | 0.234 |
| Demography | 0.996 | 0.164 | 0.976 | 0.773 | | 1.000 | 0.951 | 0.593 | 0.634 | 1.000 | -0.832 | -0.020 | -0.223 | | 0.004 | -0.045 | -0.403 | -0.363 | 0.003 |
| Globalization | 0.813 | 0.087 | 0.783 | 0.367 | 0.542 | | 0.961 | 0.945 | 0.483 | 0.870 | -0.726 | -0.030 | -0.447 | -0.271 | | 0.148 | 0.132 | -0.330 | 0.057 |
| Income Inequality | 1.000 | 0.242 | 0.956 | 1.000 | 0.268 | 0.586 | | 0.338 | 0.803 | 0.525 | -0.758 | -0.044 | 0.000 | -0.732 | -0.414 | | -0.662 | -0.197 | -0.475 |
| Macroeconomic Policy | 1.000 | 0.521 | 0.998 | 1.000 | 0.444 | 0.997 | 1.000 | | 0.990 | 0.958 | -0.479 | -0.002 | 0.000 | -0.556 | -0.003 | 0.000 | | -0.010 | -0.042 |
| Political Institution | 0.853 | 0.999 | 0.982 | 0.642 | 1.000 | 0.713 | 0.350 | 1.000 | | 1.000 | 0.146 | 0.129 | -0.211 | 0.147 | -0.140 | -0.503 | 0.147 | | 0.147 |
| Wagner's Law | 0.717 | 1.000 | 0.888 | 0.639 | 0.997 | 0.998 | 0.683 | 1.000 | 0.736 | | 0.283 | 0.170 | -0.079 | 0.280 | 0.281 | -0.035 | 0.283 | 0.019 | |

## Table 7: Channels of Transmission Analysis - Posterior Probability of Theories - Keeping Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures when keeping the various theories one-by-one. Time and country fixed effects (unreported) are included in each model.

