Fiscal Federalism and Economic Growth in OECD Countries: A Bayesian Model Averaging Approach

Zareh Asatryan* **and Lars P. Feld**
Albert-Ludwigs-Universität Freiburg, Germany

Abstract

This paper examines the empirical relationship between sub-national governments' real fiscal autonomy and the rate of economic growth using a new panel dataset of 42 variables for 23 OECD countries from 1975 to 2000. In the analysis Bayesian Model Averaging is applied, which provides a coherent mechanism to test the robustness of the estimates: i) when there is an inclusion uncertainty over a considerable number of candidate growth determinants, often leaving most researchers to choose their explanatory variables on an arbitrary basis; and ii) when the economic theory provides relatively weak guidance on channels through which fiscal decentralization should affect growth. The results indicate that: i) the aggregate effects of fiscal federalism have no robust impact on growth rates, neither positive and nor negative, when the measure of fiscal federalism is limited to the share of tax revenues, over which sub-national governments administer full autonomy; and ii) consistent with empirical and theoretical growth models, the most robust growth determinants are gross capital formation, government spending, price of investment goods, inflation, external trade position and fertility rate.

JEL-Classification: H77, H73, E62, C11.
Keywords: Fiscal Federalism, Economic Growth, Bayesian Model Averaging.

Draft Version: November 2011

* Corresponding Author: European Centre of Economic Research, L7 1, 68161 Mannheim, Germany. Email: asatryan@zew.de, Tel.: 0049 621 1235 392.

Acknowledgements: Zareh Asatryan gratefully acknowledges Bengt-Arne Wickström, Franz Hubert, Ulrich Thießen, Armine Khachatryan, Martin Feldkircher, Francois Laisney and seminar participants at Humboldt University Berlin, Social Science Research Center Berlin (WZB) and Centre for European Economic Research (ZEW) for valuable comments on earlier versions of this research project.

1. Introduction

A couple of decades ago decentralization used to be a matter of marginal importance for public economics scholars and policy makers around most governments. Countries were constitutionally divided into federal or unitary systems and there were hardly any political or economic initiatives for restructuring (Tanzi 2000). This was the post-World War II period, characterized with rapid growth in public spending. The resulted large governmental involvement in the economy eventually raised concerns over its efficiency. Starting from 1970's, the academic debate on public economics has gone beyond Paul Samuelson's, Kenneth Arrow's and Richard Musgrave's Keynesian perspectives. Since then, public economists have been intensively searching for un-utilized sources to enhance the performance of public sectors, which was partially due to a reaction against large governments (Tanzi 2008). Among these new considerations, the issue of optimal allocation of authority between different government layers quickly came to prominence in the academic debate, as major programs to shift decision-making away from the center and closer to people started to appear in reform agendas of many governments.

Today the evolving public sector is exposed to two sharply contrasting forces (Oates 2005). On one hand, we see in both industrialized and developing nations widespread efforts to decentralize, as countries seek to develop more efficient governance systems by bringing decision-making closer to the citizens. In the United States, the national government has turned back considerable amount of central authority to the states (Oates 2002). In the United Kingdom, the establishment of Welsh and Scottish regional assemblies was a significant shift towards local power (Oates 1999). Recognizing the benefits of localized preferences has led to major movements toward decentralization in Italy, Spain and other OECD countries. On the other hand, in Europe we witness centralization processes that shift policy-making to new supra-national layers of government, namely the European Union (Oates 2002).

Hence, the multi-level government architecture is increasingly taking a more complex character. Nevertheless, one thing is clear; these processes have significantly reduced the role of national governments. Moreover, understanding the economic implications of the change in basic responsibilities of various government layers turned out to be an extremely delicate, but interesting and important task for public economists and researchers concentrating on the field of fiscal federalism (henceforth: FF). Motivated by this same reasoning one of the 'fathers' of this research area Wallace E. Oates not so long ago wrote: "These are fascinating times for the study of fiscal federalism".

Up to this point, we have developed a general concept, decentralization, which is commonly viewed as a shift of authority towards local governments and away from central governments, with total government authority over society and economy imagined as fixed. This typical characterization of decentralization has many economic and political dimensions. However, attempts to define and measure decentralization have primarily focused on fiscal and to a lesser extent on policy and political authority (Rodden 2002). We also remain on this track and, henceforth, narrow our focus on the fiscal side of decentralization. The difference in fiscal assignments between government layers attracts much academic and policy attention, because the lower-level governments

are lacking a very important policy tool compared to the central government. Decentralized governments face hard budget constraints: they have neither the capacity to create money, nor access to unlimited credit. In a federal system if the central government controls the common currency, then lower-level governments will be limited to fiscal instruments and will not have access to the "soft" option of monetized debt (Oates 1999).

It is obvious that decentralization may have a large set of various economic and non-economic effects. In this study we will examine the effects of decentralization on economic performance. It is important to analyze the growth dimension of FF for two reasons. First, enhancing economic growth is often cited as a major objective of FF (Oates 1989). Secondly, one of the most important functions of many governments is to adopt policies that lead to a sustained increase in income levels. In fact, a very central question in economics is (Bahl and Linn 1992): what causes economic growth and thus prosperity for the people of the World? In that context, it is important to recognize which level of government contributes more to economic growth (Davoodi and Zou 1998).

Recently, many benefits have been claimed for federalist institutions, generating a growing demand for increasing degrees of FF. It is widely accepted to be part of a reform package to improve efficiency in the public sector and, thus, to stimulate economic growth (Davoodi and Zou 1998). In fact, the World Bank has come to be known as a prominent supporter of FF with a recent statement: "Decentralization of government is a pivotal force that will shape global development policy in the twenty-first century" (Schwarcz 2002).

And so, decentralization is being promoted by well-meaning interest groups, often reacting to highly centralized regimes, as well as by influential international agencies. But, there is also substantial skepticism, especially from the practitioners' side. Tanzi (1995) writes: "there is a danger, that decentralization may be perceived by policy makers, especially donors, as the latest mantra – the magic potion to cure many government problems." So the question is: does it work? Can it really serve as a superior policy tool for achieving higher growth rates?

Economists have developed a wealth of theories to explain the causes of FF on economic growth. Earliest theoreticians to address the issue were Tiebout (1956), Musgrave (1959) and Oates (1972). Whereas, the first empirical analyses on the direct impact of FF on economic growth appeared only in 1990's with Oates (1994) and Davoodi and Zou (1998).

According to Breuss and Eller (2004), the uncertain results of empirical papers may be interpreted as the theoretical trade-off construction that reflects the various gains and drawback of FF. We take a different position. The empirical estimations had crucial limitations and cannot be very reliable. This paper aims at enhancing our understanding of the empirical linkage between FF and economic growth by shedding light on some of the major shortcomings of the previous literature.

In particular, there are two central issues that we address. The first challenge of empirical estimations was to find an accurate measure of the prevailing degree of FF. This turned out to be an extremely delicate task. Almost all empirical studies used International Monetary Fund's Government Finance Statistics (IMF-GFS) to quantify FF by computing the ratio of sub-national government's expenditure and revenue to the total government's expenditure and revenue. In the data section we show that these GFS measures do not properly identify sub-central government's

real fiscal autonomy, because they do not distinguish between sub-central government's real functions and administrative duties, a task that is tightly regulated by the central government. We attempt to tackle these issues by adopting a new panel dataset for 23 OECD countries from 1975 to 2001, which supposedly captures the 'true' amount of sub-central autonomy. The data goes back to OECD (1999) which differentiates tax revenue according to the degree of autonomy that the sub-central government posses over the associated tax rates and tax bases. However, this data was originally available for 19 OECD countries only for 1995. Fortunately, Stegarescu (2005) took the important job to extend the dataset to a panel of 23 OECD countries from 1975 to 2001 by using the same OECD (1999) logic, but taking into account time varying fiscal restructurings in these 23 governments.

The second major shortcoming is that the theoretical foundations of FF's impact on economic growth have in principal remained under-developed and have, therefore, limited the legitimacy of the empirical work (Breuss and Eller 2004). The relative absence of guidance from economic theory on channels through which FF should affect growth left most researchers to choose their explanatory variables on an arbitrary basis. Moreover, these studies do not sufficiently involve new results of the empirical growth theory (Breuss and Eller 2004). The vast amount of literature on the determinants of economic growth has identified over 60 or more variables to have explanatory power and has accordingly developed new methodological approaches of analyzing such amount of regressors, in the extreme cross-country cases even exceeding the number of observation. Ironically, FF has never had its place among these determinants of economic growth. Furthermore, what is surprising is that the empirical FF, by definition closely being linked to empirical growth literature, did not follow these newest trends. Hence, our second purpose is to contribute to the existing decentralization literature by applying the refinements of the growth empiricism.