| | $PIP^i$ | $PIP^{i,-j}$ | | | | | | | | | $\Delta PIP^{i,-j}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Theory Drop** | | | | | | | | | **Theory Drop** | | | | | | | | |
| | **Baseline** | **Centralization** | **Conflict** | **Country Size** | **Demography** | **Globalization** | **Income Inequality** | **Macroeconomic Policy** | **Political Institution** | **Wagner's Law** | **Centralization** | **Conflict** | **Country Size** | **Demography** | **Globalization** | **Income Inequality** | **Macroeconomic Policy** | **Political Institution** | **Wagner's Law** |
| **Panel A: General Government** | | | | | | | | | | | | | | | | | | | |
| Centralization | 0.805 | | 1.000 | 0.993 | 0.692 | 0.466 | 0.398 | 1.000 | 0.796 | 0.974 | | 0.195 | 0.188 | -0.113 | -0.340 | -0.407 | 0.195 | -0.009 | 0.169 |
| Conflict | 0.607 | 0.656 | | 0.526 | 0.687 | 0.448 | 0.663 | 0.557 | 0.564 | 0.680 | 0.049 | | -0.081 | 0.080 | -0.159 | 0.056 | -0.050 | -0.043 | 0.073 |
| Country Size | 0.654 | 0.994 | 0.610 | | 0.490 | 0.534 | 0.727 | 0.717 | 0.898 | 0.802 | 0.340 | -0.044 | | -0.164 | -0.120 | 0.073 | 0.063 | 0.244 | 0.148 |
| Demography | 0.998 | 1.000 | 0.762 | 1.000 | | 1.000 | 0.857 | 1.000 | 1.000 | 0.703 | 0.002 | -0.236 | 0.002 | | 0.002 | -0.142 | 0.002 | 0.002 | -0.295 |
| Globalization | 0.956 | 0.988 | 0.771 | 0.508 | 0.978 | | 0.132 | 0.970 | 0.519 | 0.582 | 0.032 | -0.185 | -0.448 | 0.021 | | -0.824 | 0.014 | -0.437 | -0.374 |
| Income Inequality | 0.796 | 0.210 | 1.000 | 0.229 | 1.000 | 0.861 | | 0.204 | 0.617 | 0.815 | -0.587 | 0.204 | -0.567 | 0.204 | 0.064 | | -0.592 | -0.179 | 0.019 |
| Macroeconomic Policy | 0.796 | 0.746 | 1.000 | 0.960 | 1.000 | 0.466 | 0.491 | | 0.755 | 0.995 | -0.050 | 0.204 | 0.163 | 0.204 | -0.331 | -0.305 | | -0.041 | 0.199 |
| Political Institution | 0.953 | 1.000 | 0.749 | 0.989 | 0.978 | 1.000 | 0.999 | 1.000 | | 0.966 | 0.047 | -0.204 | 0.037 | 0.025 | 0.047 | 0.047 | 0.047 | | 0.013 |
| Wagner's Law | 0.863 | 0.823 | 0.794 | 1.000 | 0.820 | 0.887 | 1.000 | 0.874 | 0.786 | | -0.040 | -0.069 | 0.137 | -0.043 | 0.024 | 0.137 | 0.011 | -0.077 | |
| **Panel B: Central Government** | | | | | | | | | | | | | | | | | | | |
| Centralization | 0.899 | | 0.932 | 0.745 | 1.000 | 0.986 | 1.000 | 0.918 | 0.999 | 0.963 | | 0.033 | -0.154 | 0.101 | 0.087 | 0.101 | 0.019 | 0.100 | 0.064 |
| Conflict | 0.617 | 0.918 | | 0.659 | 0.629 | 0.619 | 0.720 | 0.786 | 0.606 | 0.466 | 0.300 | | 0.041 | 0.011 | 0.001 | 0.102 | 0.169 | -0.011 | -0.152 |
| Country Size | 0.764 | 0.416 | 0.409 | | 1.000 | 0.939 | 0.897 | 0.709 | 0.890 | 0.581 | -0.349 | -0.355 | | 0.236 | 0.175 | 0.133 | -0.056 | 0.126 | -0.183 |
| Demography | 0.996 | 1.000 | 1.000 | 0.992 | | 1.000 | 0.628 | 0.954 | 0.963 | 0.682 | 0.003 | 0.004 | -0.004 | | 0.004 | -0.368 | -0.042 | -0.034 | -0.314 |
| Globalization | 0.813 | 0.526 | 0.291 | 0.688 | 0.994 | | 0.114 | 0.919 | 0.616 | 0.981 | -0.287 | -0.522 | -0.125 | 0.180 | | -0.699 | 0.106 | -0.197 | 0.168 |
| Income Inequality | 1.000 | 0.271 | 0.493 | 0.880 | 1.000 | 0.721 | | 1.000 | 0.602 | 0.155 | -0.729 | -0.507 | -0.120 | 0.000 | -0.279 | | 0.000 | -0.398 | -0.845 |
| Macroeconomic Policy | 1.000 | 0.988 | 0.995 | 1.000 | 0.999 | 0.536 | 0.960 | | 0.979 | 0.706 | -0.012 | -0.005 | 0.000 | -0.001 | -0.464 | -0.040 | | -0.021 | -0.294 |
| Political Institution | 0.853 | 0.898 | 0.997 | 0.999 | 1.000 | 1.000 | 0.987 | 0.910 | | 1.000 | 0.045 | 0.144 | 0.146 | 0.147 | 0.147 | 0.134 | 0.057 | | 0.147 |
| Wagner's Law | 0.717 | 0.981 | 0.933 | 0.695 | 0.888 | 0.910 | 1.000 | 0.769 | 0.881 | | 0.264 | 0.215 | -0.023 | 0.171 | 0.192 | 0.283 | 0.052 | 0.163 | |

## Table 8: Globalization - Posterior Probability of Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures and components, taking into account the globalization as described in Section 4.4.1. Time and country fixed effects (unreported) are included in each model.

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: General Government** | | | | | | | | | | | |
| Centralization | 0.229 | 0.237 | 0.039 | 0.149 | 0.013 | 0.085 | 0.027 | 0.050 | 0.017 | 0.171 | 0.695 |
| Conflict | 0.489 | 0.662 | 0.363 | 0.340 | 1.000 | 0.253 | 0.230 | 0.112 | 0.239 | 0.413 | 0.470 |
| Country Size | 0.616 | 0.664 | 0.990 | 0.456 | 0.138 | 0.764 | 0.156 | 0.465 | 0.663 | 0.292 | 1.000 |
| Demographic | 0.877 | 0.469 | 0.485 | 0.259 | 0.357 | 0.315 | 0.526 | 1.000 | 0.680 | 1.000 | 0.083 |
| Globalization | 1.000 | 1.000 | 0.747 | 0.876 | 0.075 | 0.606 | 0.105 | 0.516 | 0.174 | 0.355 | 0.042 |
| Income Inequality | 0.349 | 0.915 | 0.771 | 0.178 | 0.252 | 0.087 | 0.996 | 0.907 | 0.832 | 0.282 | 0.829 |
| Macroeconomic | 0.371 | 0.244 | 0.018 | 0.083 | 0.142 | 0.428 | 0.018 | 0.236 | 0.393 | 0.053 | 0.722 |
| Political Institution | 0.586 | 0.822 | 0.969 | 0.784 | 1.000 | 0.656 | 0.923 | 0.385 | 0.233 | 0.327 | 0.813 |
| Wagner's Law | 0.967 | 0.884 | 0.747 | 0.650 | 0.724 | 0.443 | 0.457 | 0.703 | 0.792 | 0.483 | 0.913 |
| **Panel B: Central Government** | | | | | | | | | | | |
| Centralization | 0.863 | 0.254 | 0.018 | 0.138 | 0.009 | 0.944 | 0.057 | 0.069 | 0.916 | 0.061 | 1.000 |
| Conflict | 0.615 | 0.306 | 0.157 | 0.605 | 0.999 | 0.192 | 0.196 | 0.136 | 0.358 | 0.457 | 0.990 |
| Country Size | 0.949 | 0.438 | 0.996 | 0.627 | 0.198 | 0.699 | 0.254 | 0.349 | 0.992 | 0.308 | 0.917 |
| Demographic | 0.964 | 0.379 | 0.329 | 0.531 | 0.058 | 0.219 | 0.554 | 0.037 | 0.346 | 0.540 | 1.000 |
| Globalization | 0.188 | 1.000 | 1.000 | 0.057 | 0.022 | 0.035 | 0.773 | 0.091 | 0.960 | 0.136 | 1.000 |
| Income Inequality | 0.979 | 0.321 | 0.155 | 0.159 | 0.082 | 0.064 | 0.395 | 0.131 | 0.579 | 0.225 | 0.719 |
| Macroeconomic | 1.000 | 1.000 | 0.018 | 0.557 | 0.269 | 0.003 | 0.530 | 1.000 | 0.450 | 0.978 | 0.046 |
| Political Institution | 0.814 | 0.950 | 0.537 | 0.579 | 1.000 | 0.337 | 0.509 | 1.000 | 0.371 | 0.192 | 1.000 |
| Wagner's Law | 0.743 | 0.912 | 0.977 | 0.592 | 0.995 | 0.180 | 0.533 | 0.478 | 0.451 | 0.335 | 0.881 |

## Table 9: Income Inequality - Posterior Probability of Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures and components, taking into account the heterogeneity in income inequality (Section 4.4.2). Time and country fixed effects (unreported) are included in each model.

| | Total Expenditure | Compensation of Employees | Use of Goods and Services | General Public Services | Defense | Public Order and Safety | Economic Affairs | Health | Education | Social Protection | Public Goods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: General Government** | | | | | | | | | | | |
| Centralization | 1.000 | 0.077 | 0.030 | 0.022 | 0.011 | 0.010 | 0.017 | 1.000 | 1.000 | 0.136 | 0.944 |
| Conflict | 0.765 | 0.317 | 0.320 | 0.288 | 0.967 | 0.092 | 0.120 | 0.269 | 0.106 | 0.288 | 0.272 |
| Country Size | 0.956 | 0.242 | 0.997 | 0.620 | 0.116 | 0.113 | 0.295 | 0.196 | 0.553 | 0.141 | 0.953 |
| Demographic | 0.948 | 0.450 | 0.236 | 0.384 | 0.257 | 0.069 | 0.764 | 0.963 | 0.701 | 1.000 | 1.000 |
| Globalization | 0.486 | 0.142 | 0.316 | 0.060 | 0.313 | 0.054 | 0.483 | 0.288 | 0.553 | 0.034 | 0.831 |
| Income Inequality | 1.000 | 0.315 | 0.642 | 0.147 | 0.220 | 0.015 | 0.809 | 0.033 | 0.283 | 1.000 | 0.255 |
| Macroeconomic | 0.381 | 0.848 | 0.557 | 0.917 | 0.004 | 0.988 | 0.041 | 0.016 | 0.023 | 0.056 | 0.404 |
| Political Institution | 0.896 | 0.645 | 1.000 | 0.970 | 0.850 | 0.040 | 0.152 | 0.373 | 0.922 | 0.792 | 0.521 |
| The Wagner's Law | 0.665 | 0.999 | 0.959 | 0.686 | 0.810 | 0.133 | 0.432 | 0.965 | 0.918 | 1.000 | 1.000 |
| **Panel B: Central Government** | | | | | | | | | | | |
| Centralization | 1.000 | 1.000 | 0.173 | 0.796 | 0.009 | 0.244 | 0.097 | 0.140 | 1.000 | 0.020 | 0.690 |
| Conflict | 0.677 | 0.762 | 0.273 | 0.643 | 0.823 | 0.294 | 0.114 | 0.145 | 0.110 | 0.460 | 0.411 |
| Country Size | 0.971 | 0.232 | 0.716 | 0.337 | 0.089 | 0.804 | 0.697 | 0.132 | 1.000 | 0.203 | 0.444 |
| Demographic | 1.000 | 0.229 | 0.382 | 0.531 | 0.159 | 0.112 | 0.979 | 0.959 | 0.166 | 1.000 | 0.908 |
| Globalization | 0.737 | 0.167 | 0.607 | 0.035 | 0.169 | 0.289 | 0.992 | 0.705 | 0.593 | 0.676 | 0.200 |
| Income Inequality | 0.853 | 0.999 | 0.931 | 0.990 | 0.100 | 0.141 | 0.091 | 0.020 | 0.045 | 0.651 | 1.000 |
| Macroeconomic | 1.000 | 0.999 | 0.990 | 1.000 | 0.008 | 0.077 | 0.898 | 0.352 | 0.065 | 0.976 | 0.285 |
| Political Institution | 1.000 | 0.997 | 0.847 | 1.000 | 0.992 | 0.047 | 0.253 | 0.396 | 0.372 | 0.910 | 1.000 |
| The Wagner's Law | 0.785 | 0.997 | 0.850 | 0.667 | 0.580 | 0.189 | 0.491 | 0.365 | 0.603 | 1.000 | 0.823 |