The remainder of this paper is organized as follows. In the next section we briefly review the existing theoretical and empirical literature. Section 3 discusses the measurement challenges of FF and the debate on the determinants of economic growth, and describes the data. In section 4 we, first intuitively, then in a more formal manner describe the analytical framework of the empirical analysis. Section 5 presents our empirical findings and discusses their implications. Finally, the last section concludes and offers several directions for future research.

2. Literature Review

2.1. Theoretical Literature

This chapter assesses the theoretical FF literature from the prospective of its impact on economic development. We depart from the pioneering work of Oates (1972) to shape the central trade-off

facing the theory: the benefits from making decisions at appropriate levels versus the costs of duplicating efforts[1].

Decentralization is a complicated phenomenon, but the economic theorists generally agree that decentralization leads to more efficient provision of public services by better resource allocation and a more productive and possibly smaller public sector. Practitioners' perspective, on the other hand, is somewhat different and conservative to some extent. Many argue, that if countries are not already committed to decentralization, they should consider alternatives to it (Ahmad and Tanzi 2002). Such skepticism is based on the argument that decentralization is often a response to failed macroeconomic policies, while the solution may be to improve the current policies, for instance skewed or inefficient spending.

A first and most recognized economic argument in favor of FF is the Oates' (1972) 'decentralization theorem'. The theorem states that the marginal benefits of public service differ in diverse communities due to the difference in their demand schedules. Hence, the level of social welfare can be increased if Pareto-efficient levels of public good consumption are provided in each jurisdiction in accordance with local demands than if any single, central level of consumption is preserved across all of the diverse communities. The magnitude of gains from decentralization increases with both the divergence of preferences and heterogeneity in cost conditions across regions.

The benefits of differentiation, however, are based on two central assumptions of the decentralization theorem: i) the central government is itself unable to differentiate appropriately (Oates 1972), due to information asymmetry (local governments possess better knowledge of local costs and preferences) and political pressures or constitutional constraints (which prevent the central government from providing diverse levels of public output to different regions), and ii) the population will ensure the matching of preferences of local communities and local governments (Tiebout 1956); only mobile households can choose a jurisdiction of residence according to their individual needs of public output and fiscal package and so ensure a first-best outcome, which would not be relevant in a unitary system of governance.

A second and perhaps the best studied effect is the induced vertical (central vs. sub-central) and horizontal (among lower levels) competition between different layers of governments. Whereas, they may well behave as profit maximizers to the detriment of taxpayers, competition among government levels may prevent such revenue maximization (Brennan and Buchanan 1980), i.e. the 'Leviathan restraint' hypothesis. Its immediate implication is that, competing governments will have an additional incentive to set more benevolent objectives (rather than profit maximization), such as maintaining optimal tax systems, inducing efficient production of public goods and services and, most importantly, avoiding excessive governmental regulation (horizontal competition and vertically shared fiscal responsibilities imply that no government has monopoly power over economic

[1] An essay-style paper from Oates (1999) intuitively presents the historical development of this field. Additionally, Oates (2005) is an excellent reference for the most recent trends and future projections of, as he puts, the emerging second generation theory of fiscal federalism.

regulation any more)[2]. However, just like in the case of the decentralization theorem, the 'Leviathan restraint' hypothesis also relies on capital and labor mobility assumption. Decentralization can constraint the lower units in their attempts to place political limits on economic activity, only in the case where resources are free to move to other jurisdictions (Weingast 2004)[3]. In countries with de facto fragmented national markets, the positive outcomes of the Leviathan hypothesis will diminish significantly, because, given hard budget constraints, sub-national governments can rely on excessive quasi-fiscal regulation to meet their expenditure objectives (Ahmad and Tanzi 2002)[4].

In addition to the decentralization theorem and the Leviathan restraint hypothesis, FF has many other, less conventional, dimensions. One argument, that was absent in Oates' decentralization theorem, but came to prominence with the rise of political economy is that FF enhances economic development through improved government accountability, strengthened social capital and more political participation (see for instance McNab 2001). FF is also considered to enhance institutional quality and promote democracy by reducing the concentration of political power and weakening the influence of vested interests on public policy. Fukasaku and DeMello (1999) argue that FF promotes economic performance by enhancing macroeconomic stability, whereas, Ter-Minassian (1997) points to the significant costs associated with insuring macroeconomic stability through FF.

While the traditional FF literature seems to be weighed with pro-decentralization arguments, there have been significant considerations on the potential risks of decentralization recently. First, the concerns over the validity of the 'decentralization theorem' are growing, as research is failing to prove the comparative advantage of sub-national governments over the national government in terms of being a better differentiator (Prud'homme 1995).

Secondly, contrary to the macroeconomic stability and government accountability hypotheses, poorer regions may be at a further disadvantage in delivering efficient policies, are more likely to promote a lower quality of government decisions and more corruption (Ahmad and Tanzi 2002). The reason is that especially in countries with unevenly developed communities, local institutions lack human resources and the adequate expertise to implement competent policies and organize efficient governance[5]. Moreover, richer regions have the advantage of extracting more resources, either through using their greater political influence to negotiate with the national government for more shared revenues or through the taxation of their own citizens (Rodrigues-Pose and Ezcurra 2010). Local governments are also more likely to be influenced by special-interest groups and, thus, promote corruption, nepotism and clientelism (Rodriguez-Pose and Ezcurra 2010).

---

[2] A whole line of empirical and theoretical literature emerged to show the inverse relation between FF and government size; see Rodden (2003) for an overview.

[3] Weingast (1995) calls this 'Market Preserving Federalism'.

[4] Although, this typically happens in poorer countries with a weaker tradition of respect for free markets (China, Russia and to some extend India), high income OECD countries are also not guaranteed from some autonomous subnational jurisdictions implementing aggressive protectionist policies in the extreme case (e.g. like Spain, Italy or Belgium).

[5] For instance, a trivial explanation is that the brightest people tend to join the national government where their long-run career interests and salaries tend to be higher (Tanzi 1995).

Finally, the well-known scale argument may also be well relevant. As soon as large economies of scale are implicated, especially in cases of infrastructure provision, lower governmental layers may be too small to efficiently deliver these public goods and services (Prud'homme 1995). The benefits of centralized provision are thus expected to be superior for capital intensive goods, where large amount of investment is required to facilitate per-unit low costs of delivery (Rodriguez-Pose and Ezcurra 2010).

2.2. Empirical Literature

With the growing interest on FF among academic scholars and practitioners, many empirical studies on the effects of FF on economic growth have appeared in the last decade, which, however, yield conflicting results. They do not grant clear-cut evidence whether there is such a relation at all, how strong it is, and whether the effect is positive or negative[6]. Existing empirical papers virtually fit every possible theoretical position (Rodriguez-Pose and Ezcurra 2010). The reason behind such inconclusiveness is that the impact of decentralization on growth has hardly been analyzed in a systematic manner (Feld et al 2009). Each paper basically analyzes a different dataset with various measures of decentralization and with diverse methodologies.

Davoodi and Zou (1998) have created one of the most prominent works in the field, because they have developed a comparatively more solid analytical framework which is often used by other authors as a starting point. They depart from a neoclassical production function with two inputs: private capital and public spending, and analytically show that what matters for growth is not only total public spending, but also how this spending is allocated among different layers of the government. Therefore, growth can be maximized by optimal reallocation of fiscal spending without altering the total budget's share in GDP. Their empirical results show a negative, but weakly significant effect of GFS's expenditure decentralization on economic growth for developing countries and no clear relationship for developed countries in the period from 1970 to 1989.

Iimi (2005) uses a similar methodology to extend the analysis to 1997–2001. He reports a significantly positive relation and concludes that FF has become a determinant of growth starting in the late 1990's. A major limitation of this study is that Iimi does not take into account FF's long term effects, instead he carries out the analysis on an annual basis.

Woller and Phillips (1998) report no significant relationship between the ratios of sub-national revenues and expenditure to total revenue and expenditure using annual and five-year averaged data for 1974–1991 for 23 developed and developing countries. They additionally hypothesize that the process of FF has a historical tendency to increase and so, they consider a common time trend variable.

Thornton (2007) reports a statistically insignificant effect in a cross-country study on 19 OECD countries. Although his findings have merely marginal importance due to the small number of observations, a major contribution is the first attempt to improve the measure of FF. In

[6] Feld et al (2009) presents a detailed literature review, followed by a literature meta-analysis, which does not show a strong FF-growth relation.

particular, he adopts data on decentralization measures from a 1999 OECD tax policy study (OECD 1999), where the extent of real revenue autonomy of sub-central governments is evaluated by identifying the amount of sub-central government's tax revenue over which they had autonomy to determine the tax rate and the tax base.

Baskaran and Feld (2009) continue this line of research by using similar measures of FF, but for a panel data of 23 OECD countries from 1975 to 2001. The data comes from Stegarescu (2005), who adopts the principles suggested by OECD (1999) and by considering cross-time changes in the assignment of decision-making competencies (e.g. tax reforms effecting vertical division of fiscal authority) constructs a new panel dataset. Baskaran and Feld (2009) initially find a negative relation, but show that this effect is not robust, when the measure of FF is limited to the revenues over which sub-national governments have 'full' autonomy.