## Table 10: Parameter Heterogeneity - Posterior Probability of Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures and components, taking into account the parameter heterogeneity (Section 4.5.1). Time and country fixed effects (unreported) are included in each model.

| | **General Government** | | | | **Central Government** | | | |
|---|---|---|---|---|---|---|---|---|
| | **High Income** | **Upper Middle Income** | **Lower Middle Income** | **Low Income** | **High Income** | **Upper Middle Income** | **Lower Middle Income** | **Low Income** |
| Centralization | 1.000 | 0.094 | 0.125 | 0.194 | 1.000 | 0.189 | 0.325 | 0.187 |
| Conflict | 0.788 | 0.656 | 0.847 | 0.753 | 0.696 | 0.525 | 0.650 | 0.571 |
| Country Size | 0.452 | 0.447 | 0.779 | 0.769 | 0.857 | 0.468 | 0.638 | 0.673 |
| Demographic | 0.959 | 0.560 | 0.601 | 0.193 | 0.789 | 0.693 | 0.921 | 0.194 |
| Globalization | 0.987 | 0.766 | 0.927 | 0.184 | 0.939 | 0.674 | 0.988 | 0.116 |
| Income Inequality | 0.329 | 0.556 | 0.219 | 0.212 | 0.918 | 0.562 | 0.663 | 0.208 |
| Macroeconomic | 1.000 | 0.995 | 0.380 | 0.421 | 1.000 | 0.753 | 0.167 | 0.534 |
| Political Institution | 0.671 | 0.896 | 0.548 | 0.592 | 0.985 | 0.808 | 0.835 | 0.360 |
| The Wagner's Law | 0.694 | 0.736 | 0.612 | 0.670 | 0.837 | 0.826 | 0.700 | 0.630 |

## Table 11: Prior of the Theories - Posterior Probability of Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures, taking into account different priors. Time and country fixed effects (unreported) are included in each model.

| | General Government | | Central Government | |
|---|---|---|---|---|
| | **One Variable per Theory** | **Each Variable is a Theory** | **One Variable per Theory** | **Each Variable is a Theory** |
| **Centralization** | 0.798 | 0.997 | 1.000 | 1.000 |
| **Conflict** | 0.651 | 0.456 | 0.700 | 0.448 |
| **Country Size** | 0.317 | | 0.921 | |
| Land area | | 0.857 | | 0.318 |
| Population | | 0.825 | | 0.998 |
| **Demographic** | 1.000 | | 1.000 | |
| Dependency share $< 15$ | | 0.732 | | 0.065 |
| Dependency share $> 64$ | | 1.000 | | 1.000 |
| Urbanization | | 0.074 | | 0.052 |
| Population growth | | 0.936 | | 1.000 |
| **Globalization** | 0.229 | 0.960 | 0.188 | 0.029 |
| **Income Inequality** | 0.368 | 0.135 | 0.057 | 0.061 |
| **Macroeconomic** | 0.939 | | 0.750 | |
| Central government debt | | 0.652 | | 0.323 |
| FDI liabilities | | 0.458 | | 0.938 |
| Inflation | | 0.028 | | 0.019 |
| **Political Institution** | 0.406 | | 0.253 | |
| Democracy score | | 0.516 | | 0.331 |
| Political competition index | | 0.999 | | 0.831 |
| Presidential systems | | 0.999 | | 1.000 |
| Plurality systems | | 0.976 | | 0.847 |
| Political Rights index | | 0.928 | | 0.545 |
| **The Wagner's Law** | 0.999 | 0.869 | 0.897 | 0.420 |