Rodriguez-Pose and Ezcurra (2010) is another recent study focusing on OECD during the period between 1990 and 2005. A major contribution is that they are looking at decentralization from a multi-dimensional perspective: They find that GFS's FF negatively affects growth, whereas the influence of the two other dimensions of decentralization, political and administrative decentralization, on economic growth is weaker and sensitive to the measurement.

Studies that have reported a significantly positive impact of FF on growth include Yilmaz (2000), who distinguished between unitary and federal states in a panel study of 46 countries with 1971 to 1990 annual data, and found that FF had a positive and statistically significant impact on growth in unitary states, but none in federations.

Thiessen (2003) uses an averaged cross-sectional data of high-income OECD economies for 1973–1998 and a panel of 26 countries for the period from 1981 to 1995 in a companion study (Thiessen 2003a). He finds an inverse U-shaped non-linear relationship between FF and growth.

Enikolopov and Zhuravskaya (2003) additionally consider institutional aspects in a 1978-2003 cross-section averaged data of 21 developed and 70 developing countries. They report that for the developing countries in particular, the strength of national political parties significantly improves the outcomes of FF, whereas administrative subordination (i.e. appointing local politicians rather than electing them) weakens the effects of FF.

3. Data

Over the last two decades the rapidly growing literature on cross-country growth empiricism has proposed a huge, around 150[7], number of variables as growth determinants. The starting point of our selection criterion is to gather data for 23 OECD countries from 1975 to 2000, a sample, for which reliable measures of decentralization are available. Secondly, our methodology requires a strictly balanced panel. The third constraint is the potential danger of multicollinearity, therefore we have eliminated variables that had strong pairwise correlation with those capturing a similar phenomenon.

[7] See Durlauf et al (2005) for an overview of these variables.

With these restrictions, we are able to construct a dataset consisting of a total of 42 variables[8]. The dependent variable is the annual growth rate of GDP per capita measured in two distinct ways. In the main part of the analysis we use PPP-adjusted growth rates from Penn World Tables (PWT), but, to check for the robustness of the results, we also adopt growth measured in constant local currency based on national accounts data from World Banks's World Development Indicators (WB-WDI). The next two sections describe the two (and one in quadratic form) measures of fiscal decentralization, three measures of political decentralization and the remaining 32 (and two in quadratic form) economic control variables entering our regression. Since we will be interested in FF's long-term structural effects on economic performance (rather than short-run fluctuations), from the annual panel we derive our dataset of five-year averages, and thus 115 observations.

3.1 Measuring Decentralization

In recent years, many studies have attempted to quantify the impact of FF. However, decentralization is difficult to measure (Rodden 2004, Ebel and Yilmaz 2002). In vast majority of the studies examining the relationship between FF and macroeconomic performance, the degree of FF is measured by the share of state and local governments' expenditure and/or revenue in those of the total government (ExpDCT and RevDCT). The primary data source for these measures is the IMF's Government Finance Statistics (GFS).

Despite its merits and popularity among researchers, concerns are rising over these widely used measures of FF recently, as they fail to provide enough confidence among researchers to be a useful composite measure of decentralized authority. Particularly, they severely overestimate fiscal independence of sub-central governments (see figure 2) by failing to make an appropriate distinction between the real fiscal autonomy and the sub-central government's organizational activities. This is what Thornton (2007) calls "substantive" and "administrative" decentralization. For instance, although GFS provides a breakdown of expenditure by function and economic type, the measure of expenditure decentralization makes no distinction between state or local governments' 'own-decision' spending and those tightly regulated by the center. Similarly, revenue decentralization makes no distinction between sub-central government's own sources of grants, tax and non-tax revenues.

Joumard and Kongsrud (2003) and Darby et al (2003) show that central government's imposed limits on the sub-national governments' ability to decide on tax rates and tax bases significantly reduces the true sub-national fiscal autonomy. In a 1999 tax policy study the OECD measured the extent of revenue autonomy of sub-central governments in 19 OECD member countries for 1995 by identifying the amount of their tax revenue over which the sub-central governments had autonomy to determine the tax rate and the tax base. Thornton (2007) was the first to apply these datasets to empirical FF research; however his results had only a marginal contribution due to the small sample size. Stegarescu (2005) adopts the principles suggested by OECD (1999) to construct a panel dataset of 23 OECD countries in the time period between 1975 and 2001, by taking into

[8] Appendix 1 presents the summary statistics, sources and explanations of the data.

account cross-time changes in the assignment of decision-making competencies (e.g. tax reforms) and by running the same procedure for additional four OECD countries.

The OECD (1999) study classifies different categories of taxes in terms of the class of autonomy they provide to sub-national governments. In the case of tax categories (a) to (c) sub-central government has total control over its taxes (SCG has the authority to set the tax rate and/or the tax base) and in the case of revenue sharing categories (d.1) to (d.2) it has limited, but still significant control (SCG itself or partly with the CG co-decides on splitting the revue). Whereas for tax revenue categories (d.3) to (e) the sub-central government's tax autonomy is limited or non-existent.

Table 1: Classification of tax revenue (in decreasing order of control over revenue sources)

a) SCG sets tax rate and tax base
b) SCG sets tax rate only
c) SCG sets tax base only
d) tax sharing arrangements
d.1) SCG determines revenue-split
d.2) revenue-split can only be changed with consent of SCG
d.3) revenue-split fixed in legislation, may unilaterally be changed by central government
d.4) revenue-split determined by central government as part of the annual budget process
e) central government sets rate and base of SCG tax.

Source: OECD (1999)

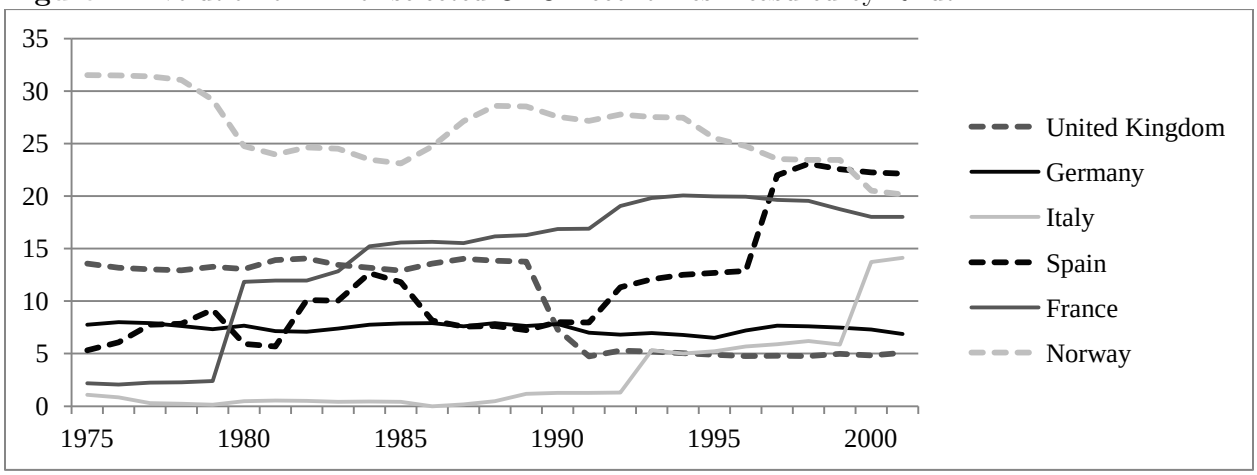
From the above classification two measures of FF can be defined: Revenue autonomy of first degree and a softer Revenue autonomy of second degree, which additionally considers shared tax revenues:

$$RAut1 = \frac{\text{SCG own tax rev (a) to (c)} + \text{non tax \& } capital\ revenue}{\text{GG total tax rev} + \text{non tax \& } capital\ revenue}$$

$$RAut2 = \frac{\text{SCG own tax rev (a) to (c)} + \text{shared tax rev (d. 1)to(d. 2)} + \text{non tax \& } capital\ revenue}{\text{GG total tax rev} + \text{non tax \& } capital\ revenue}$$

The latter two measures, although valuable, are not without their critiques. Particularly, they do not address the important issue of how the revenue of shared taxes is allocated (OECD 1999). Moreover, horizontal and vertical intergovernmental grants are not captured by the OECD (1999) and Stegarescu (2005) studies. This is due to the fact that intergovernmental grants are not reported as tax sharing arrangements, since provided grants are counted as expenditure in the budget of the dispensing government unit and as a grant in the budget of the receiving government unit (rather than shared taxes). Finally, the extent of cross-country consistency of Stegarescu (2005)'s methodology is still to be evaluated.