## Table 12: Components of the Theories - Posterior Probability of Theories

The table provides the IVBMA posterior inclusion probability for the different theories for general and central government total expenditures. Columns 2 and 4 present the model which trade openness is part of the Macroeconomic theory. Columns 3 and 5 present the model which each variable of the Political Institution theory is a theory by its own. Time and country fixed effects (unreported) are included in each model.

| | **General Government** | | **Central Government** | |
|---|---|---|---|---|
| | **Trade in Macro Theory** | **1-1 Political Institutions** | **Trade in Macro Theory** | **1-1 Political Institutions** |
| Centralization | 1.000 | 0.664 | 1.000 | 0.969 |
| Conflict | 0.431 | 0.640 | 0.483 | 0.501 |
| Country Size | 0.749 | 0.520 | 0.966 | 0.982 |
| Demographic | 0.950 | 0.982 | 0.999 | 0.999 |
| Globalization | | 1.000 | | 0.243 |
| Income Inequality | 0.785 | 1.000 | 0.894 | 0.140 |
| Macroeconomic | 0.994 | 1.000 | 1.000 | 0.819 |
| Political Institution | 1.000 | | 0.791 | |
| Democracy score | | 0.962 | | 0.712 |
| Political competition index | | 0.659 | | 0.659 |
| Presidential systems | | 0.735 | | 0.735 |
| Plurality systems | | 0.520 | | 0.520 |
| Political Rights index | | 0.869 | | 0.869 |
| The Wagner's Law | 0.999 | 0.702 | 0.794 | 0.702 |

# Appendices

## A1 Bayes Factors

In a general framework, incorporating model uncertainty involves considering a collection of candidate models $\mathcal{I}$, using the data $\mathcal{D}$. Each model $I$ consists of a collection of probability distributions for the data $\mathcal{D}$, $\{pr(\mathcal{D}|\psi), \psi \in \Psi_I\}$ where $\Psi_I$ denotes the parameter space for the parameters of model $I$ and is a subset of the full parameter space $\Psi$.

By letting the model become an additional parameter to be assessed in the posterior, we aim to calculate the posterior model probabilities given the data $\mathcal{D}$. By Bayes' rule

$$pr(I|\mathcal{D}) = \frac{pr(\mathcal{D}|I)pr(I)}{\sum_{I' \in \mathcal{I}} pr(\mathcal{D}|I')pr(I')}, \tag{A1}$$

where $pr(I)$, denotes the prior probability for model $I \in \mathcal{I}$.

The integrated likelihood $pr(\mathcal{D}|I)$, is defined by

$$pr(\mathcal{D}|I) = \int_{\Psi_I} pr(\mathcal{D}|\psi)pr(\psi|I)d\psi, \tag{A2}$$

where $pr(\psi|I)$ is the prior for $\psi$ under model $I$, which by definition has all its mass on $\Psi_I$.

One possibility for pairwise comparison of models is offered by the Bayes factor (BF), which is in most cases defined together with the posterior odds (Kass and Raftery (1995)). The posterior odds of model $I$ versus model $I'$ is given by $\frac{pr(I|\mathcal{D})}{pr(I'|\mathcal{D})} = \frac{pr(\mathcal{D}|I)}{pr(\mathcal{D}|I')}\frac{pr(I)}{pr(I')}$, where $\frac{pr(\mathcal{D}|I)}{pr(\mathcal{D}|I')}$ and $\frac{pr(I)}{pr(I')}$ denote the Bayes factor and the prior odds of $I$ versus $I'$, respectively.

When the integrated likelihood (A2) and thus, the BF can be computed directly, a straightforward method for exploring the model space, Markov Chain Monte Carlo Model Composition (MC3), was developed by Madigan and York (1995).

MC3 determines posterior model probabilities by generating a stochastic process that moves through the model space $\mathcal{I}$ and has equilibrium distribution $pr(I|\mathcal{D})$. Given the current state $I^{(s)}$, MC3 proposes a new model $I'$ according to a proposal distribution $q(\cdot|\cdot)$, calculates

$$\alpha = \frac{pr(\mathcal{D}|I')pr(I')q(I^{(s)}|I')}{pr(\mathcal{D}|I^{(s)})pr(I^{(s)})q(I'|I^{(s)})}$$

and sets $I^{(s+1)} = I'$ with probability $\min\{\alpha, 1\}$ otherwise setting $I^{(s+1)} = I^{(s)}$.

It should be stressed that moving between models via the MC3 approach constitutes a valid MCMC transition. This feature is critical in the development below, in that MC3 moves may be nested inside larger structures in a manner similar to Gibbs updates.

## A2 Determining the CBF calculations

Here we outline the calculation of $pr(\mathcal{D}|M_r, \boldsymbol{\beta}_{-r}, \boldsymbol{K})$. Note that

$$pr(\mathcal{D}|M_r, \boldsymbol{\beta}_{-r}, \boldsymbol{K}) = \int_{\Lambda_{M_r}} pr(\mathcal{D}|\boldsymbol{\beta}_r, \boldsymbol{\beta}_{-r}, \boldsymbol{K}) pr(\boldsymbol{\beta}_r|M_r) d\boldsymbol{\beta}_r$$

Let $\boldsymbol{X}_{r,M_r}$ be the submatrix of $\boldsymbol{X}_r$ associated with the variables in $M_r$ and set $\tilde{\boldsymbol{Y}}_r$ as above. Then

$$\int_{\Lambda_{M_r}} pr(\mathcal{D}|\boldsymbol{\beta}_r, \boldsymbol{\beta}_{-r}, \boldsymbol{K}) pr(\boldsymbol{\beta}_r|M_r) d\boldsymbol{\beta}_r \propto \int_{\Lambda_{M_r}} (2\pi)^{-|M_r|/2} \exp\left(-\frac{1}{2}\left[-2\hat{\boldsymbol{\beta}}_{M_r}\boldsymbol{\Omega}_{M_r}\boldsymbol{\beta}_r + \boldsymbol{\beta}_r'\boldsymbol{\Omega}_{M_r}\boldsymbol{\beta}_r\right]\right) d\boldsymbol{\beta}_r.$$

where $\Omega_{M_r} = K_{rr}\boldsymbol{X}_{r,M_r}'\boldsymbol{X}_{r,M_r} + \mathbb{I}_{|M_r|}$ and $\hat{\boldsymbol{\beta}}_{M_r} = K_{rr}\boldsymbol{\Omega}_{M_r}^{-1}\boldsymbol{X}_{r,M_r}'\tilde{\boldsymbol{Y}}_r$.

We can now see that the term in the integral is the canonical form of a Gaussian distribution. Appropriate completion therefore yields

$$pr(\mathcal{D}|M_r, \boldsymbol{\beta}_{-r}, \boldsymbol{K}) \propto |\Omega_{M_r}|^{-1/2} \exp\left(-\frac{1}{2}\hat{\boldsymbol{\beta}}_{M_r}'\boldsymbol{\Omega}_{M_r}\hat{\boldsymbol{\beta}}_{M_r}\right).$$

## A3 Priors in Theory Space

The simplest prior that corrects for mulitiplicity issues simply divides each theory by its size. In particular

$$pr(M_{rt}) = \frac{1}{2^{p_{rt}} - 1} pr(\gamma_{rt} = 1)$$

Since there are $2^{p_{rt}} - 1$ models in $\mathcal{M}_{rt}$ we see that this prior places equal probability on each model in $\mathcal{M}_{rt}$ while still presevering the structure that theory $t$ has total prior probability $pr(\gamma_{rt} = 1)$. Since this prior probability can be explicitly stated, it should be noted the model search procedures discussed above could function with minor modifications.

In practice, multiple measurements that represent the same theory are likely to be highly correlated and various priors have been proposed which account for this feature. Let $\varsigma_{M_{rt}} = |C_{M_{rt}}|$ be the determinant of the correlation matrix $C_{M_{rt}}$ defined by $\boldsymbol{X}_{r,M_{rt}}$. The dilution prior of Durlauf, Kourtellos, and Tan (2011) is defined by

$$pr(M_{rt}) = \frac{\varsigma_{M_{rt}}}{\sum_{M'_{rt} \in \mathcal{M}_{rt}} \varsigma_{M'_{rt}}} pr(\gamma_{tr} = 1) \tag{A3}$$

We note that this construction still preserves the feature that the total probability of theory $t$ is $pr(\gamma_{rt} = 1)$ but places different weights on each model in $\mathcal{M}_{rt}$ according to the degree to which the constituent variables are correlated, with greater weight placed on sets of less correlated variables.