Figure 1: Evolution of FF for selected OECD economies measured by RAut1.

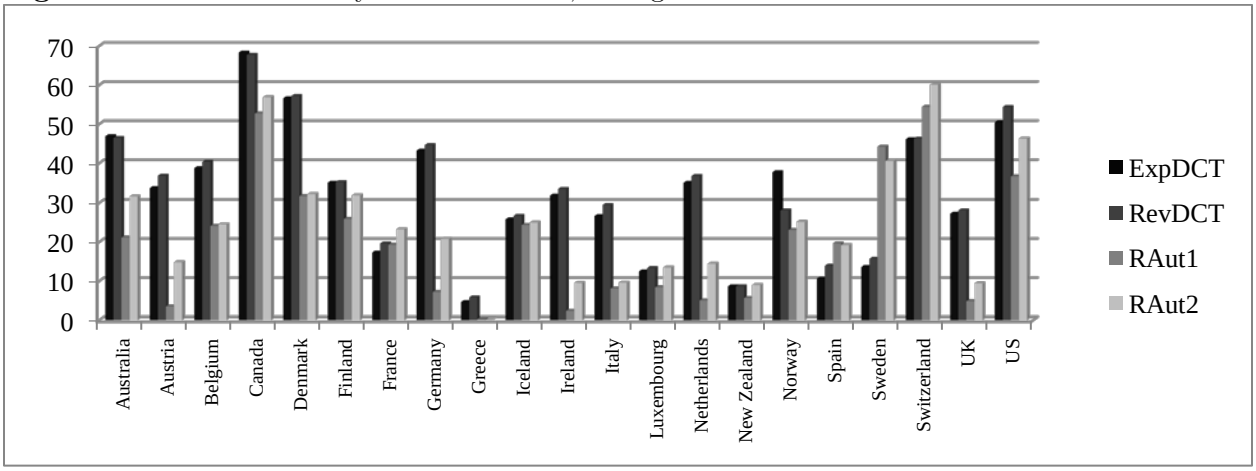


Source: Own calculations based on data from Stegarescu (2005).

Figure 1 presents the evolution of FF measured by RAut1 for selected economies. Governments of Italy, Spain and France significantly shifted their fiscal power towards lower governmental layers, whereas Norway and Finland (not reported) became more centralized. Germany stagnated at a low 7.4% average level. This is probably due to the fact, that the intermediate level of the Länder (States) has no power to directly change tax bases or tax rates autonomously. However, the Länder do have a strong position in the tax law-making process, as the Federal government (the 'Bund') needs the majority of the 'Bundesrat' (the second chamber of Parliament, an elected body representing the Länder) to pass any legislative changes on the tax laws affecting the Länder (OECD 1999). Note also that in Germany the RAut2 measure also did not suffer any shocks remaining at an average of 21.5%, 14 percentage points higher than RAut1. This is twice as high as the sample average of the difference of the two measures and is the result of the intensive use of revenue sharing mechanisms: the Länder have a 50% share in the corporate income tax and the withholding tax on interest and dividends, 44% share in value added tax, 42.5% share in the revenue of the wage withholding tax and, finally, they keep 5% of the revenue from the local business tax (OECD 1999).

Figure 2 graphically illustrates i) the variation of FF between 21 OECD countries, and ii) the within country correlation among the four basic FF measures based on GFS and Stegarescu data. By construction, both measures of revenue autonomy should always be below the GFS's measure of RevDCT indicating that the GFS data is severely overestimating the degree of SNG autonomy. However, this does not hold for the entire sample demonstrating that the two datasets are not robust to each other and, thus, should be treated with care, when used jointly.

Figure 2: Four cross-country measures of FF, averaged over 1995-2001.



Source: Own calculations based on data from IMF-GFS and Stegarescu (2005).

3.2. Determinants of Economic Growth

At the explanatory side, in addition to the two measures of revenue autonomy, we include three measures of political decentralization and 32 economic control variables, which are briefly discussed below.

In 2010 the WB's Database of Political Institutions, for the first time, has updated its database to include federalism variables (Keefer 2010). These are three dummy variables that ask whether a country has any autonomous regions and whether the municipal and state governments (executive and legislative) are elected (see Rodden (2004) for an overview of measures of political decentralization)[9].

The first economic control variable that enters into our model is the level of per capita GDP at each period. The convergence hypothesis of neoclassical growth models is that growth is negatively related to the initial level of per capita GDP[10].

Human capital plays a special role in a number of endogenous growth models. In Romer (1990) human capital is the key input to the research sector. Lucas (1988) draws attention on the adoption of new technologies facilitated by a highly skilled workforce. Barro (1991) argues that human capital reduces fertility rates. As proxies for human capital we take 11 variables: labor participation rate, proportion of population under 15 and (separately) over 65, an indicator of life

[9] While, political federalism is not the primary concern of this paper and we do not necessarily expect them to be significant determinants of growth, we do believe in the importance of these variables. To the best of our knowledge, DPI has not yet been used in the empirical literature of fiscal federalism, and so we would like to underline the existence of this recent data, since it is the only measure of political federalism available for such a large sample.

[10] Recent critiques of the neo-classical growth model have brought forward the concept of conditional convergence, i.e. a relation between growth rate and initial conditions after controlling for other variables (see for example Bassanini and Scarpetta, 2001).

expectancy at birth and seven measures of education, i.e. primary, secondary and tertiary school enrollment and completion rates, percentage of no schooling and average schooling years in total population.

The rate of accumulation of physical capital has been empirically proven to be one of the main factors determining the level of output in OECD countries (Bassanini and Scarpetta 2001). For physical capital we take three proxies: the gross capital formation, investment and the net inflows of foreign direct investment. Healthy financial systems are also hypothesized to contribute to economic growth. We take lending interest rate, the average rate charged by banks on loans to prime customers, assuming that accessibility to cheap money positively affects capital accumulation and, thus, economic growth.

In a macro perspective we control for several important aspects. On the monetary side, the standard arguments for lower and more stable inflation rates are reduced economic uncertainty and improved efficiency of the price mechanism (Barro 1990, Bassanini and Scarpetta 2001). To control for the economic benefits of exploiting comparative advantages of foreign trade and other gains of economic integration we adopt the share of the sum of exports and imports in GDP as a proxy for economic openness (Frankel and Romer 1999). Concerning the two latter arguments, there has been considerable debate on the non-linearity of the growth-inflation (Sarel 1995) and growth-openness (Crespo-Cuaresmo and Doppelhofer 2003) relations; therefore we also include the quadratic forms of the two variables. To control for macroeconomic distortions in the economy we adopt the share of government spending in GDP (Barro 1991, Levine and Renelt 1992) and the price level of investment (Easterly 1993). We take current account balance to check whether strong exports and external trade surpluses boost economic growth (Kormendi and Meguire1985). The last macroeconomic variable that enters our regression is the share of consumption in GDP, which captures changes in demand (Moral-Benito 2011).

There are number of demographic and geographic variables that are important to control for as well. Empirical growth literature frequently showed that population growth rate and average fertility rate are negatively correlated to growth. A common argument is that increased resources must be devoted to child rearing rather than to production and investment. The percentage of urban population is taken to control for the economic costs and benefits of increasing city sizes. Area, population and population density are variables to control for scale effects and as proxies for remoteness we take the fraction of land area near navigable water and the air distance from New York, Rotterdam or Tokyo.

Last but not least, there are another two well-known obstacles of economic development: the military burden and the so called paradox of plenty. We include the level of military spending, since they can distort efficient allocation of resources and crowd-out private investment (Aizenman and Glick 2003). To test the resource curse hypothesis, we adopt the share of fuel and mining in total merchandise exports (Sachs and Warner 1996).

4. Analytical Framework

Over the last two decades, hundreds of empirical studies have attempted to identify the factors explaining the differences in growth rates. This line of research is heavily influenced by seminal works from Kormendi and Meguire (1985), Grier and Tullock (1989) and Barro (1991), which have identified a substantial number of variables that are partially correlated with the rate of economic growth (Sala-i-Martin et al 2004). Among these fiscal policies are also said to be a significant determinant of economic growth. Researchers typically include the level of public spending or taxing systems as proxies for fiscal policy, but they did not pay attention on the assignment of fiscal responsibilities to various vertical layers of the government structure. The empirical literature on FF attempts to show that this division of fiscal power actually matters for growth. In particular, Davoodi and Zou (1998) depart from Barro (1990)'s model to show that for a given share of total government spending in GDP, a reallocation of public spending among different levels of government affects economic growth. Therefore, as long as the actual level of FF is different from the growth maximizing one, an optimal decision of FF can lead to higher rates of economic growth.