This construction is worthwhile to consider, but complicates the straightforward implementation of the IVBMA algorithm discussed in Section 2.2. This is because, in general, the denominator of (A3) is unknown and thus when attempting to transition from a model $M_{rt} \in \mathcal{M}_{rt}$ to $\emptyset$ (i.e. the model where theory $t$ is not entertained) would require the evaluation of this denominator.

## A4 Assessing Instrument Validity

Let $\{\boldsymbol{\theta}^{(1)}, \ldots, \boldsymbol{\theta}^{(S)}\}$ be an MCMC sample of $pr(\boldsymbol{\theta}|\mathcal{D})$ and $\{\boldsymbol{\varsigma}^{(1)}, \ldots, \boldsymbol{\varsigma}^{(S)}\}$ be the associated realization of $\boldsymbol{\varsigma}$ from each MCMC draw. This draw then enables us to approximate (2.13) with $\int pr(J_0|\boldsymbol{\varsigma}, \mathcal{D})pr(\boldsymbol{\varsigma}|\mathcal{D})d\boldsymbol{\varsigma} = \frac{1}{S}\sum_{s=1}^{S} pr(J_0|\boldsymbol{\varsigma}^{(s)}, \mathcal{D})$.

Note that $pr(J_0|\boldsymbol{\varsigma}^{(s)}, \mathcal{D}) = \frac{1}{1+\frac{pr(J_1|\boldsymbol{\varsigma}^{(s)},\mathcal{D})}{pr(J_0|\boldsymbol{\varsigma}^{(s)},\mathcal{D})}}$ and therefore we have reduced the problem of assessing $pr(J_0|\mathcal{D})$ to that of evaluating a number of CBFs. At this juncture, note that

$$pr(J_0|\varsigma^{(s)}, \mathcal{D}) \propto pr(\varsigma^{(s)}|J_0, \mathcal{D})pr(J_0) = \int_0^\infty pr(\varsigma^{(s)}|\tau, \mathcal{D})pr(\tau)d\tau pr(J_0),$$

while

$$pr(J_1|\varsigma^{(s)}, \mathcal{D}) \propto pr(\varsigma^{(s)}|J_1, \mathcal{D})pr(J_1) = \int_0^\infty \int_{\mathbb{R}^q} pr(\varsigma^{(s)}|\tau, \boldsymbol{\xi}, \mathcal{D})pr(\boldsymbol{\xi}, \tau)d\boldsymbol{\xi}d\tau pr(J_1).$$

Evaluation of these integrals therefore, requires the specification of priors $pr(\tau)$ under $J_0$ and $pr(\boldsymbol{\xi}, \tau)$ under $J_1$. Under model $J_0$, we propose the standard prior $\tau \sim \Gamma(1/2, 1/2)$ which yields

$$pr(J_0|\varsigma^{(s)}, \mathcal{D}) \propto \left(\frac{1}{2} + \frac{\boldsymbol{\varsigma}^{(s)\prime}\boldsymbol{\varsigma}^{(s)}}{2}\right)^{-(n+1)/2}. \tag{A4}$$

For $J_1$ we use the prior $\tau \sim \Gamma(1/2, 1/2)$ and $\boldsymbol{\xi}|\tau \sim \mathcal{N}(0, \tau^{-1}\mathbb{I}_q)$ which yields

$$pr(J_1|\varsigma^{(s)}, \mathcal{D}) \propto |\Xi|^{-1/2} \left(\frac{1}{2} + \frac{(\varsigma^{(s)} - \boldsymbol{Z}\hat{\boldsymbol{\xi}}^{(s)})'(\varsigma^{(s)} - \boldsymbol{Z}\hat{\boldsymbol{\xi}}^{(s)})}{2}\right)^{-(n+1)/2} \tag{A5}$$

where $\boldsymbol{\Xi} = \tau(\boldsymbol{Z}'\boldsymbol{Z} + \mathbb{I}_q)$ and $\hat{\boldsymbol{\xi}} = \tau\boldsymbol{\Xi}^{-1}\boldsymbol{Z}\boldsymbol{\varsigma}^{(s)}$.

### A4.1 Extensions to Generalized Linear Models

The developments in Sections 2.1 and 2.2 implicitly assume a continuous response with Gaussian errors. However, in the context of a random effects framework, it is straightforward to extend these developments to alternative sampling models. Let $g$ be a link function such that for the response $Y_i$, $E[Y_{i1}] = g^{-1}(\boldsymbol{X}_i 1' \boldsymbol{\beta}_1 + \epsilon_{i1})$ while the remaining $Y_{ir}$ have forms given by (2.3) and the residual vector $bs\epsilon_i$ remains distributed according to a $\mathcal{N}(0, \boldsymbol{K}^{-1})$ distribution. The term $\epsilon_{i1}$ is no longer observable (even when $\boldsymbol{\beta}_1$) and is often referred to as a random effect. However, in a Gibbs sampling framework these factors may be incorporated in additional parameters to be determined in the posterior. Therefore, we now aim to determine the posterior distribution $pr(\{M^{(r)}\}_{r=1}^R, \{\boldsymbol{\beta}_r\}_{r=1}^R, \boldsymbol{K}, \boldsymbol{\epsilon}_1|\mathcal{D})$. Appendix A5 shows how such an MCMC can be conducted in the case where $Y_i$ is has a Poisson likelihood.

# A5 Posterior Determination in the Poisson Case

Let $Y_{i1} \sim \mathcal{P}\left(\boldsymbol{X}_i r' \boldsymbol{\beta}_i + \epsilon_{i1}\right)$ and for $r > 1$ $Y_{ir} = \boldsymbol{X}_i r' \boldsymbol{\beta}_r + \epsilon_{ir}$. Finally, $\boldsymbol{\epsilon}_i \sim \mathcal{N}(0, \boldsymbol{K}^{-1})$.

The MCMC for this model roughly follows that of the methods above, but with the additional handling of the random effect $\epsilon_{i1}$ and the subsequent updating of $\boldsymbol{\beta}_1$. Note that $pr(\epsilon_{i1}|\cdot) \propto pr(Y_i|\boldsymbol{X}_{i1}, \boldsymbol{\beta}_1, \epsilon_{i1}) pr(\epsilon_{i1}|\boldsymbol{\epsilon}_i \setminus \epsilon_{i1}, \boldsymbol{K})$ where $pr(\epsilon_{i1}|\boldsymbol{\epsilon}_i \setminus \epsilon_{i1}, \boldsymbol{K}) = \mathcal{N}(\eta_i, \kappa_i^{-1})$ with $\eta_i = -\sum_{r=2}^R \frac{K_{1r}}{K_{11}} \epsilon_{ir}$ and $\kappa_i = \frac{1}{K_{11}}$.

Further, denote $\mu_i = \boldsymbol{X}_{i1}' \boldsymbol{\beta}_1$. Then

$$pr(\epsilon_{i1}|\cdot) \propto \exp\left(-\exp(\mu_i + \epsilon_{i1}) + (\mu_i + \epsilon_{i1})Y_{i1}\right) \exp\left(-\frac{1}{2}\kappa_i(\epsilon_{i1} - \eta_i)^2\right).$$

Writing $f(\epsilon_{i1}) = -\exp(\mu_i + \epsilon_{i1}) + (\mu_i + \epsilon_{i1})Y_{i1} - \frac{1}{2}\kappa_i(\epsilon_{i1} - \eta_i)^2$ we have $f'(\epsilon_{i1}) = -\exp(\mu_i + \epsilon_{i1}) + Y_{i1} - \kappa_i(\epsilon_{i1} - \eta_i)$ and $f''(\epsilon_{i1}) = -\exp(\mu_i + \epsilon_{i1}) - \kappa_i$

Hence, by setting $b(\epsilon_{i1}) = f'(\epsilon_{i1}) - f''(\epsilon_{i1})\epsilon_{i1}$ and $c(\epsilon_{i1}) = -f''(\epsilon_{i1})$ we may sample $\epsilon_{i1}' \sim \mathcal{N}(b(\epsilon_{i1})/c(\epsilon_{i1}), 1/c(\epsilon_{i1}))$ and accept this update with probability $\min\{\alpha, 1\}$ where

$$\alpha = \frac{pr(Y_{i1}|\mu_i, \epsilon_{i1}') pr(\epsilon_{i1}'|\eta_i, \kappa_i) pr(\epsilon_{i1}|b(\epsilon_{i1}'), c(\epsilon_{i1}'))}{pr(Y_{i1}|\mu_i, \epsilon_{i1}) pr(\epsilon_{i1}|\eta_i, \kappa_i) pr(\epsilon_{i1}'|b(\epsilon_{i1}), c(\epsilon_{i1}))}.$$

Once all $\epsilon_{i1}$ are updated, all other updates essentially follow the steps above.

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