The basic analytical framework usually departs from Davoodi and Zou (1998) to regress GDP growth on different measures of FF and on a vector of country characteristics. The problem faced by this line of empirical growth economists is that growth theories are not explicit enough about what independent variables belong in the 'true' regression (Sala-i-Martin 1997). The relative absence of guidance from economic theory as to which variables to include in the regressions, resulted in a new series of papers trying to tackle this issue. A particularly contentious issue was the robustness of growth regression methods, which was first addressed by Levine and Renelt (1992) and later on works by Sala-i-Martin (1997 and 1997a), Fernandez et al (2001), Sala-i-Martin et al (2004) and others contributed to accounting for model uncertainty in estimation procedures.

The problem in empirical FF literature is similar to the one in empirical growth literature: the usual approach of selecting a particular model and building conclusions on this single model underestimates uncertainty over quantities of interest, as it ignores the ambiguity over model size and form (Raftery 1995).

Surprisingly, while the growth literature has paid considerable amount of attention to the issue of model uncertainty, decentralization literature has exceptionally relied on traditional estimation techniques.

We use the method developed by Fernandez et al (2001) and applied by Fernandez et al (2001a) to tackle the issue of model uncertainty. The idea is to apriori declare that the 'true' model is unknown, which immediately implies a departure from the classical methodology in which conditioning on a specified model is essential. Consequently, instead of traditional conditioning, the employed Bayesian inference attaches probabilities to all possible models. This method has been recently referred to as 'Bayesian Model Averaging' (henceforth: BMA) [11].

[11] See Hoeting et al (1999) for an overview of the statistics of the Bayesian Model Averaging techniques and its applications.

More formally, with k possible explanatory variables we will have 2^k possible combinations of regressors, i.e. 2^k different models, each model denoted by M_j for j = 1, 2, …,2^k. Now consider the linear growth regression M_j:

$$y_{it} = \alpha^j + \beta^j x_{it}^j + \sigma\varepsilon_{it} \qquad (1)$$

where the dependent variable y is a vector of per capita GDP growth rates of $i = 1,\ldots,n$ countries and $t = 1,\ldots,T$ years, α^j is the intercept of model M_j, x_{it}^j is the jth combination of k regressors with β coefficients, ε_{it} are the error terms following an n-dimensional Normal distribution with σ as a scale parameter.

The starting point of the Bayesian Model Averaging approach is to assign some probability of being the 'true' model to each of the large number of models M_j, i.e. the researcher has to subjectively choose prior distributions for the three parameters α, β^j and σ. The appropriate choice of these distributions is currently a widely debated topic in applied statistics, as it can potentially impact the posterior model probabilities[12]. Fernandez et al (2001a) tackle this issue by proposing a 'benchmark' prior distribution, which, they claim, has modest influence on posterior inference and predictive results. They make an additional conjecture, by assuming that the variance parameter has a common prior across different models, i.e. the residual standard deviation of y given the full set of regressors X is constant across models. In particular, for the intercept α and the variance parameter σ, Fernandez et al (2001) propose a common, improper and non-informative prior:

$$p(\alpha, \sigma) \propto \sigma^{-1} \qquad (2)$$

For the prior of the slope parameters β_j, Fernandez et al (2001) use Zellner's (1986) g-prior structure. The prior of β_j, $p(\beta_j|\alpha, \sigma, M_j)$, equals to the density function of a Normal distribution on β_j with zero mean and covariance matrix: $\sigma^2(gX'_jX_j)^{-1}$, where $g = 1/\max\{nT, k^2\}$[13].

Once we have specified the sampling and prior setting under model M_j, we only need to define the prior distributions for each of the models M_j. In particular, Fernandez et al (2001) assume that every model has the same uniform distribution over the whole model space, i.e. apriori each model has equal probability of being the true one:

$$P(M_j) = p_j = 2^{-k}, \quad \sum_{j=1}^{2^k} p_j = 1 \qquad (3)$$

The posterior distribution of any randomly chosen subset of regressors of quantity Δ is the weighted average of the posterior distributions of that quantity in each model with weights given by the posterior model probabilities, $P(M_j|y)$. Thus:

$$P_{\Delta|y} = \sum_{j=1}^{2^k} P_{\Delta|y,M_j} P(M_j|y) \qquad (4)$$

---

[12] The impact of the specification of the prior distribution is indeed one of the main reasons for Bayesian inference remaining relatively unpopular among researchers (Sala-i-Martin et al 2004). On the other hand, however, contribution of the prior distribution to the posterior mean and variance in on the order of the inverse of the sample size (Raftery 1995), i.e. in the order of $(1/621)^{th}$ in our case.

[13] See Ley and Steel (2009) for a recent discussion of the effects of prior assumptions (including the one proposed by Fernandez et al 2001) on posterior inference.

Equation (4) is the central BMA argument. For a given choice of regressors this formula gives the posterior distribution of parameters. Hence, it is straightforward to say that the marginal posterior probability of a certain variable to belong to the 'true' model is simply the sum of the posterior probabilities of all models that hold this regressor.

Now we turn to the point of computing the posterior model probabilities, namely $P(M_j|y)$, which, to put intuitively, is the probability of model M_j being the true model conditional on our information set, i.e. given our data. The logic of Bayesian inference suggests that given the prior model probability$P(M_j)$, we can derive the posterior model probability using the famous Bayes' Rule:

$$P(M_j|y) = \frac{f(y|M_j)P(M_j)}{f(y)} \qquad (5)$$

where $f(y|M_j)$ is the marginal (or integrated) likelihood of model M_j and $f(y)$ is the average of the marginal likelihoods over all possible models weighted by the prior model probability:

$$f(y|M_j) = l_y(M_j) = \int p\left(y\middle|\alpha,\beta_j,\sigma,M_j\right)p(\alpha,\sigma)\,p\left(\beta_j\middle|\alpha,\sigma,M_j\right)d\alpha\,d\beta_j\,d\sigma \qquad (6)$$

$$f(y) = \sum_{h=1}^{2^k} l_y(M_h)p_h \qquad (7)$$

This ratio of integrated likelihoods, also in statistical literature commonly referred as Bayes factor, will serve as the weighting scheme as it gives more weight to the models that are more likely to be close to the 'true' model (Sala-i-Martin 1997). Also note, that the derived Bayes factor is closely related to the likelihood ratio statistic in classical econometrics.

Fernandez et al (2001a) show that the derived marginal likelihoods can be analytically computed, and, therefore, posterior model probabilities in equation (5) are known. However, k=40 independent variables produce a huge, computationally prohibitive, set of models. To escape multicollinearity, RAut1 and the three quadratic terms in the sample enter the regression separately, thus we allow every possible subset of the remaining k=36 independent variables to enter the model. The number of different possible linear models is 2^{36}; that is around seventy billion regressions. Evaluation of all these regressions is computationally prohibitive and, thus, we, similar to most authors, adopt Markov Chain Monte Carlo (MCMC) techniques of Model Composition (MC^3) to solve this numerical problem[14].

Our use of BMA is a step forward compared to Fernandez et al (2001)'s applications, in a sense that we extend the BMA approach to a panel dataset. First, the analysis gains from the additional information of the within country variation, while at the same time maintaining the large set of independent variables. Secondly, the use of panel data fixed effects methods allows tackling the issue of unobserved heterogeneity across countries.

In particular, we are interested in studying country and time fixed effects models. According to the Frisch-Waugh-Lovell theorem (Lovell 2008), we can get these models by estimating the demeaned data, i.e. subtract from each observation the within country mean to get the country fixed effects and for the case of time fixed effects, similarly, subtract from each observation the mean across countries per period.

[14] See Madigan and York (1995) for the MC^3 methodology or the computational appendix of Moral-Benito (2011) for its application to Fernandez et al (2001).

5. Analysis and Results

We run BMA estimations for three models: pooled, time fixed effects (TFE) and country fixed effects (CFE), so first some general properties. All the estimations are based on two million recorded iterations after a burn-in of one million discarded drawings of the Markov Chain Monte Carlo Model Composition (MC^3) sampler. The posterior model probabilities (PMP) based on MCMC frequencies and the exact marginal likelihoods are perfectly correlated. The first column of each model shows the posterior inclusion probabilities (PIP) for each of the hypothesized determinants of growth; that is the sum of the posterior probabilities of all models that hold this regressor. The second column, posterior mean (PM), reports the weighted average of the regressors' coefficients and since it is not straightforward to interpret the coefficients that had been averaged over many models of different size and form, we will be mainly interested in the sign, rather than the value of the posterior mean.

Table 2 plots the results of the BMA estimation of TFE and pooled models, each for two dependent variables: per capita GDP growth adjusted for purchasing power parity (PPP) from PWT 7.0 and based on constant local currency (CLC) from WDI. The estimation includes seven additional variables that are omitted from the country fixed effects models, due to zero or very low time variance. These include three geographical variables (area, navigable water and direct distance), the three measures of political federalism (low time variance) and military expenditure (data is available only for 1988-2000, thus we take averages).

In general, the TFE models have very low explanatory power, due to the restrictively small number of countries and the country specific unobserved heterogeneity. A good strategy in assessing our results would be their comparison to other cross-country growth studies that use a similar methodological approach. If we are to take Fernandez et al (2001) as a benchmark, the obvious conclusion would be that, given the relatively small number of countries in the sample, the cross-country variation of our homogenous sample of high income countries is not enough to reliably assess the significance of the hypothetical determinants of growth that we are interested in. On the other hand, our estimation does not contradict to Fernandez et al (2001)'s results, since the variables that appear to have high PIPs in their estimation are usually phenomena that hold significant gap between high income countries and the developing world, e.g. life expectancy, initial GDP, fraction of Muslim population, dummy for Sub-Saharan Africa etc.

Another interesting observation is the difference between the two estimations using different measures of growth. In the second model with growth rates measured at constant local currency distance from large trade centers (0.49), share of population under 15 years of age (0.47) and population density (0.42) have much higher PIPs than in the case where the dependent variable is PPP adjusted.

Among these is also the measure of revenue autonomy of first degree with 0.39 PIP and a negative PM. However, the value of its PIP is still modest to argue for a negative decentralization-growth relation; it is more likely, that the significance of this relation would vanish in a model with more powerful economic control variables, given the significant cross-country variation of RAut1.

Table 2: BMA estimation of Time Fixed Effects and Pooled models.

	Time FE				**Pooled Data**			
	GDP (ppp)		**GDP (clc)**		**GDP (ppp)**		**GDP (clc)**	
	PIP	PM	PIP	PM	PIP	PM	PIP	PM
RAut1	0.16	0.00	0.39	-1.05	0.13	-0.26	0.20	-0.50
Consumption/GDP	0.75	-5.65	0.73	-5.70	0.50	-3.89	0.39	-2.94
Openness	0.22	0.08	0.22	0.08	0.21	0.09	0.24	0.10
Pop_15	0.21	1.77	0.47	4.70	0.03	0.15	0.06	0.37
Life_exp	0.20	-0.04	0.12	-0.02	0.02	0.00	0.02	0.00
Tot_School_years	0.12	-0.02	0.18	-0.03	0.04	0.00	0.04	0.00
Dir_Distance	0.10	-0.03	0.49	-0.25	0.03	-0.01	0.10	-0.04
Investment/GDP	0.09	0.55	0.17	1.25	0.25	2.38	0.43	4.36
Capital/GDP	0.08	0.59	0.11	0.87	0.07	0.55	0.06	0.48
Invest_price	0.08	0.00	0.05	0.00	0.18	0.00	0.20	0.00
Pop_density	0.07	0.00	0.42	0.00	0.03	0.00	0.09	0.00
Gov_consump/GDP	0.06	-0.50	0.04	-0.30	0.07	-0.65	0.05	-0.41
Current Account Balance	0.05	0.37	0.05	0.41	0.10	0.93	0.09	0.90
Urban	0.05	-0.07	0.05	-0.08	0.04	-0.06	0.05	-0.08
State_elect	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.02
Labor_force	0.04	-0.12	0.04	-0.16	0.02	-0.02	0.03	-0.06
FDI/GDP	0.03	0.16	0.04	0.22	0.25	2.70	0.25	2.63
Prim_School_att	0.03	0.03	0.04	0.05	0.02	0.01	0.02	0.00
GDP p.c.	0.03	0.01	0.04	0.02	0.05	0.03	0.06	0.05
Tert_School_att	0.03	-0.03	0.05	-0.11	0.02	0.02	0.02	0.01
Area	0.03	0.00	0.02	0.00	0.03	0.00	0.03	0.00
Sec_School_comp	0.02	-0.02	0.03	-0.04	0.02	-0.01	0.02	-0.01
Sec_School_att	0.02	-0.01	0.02	0.00	0.02	-0.01	0.02	0.00
Prim_School_comp	0.02	0.00	0.02	0.00	0.02	-0.02	0.03	-0.05
Ln_Population	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00
Pop_65	0.02	0.00	0.01	0.00	0.02	-0.02	0.02	-0.01
Resource_export	0.02	0.00	0.02	-0.02	0.02	-0.01	0.02	-0.01
No_school	0.02	-0.01	0.02	0.00	0.02	-0.02	0.02	-0.04
Muni_elect	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00
Military_exp	0.02	0.14	0.02	-0.09	0.02	0.15	0.02	0.05
Nav_Water	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.01
Fertility	0.02	0.00	0.02	0.00	0.02	-0.01	0.02	0.00
Inflation	0.02	-0.02	0.02	-0.01	0.09	-0.32	0.06	-0.18
Autonomy	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00
Pop_growth	0.02	0.12	0.02	-0.04	0.02	-0.11	0.02	-0.20
Lending_int	0.02	0.00	0.01	0.00	0.05	-0.10	0.04	-0.10

Table 3: BMA estimation of Country Fixed Effects model.

	Dependent Variable									
	GDP (ppp)								GDP (clc)	
Explanatory Variables	PIP	PM	PIP	PM	PIP	PM	PIP	PM	PIP	PM
RAut1	0.03	-0.07					0.03	-0.02	0.04	-0.09
RAut2			0.03	-0.04						
RAut1_sq					0.03	-0.10				
Capital/GDP	1.00	40.17	1.00	40.17	1.00	40.17	1.00	37.49	1.00	40.20
Current Account Balance	1.00	27.79	1.00	27.80	1.00	27.79	1.00	28.99	1.00	26.39
Fertility Rate	1.00	-2.39	1.00	-2.39	1.00	-2.39	1.00	-2.71	1.00	-2.31
Investment Price	0.96	-0.03	0.96	-0.03	0.96	-0.03	0.93	-0.03	1.00	-0.04
Inflation	0.92	-7.16	0.92	-7.16	0.92	-7.16			0.87	-5.76
Gov Consump/GDP	0.60	-29.55	0.60	-29.64	0.60	-29.73	0.40	-18.74	0.44	-18.13
Labor Force	0.13	-1.18	0.13	-1.17	0.13	-1.17	0.06	-0.39	0.29	-3.14
FDI/GDP	0.11	0.75	0.11	0.73	0.11	0.71	0.14	1.03	0.11	0.67
Lending Int	0.11	-0.26	0.11	-0.26	0.11	-0.26	0.37	-1.23	0.08	-0.16
Tert_School_att	0.10	0.74	0.10	0.74	0.10	0.74	0.26	2.24	0.17	1.33
Population	0.09	-0.43	0.09	-0.43	0.09	-0.43	0.04	-0.10	0.05	-0.11
Pop_65	0.09	0.04	0.09	0.04	0.09	0.04	0.35	0.25	0.06	0.02
Life_exp	0.07	-0.01	0.07	-0.01	0.07	-0.01	0.04	0.00	0.04	0.00
Sec_School_att	0.06	-0.19	0.06	-0.19	0.06	-0.19	0.06	-0.21	0.07	-0.23
GDP p.c.	0.05	-0.03	0.05	-0.03	0.05	-0.03	0.05	0.04	0.05	0.01
Consumption/GDP	0.05	-0.26	0.05	-0.26	0.05	-0.26	0.05	-0.31	0.07	-0.52
Pop_density	0.04	0.00	0.04	0.00	0.04	0.00	0.06	0.00	0.04	0.00
Urban	0.04	-0.18	0.04	-0.18	0.04	-0.18	0.03	-0.13	0.04	-0.10
Tot_School_years	0.04	0.01	0.04	0.01	0.04	0.01	0.06	0.02	0.04	0.01
Investment/GDP	0.04	0.16	0.04	0.16	0.04	0.16	0.05	0.47	0.07	0.66
Resource_export	0.03	0.05	0.03	0.05	0.03	0.05	0.04	-0.11	0.03	0.00
Prim_School_comp	0.03	-0.09	0.03	-0.09	0.03	-0.09	0.04	-0.19	0.05	-0.20
No_school	0.03	-0.14	0.03	-0.14	0.03	-0.14	0.04	-0.33	0.03	-0.02
Pop_15	0.03	0.08	0.03	0.08	0.03	0.08	0.03	-0.01	0.03	0.05
Openness	0.03	0.00	0.03	0.00	0.03	0.00			0.04	0.02
Pop_growth	0.03	0.24	0.03	0.24	0.03	0.23	0.03	0.89	0.04	0.97
Prim_School_att	0.03	-0.01	0.03	-0.01	0.03	-0.01	0.03	-0.06	0.04	-0.05
Sec_School_comp	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	-0.02
Inflation_sq							0.15	-1.22		
Openness_sq							0.05	0.00		

Notes: Estimations of table 2 and 3 are performed using Martin Feldkirchner's and Stefan Zeugner's BMS package written for R. PIP corresponds to posterior inclusion probabilities; PM is the posterior mean standardized by a factor of 10^2.

Table 3 plots the results of the BMA estimation with country fixed effects. Revenue autonomy of first degree, its quadratic form and the softer measure of revenue autonomy of second degree have high and significant pairwise correlation, thus we estimate different models for them to escape issues of multicollinearity. That also holds for the quadratic forms of inflation and openness. The last two columns report estimation results where the dependent variable is measured at current local currency, which, unlike the case with time fixed effects, are not much different from the results of the first model of table 3, since the difference was due to the cross-country PPP adjustment (rather than inconsistency in sources, which some authors claim).

A fair number of regressors, five to six, can be considered as robust determinants of growth. Moreover, there is a clear gap between them and the rest of the independent variables, making the interpretation of PIPs considerably easier[15]. That being said, we can now take a closer look at the strongest determinants of growth starting from the augmented Solow model as the baseline empirical growth model.

As a proxy for physical capital accumulation, gross capital formation (capital/GDP) is significantly (PIP=1.0) and positively related to growth. Our educational variables that capture the rate of human capital accumulation do not have high PIPs, since their time variation is not high. Accordingly, tertiary school attainment, a measure that has much higher variation than primary and secondary school attainments, has the highest (PIP=0.1), still modest significance among the educational variables. Nevertheless, their signs are as expected. Solow model's another determinant of growth, average fertility rate per woman, is consistent (PIP=1.0) with the hypothesis that it negatively affects growth, as increased resources are devoted to child rearing rather than to production and investment. The last, fourth, variable of the Solow growth model is the initial GDP. Unlike the convergence hypothesis of the neoclassical growth theory that growth is negatively related to the level of initial income, per capita GDP was not a significant determinant of growth in our sample, neither in the country nor time fixed effect models. The latter implies that the convergence hypothesis is possibly more relevant when analyzing a larger and more heterogeneous sample[16], but is less or not essential when the sample consists of high income countries only.

Two macroeconomic variables that measure the level of distortions in the economy, investment price level or PPP investment deflator (Easterly 1993) and the size of the government measured by the ratio of government consumption to GDP (Barro 1991), have negative signs as expected and are significant with 0.96 and, somewhat lower, 0.60 PIPs accordingly.

The two remaining strong determinants of growth are current account balance (PIP=1.0) and inflation (PIP=0.92). The significance and the positive sign of the current account balance shows that strong exports and external trade surpluses boost economic growth (Kormendi and Meguire1985). Finally, inflation is negatively correlated with growth proving the standard argument that lower and more stable inflation rates are reduced economic uncertainty and improved efficiency of the price mechanism (Barro 1990).

---

[15] A standard critique of the applied method is the absence of a threshold value for PIPs; fortunately this question does not rise in our estimation.

[16] In Moral-Benito (2011)'s BMA estimations the level of GDP in each period is included in all models.

Now we turn to the FF variables. Both RAut1 and a weaker measure of autonomy, RAut2, have very small PIPs in our country fixed effects model, which we believe is specified appropriately and which correctly predicts the main determinants of growth that have been put forward by various growth theories and supported by substantial amount of empirical studies. Similarly, the quadratic form of RAut1 is not significant, thus rejecting the hypothesis of the non-linearity of the FF-growth relationship. Subsequently, our analysis allows us to claim that fiscal federalism has no robust effect on growth rates, neither positive and nor negative.

Contrary to this finding, many empirical papers argue for a significantly negative or positive relation between growth and FF. But, there is also considerable amount of literature claiming of no such significance. Existing empirical papers virtually fit every possible theoretical position (Rodriguez-Pose and Ezcurra 2010). The reason behind such inconclusiveness is that the impact of decentralization on growth has hardly been analyzed in a systematic manner and, we believe, that this paper has been able to address a considerable amount of drawbacks of this line of literature. First, as argued in section 3, the FF measures employed in this study are superior to the ones usually used. Secondly, the large amount of variables that we use makes our estimations more robust than any of the earlier studies, which restrict their analysis to a maximum of a dozen growth determinants and, surprisingly, do not follow the developments of the empirical growth literature. Thirdly, given the diverse range of the theoretical arguments of both federalist and growth theories, the method we have employed allows an appropriate estimation without the necessity of relying on diverse and shaky theoretical hypotheses and, ultimately, leads to a model that is able to correctly predict the main determinants of growth.

In any case, some care should still be taken when comparing the results of this paper to the empirical evidence reviewed in section 3.2. The reason is the difference in samples. The GFS data, although problematic, covers a much wider range of countries, thus allowing distinguishing between OECD and non-OECD countries. It turns out that the average expenditure decentralization measure is almost twice higher for OECD countries than the rest (non-OECD data is not reported here), implying that it may well be the case of comparing apples and oranges, given the vast institutional differences between high income and developing countries, which are often not properly measured.

That being said, we believe, that our central finding is clear cut: there is no direct link between growth rates and aggregate effects of fiscal decentralization in our sample of 23 OECD countries from 1975 to 2000.

6. Conclusions and Directions for Future Research

In the present paper we have examined the empirical relationship between FF and economic growth in a Bayesian framework. While theoreticians identify several channels through which FF can have significantly both positive and negative impacts on economic performance, empirical studies do not grant clear-cut evidence whether there is such a relation and whether the gross effect can promote growth. We have identified two major limitations of the previous studies that possibly lead to such

inconclusiveness. Whereas the first limitation, namely issues concerning quantifying FF, is widely recognized, our second concern, the robustness of estimates, is not properly addressed in the decentralization literature.

The relative absence of guidance from economic theory on channels through which FF should affect growth left most researchers to choose their explanatory variables on an arbitrary basis. Moreover, these studies do not sufficiently involve new results of the empirical growth theory. The vast amount of literature on the determinants of economic growth has identified around 150 or more variables to have explanatory power and has accordingly developed new methodological approaches to deal with them. Ironically, FF has never had its place among these determinants of economic growth. Furthermore, what is surprising is that the empirical FF, by definition closely being linked to growth empiricism, did not follow these newest trends.

Therefore, we have first constructed a large panel dataset for 23 OECD countries from 1975 to 2000 with 42 variables including two measures of sub-national governments' real fiscal autonomy, defined as the share of tax revenues over which local governments possess the authority to set the tax rate and the tax base. Then, we have applied Bayesian Model Averaging to tackle the common problem of the arbitrary choice of determinants of growth and associated errors of conditioning on 'blindly' specified models leading to non-robust estimates.

Overall, our analysis shows, that in the selected 23 OECD countries in the course from 1975 to 2000, the aggregate effects of fiscal federalism have no robust connection to growth rates, neither positive and nor negative.

One shortcoming of the present study, however, is that we have aggregated values on both sides of the scale: revenue autonomy measures only some properties of fiscal federalism, whereas the rate of GDP growth does not indicate many important aspects of a country's economic performance. Therefore, future empirical research should take the important task of analyzing the channels through which federalism might influence overall economic performance by paying particular attention to the relevant mechanisms in detail. In particular, this study suggests that the possibility of enhancing the efficiency of public good provision by better preference matching ('decentralization theorem'), increased competition among governments and higher government accountability and, on the other hand, sub-national governments' scarce resources to better address local preferences, its insufficient capacities to lever the argument of economies of scale, and its comparative lack of power and authority to overcome issues concerning lower quality of governance are complex phenomena that deserve individual analyses.

Another direction of future research that we think is important is methodological. Bayesian model averaging has recently become a very important method in growth econometrics; however, being a new and trendy tool, it is still emerging. First, there is a large ongoing debate on the effect of a variety of prior assumptions on the posterior inference, which applied researchers should watch closely (see for example a recent application by Ley and Steel 2009. Secondly and more specifically, the model we have employed can have two useful extensions: estimating a random effects model and Introducing lagged dependent variable on the left hand side (i.e. dynamic model), which is important when the data has time dimension. Due to endogeneity, the latter would be inappropriate

in our case, but is recently made available by Moral-Benito (2011), who extends BMA to BAMLE, i.e. Bayesian averaging of maximum likelihood estimates.

Finally, some policy implications of our results (Feld and Schnellenbach 2011): the lack of a direct link between decentralization and growth implies that there is no tradeoff between fiscal decentralization and economic performance. Given the many other benefits of fiscal federalism such as increased political accountability and the positive welfare effects of the Tiebout mechanism, our results are even encouraging: federalism allows the realization of these positive effects without having to sacrifice economic performance for them. Thus, federalism may even be beneficial, provided, that the broader institutional framework facilitates the merits of federalism and does not allow it to evolve into a state corroding federalism.

Appendix 1: Summary statistics of used variables.

Description	Abbreviation	Average	St Dev	Min	Max	Source
Dependent Variable						
GDP Per Capita Growth (CLC), %	*GDP_growth*	0.021	0.015	-0.019	0.085	WDI
GDP Per Capita Growth (PPP), %	*GDP_growth_PPP*	0.021	0.015	-0.028	0.084	PWT 7.0
Fiscal decentralization						
Revenue Autonomy of 1st Degree, %	*RAut1*	0.188	0.166	0.002	0.596	Stegarescu
Revenue Autonomy of 2nd Degree, %	*RAut2*	0.234	0.166	0.005	0.639	Stegarescu
RAut1 Squared	*RAut1_sq*	0.082	0.103	0.000	0.409	Stegarescu
Political decentralization						
Are there autonomous regions?	*autonomy*	0.304	0.462	0.000	1.000	DPI
Are municipal governments locally elected?	*muni_elect*	0.835	0.373	0.000	1.000	DPI
Are state/province governments locally elected?	*state_elect*	0.843	0.365	0.000	1.000	DPI
Initial Conditions						
GDP p.c. each period (constant 2000 USD)	*GDP*	19060	7157	5682	40467	WDI
Human Capital						
Ratio of workers to population, %	*Labor_force*	0.467	0.052	0.357	0.593	PWT 7.0
Share of population under 15, %	*Pop_15*	0.221	0.036	0.146	0.356	Barro and Lee,
Share of population over 65, %	*Pop_65*	0.160	0.364	0.079	0.179	Eurostat
Life expectancy at birth, total (years)	*Life_exp*	75.5	2.0	70.2	80.4	WDI
No schooling in the total pop., %	*No_school*	0.035	0.051	0.000	0.275	Barro and Lee
Primary school attained in the total pop., %	*Prim_School_att*	0.384	0.144	0.063	0.702	Barro and Lee
Secondary school attained in the total pop, %	*Sec_School_att*	0.405	0.122	0.106	0.696	Barro and Lee
Higher school attained in the total pop., %	*Tert_School_att*	0.177	0.105	0.033	0.530	Barro and Lee
Primary school complete in the total pop., %	*Prim_School_comp*	0.201	0.081	0.037	0.443	Barro and Lee
Secondary school complete in the total pop., %	*Sec_School_comp*	0.211	0.107	0.046	0.475	Barro and Lee
Average schooling years in the total pop.	*Tot_School_years*	8.81	1.86	3.27	12.25	Barro and Lee
Physical Capital						
Gross capital formation (% of GDP)	*Capital/GDP*	0.229	0.037	0.160	0.337	WDI

Investment Share of GDP p.c. (PPP), %	*Investment/GDP*	0.216	0.039	0.128	0.320	PWT 7.0
FDI, net inflows (% of GDP)	*FDI/GDP*	0.018	0.031	0.000	0.286	WDI
Lending interest rate, %	*Lending_int*	0.128	0.089	0.025	0.850	WDI
Macroeconomic Variables						
Inflation, consumer prices, %	*Inflation*	0.074	0.076	-0.017	0.548	WDI
Inflation Squared	*Inflation_sq*	0.012	0.035	0.000	0.331	WDI
Exports and Imports, (% of GDP)	*Openness*	0.458	0.894	0.013	5.784	PWT 7.0
Squared Openness	*Openness_sq*	1.014	4.307	0.000	34.189	PWT 7.0
Government Consumption of GDP p.c. (PPP), %	*Gov_consump/GDP*	0.097	0.024	0.045	0.168	PWT 7.0
Price Level of Investment	*Invest_price*	98.6	20.0	57.9	155.4	PWT 7.0
Current account balance (% of GDP)	*Curr Acc Balance*	-0.008	0.032	-0.087	0.102	WDI
Consumption of GDP p.c. (PPP), %	*Consumption/GDP*	0.669	0.057	0.481	0.780	PWT 7.0
Demography and Geography						
Population growth, %	*Pop_growth*	0.006	0.004	-0.003	0.020	WDI
Fertility rate (births per woman)	*Fertility*	1.749	0.328	1.180	3.289	WDI
Urban population (% of total)	*Urban*	0.734	0.122	0.416	0.970	WDI
Population (in thousands)	*Population*	34258	54419	222	274231	PWT 7.0
Population density (people/km^2)	*Pop_density*	121.6	119.4	1.8	464.1	WDI
Area in km^2	*Area*	1315362	2879151	2586	9220970	Gallup et al
Fraction of land area near navigable water	*Nav_Water*	0.655	0.341	0.000	1.000	Gallup et al
Air distance to New York, Rotterdam, or Tokio (km)	*Dir_Distance*	1524	2271	140	9280	Gallup et al
Military and Resource Burden						
Military expenditure (% of GDP), avg. over 1988-2000	*Military_exp*	0.020	0.009	0.001	0.042	SIPRI
Share of fuel and mining in Total merchandise exports, %	*Resource_export*	0.117	0.133	0.010	0.607	WTO

Notes: Stegarescu (2005) does not report RAut2 for Greece and Japan, therefore we calculate them from OECD's Revenue Statistics based on the tax revenue categorization of OECD (1999), assuming there have been no significant structural changes over time.

Data Sources: WDI: World Bank's World Development Indicators; DPI: WB's Database of Political Institutions; PWT 7.0: Penn World Table Version 7.0 (Heston et al 2011); WTO: World Trade Organization's International Trade and Tariff Database; SIPRI: Military Expenditure Database of the Stockholm International Peace Research Institute; Eurostat: Statistical Database of the European Commission; GFS: IMF's Government Finance Statistics; Stegarescu (2005); Barro and Lee (1994) and Gallup, Mellinger and Sachs (2001).

References

Ahmad, E. and V. Tanzi (2002), *Managing Fiscal Decentralization*. Routledge, New York.

Aizenman, J. and R. Glick (2003), Military Expenditure, Threats and Growth, National Bureau of Economic Research Working Paper No. 9618.

Bahl, R. and J. Linn (1992), *Urban Public Finance in Developing Countries*, Oxford University Press, New York.

Barro, R.J.(1990), Government spending in a simple model of endogenous growth, *Journal of Political Economy*, 98, 103-125.

Barro, R.J.(1991), Economic growth in a cross section of countries, *Quarterly Journal of Economics*, 106, 407-444.

Barro, R. and J.-W. Lee (1994), Sources of Economic Growth, Carnegie-Rochester Conference Series on Public Policy, 40, 1-57.

Baskaran, T. and L. P. Feld (2009), Fiscal Decentralization and Economic Growth in OECD Countries: Is there a Relationship? CESIFO Working Paper No 2721.

Bassanini, A. and S. Scarpetta (2001), The Driving Forces of Economic Growth: Panel data Evidence for the OECD Countries, *OECD Economic Studies*, 33, 9-56.

Brennan, G. and J. Buchanan (1980), *The Power to Tax: Analytical Foundations of a Fiscal Constitution*, Cambridge, U.K.

Breuss, F. and M. Eller (2004), Fiscal Decentralization and Economic Growth: Is There Really a Link? *Journal for Institutional Comparisons*, 2, 3-22.

Crespo-Cuaresma, J. and G. Doppelhofer (2003), Non-Linarities in Cross-Country Growth Regressions: A Bayesian Averaging of Thresholds Approach, *Journal of Macroeconomics*, 29(3), 541-554.

Darby, J., R. Muscatelli and G. Roy (2003), Fiscal decentralization in Europe: A review of recent experience. Regional Public Finance, *European Research in Regional Science*, vol. 13.

Davoodi, H. and H. Zou (1998), Fiscal Decentralization and Economic Growth: A Cross- Country Study, *Journal of Urban Economics*, 43, 244 – 257.

Durlauf, S., P. Johnson and J. Temple (2005), Growth Econometrics. In P. Aghion and S. N. Durlauf eds., Handbook of Economic Growth, 1(A), 555-677, Amsterdam, North-Holland.

Easterly, W. (1993), How Much Do Distortions Affect Growth? *Journal of Monetary Economics*, 32(2), 187-212.

Ebel, R., and S. Yilmaz (2002), On the Measurement and Impact of Fiscal Decentralization, World Bank Policy Research Working Paper 2809.

Enikolopov, R., and E. Zhuravskaya (2003), Decentralization and Political Institutions, CEPR Discussion Paper No. 3857.

Feld, L. P., T. Baskaran and J. Schnellenbach (2009), Fiscal Federalism, Decentralization and Economic Growth: A Meta-Analysis, Working Paper, University of Heidelberg.

Feld, L. P. and J. Schnellenbach (2011), Fiscal federalism and long-run macroeconomic performance: a survey of recent research, *Environment and Planning C: Government and Policy*, 29(2), 224-243.

Fernandez, C., E. Ley and M. Steel (2001), Model Uncertainty in Cross-Country Growth Regressions, *Journal of Applied Econometrics*, 16(5), 563–576.

Fernandez, C., E. Ley and E. Steel (2001a), Benchmark Priors for Bayesian Model Averaging, *Journal of Econometrics*, 100, 381-427.

Frankel, J. and D. Romer (1999), Does Trade Couse Growth? *American Economic Review*, 89, 379-399.

Fukasaku, K. and L.R. De Mello (1999), Fiscal Decentralization in Emerging Economies: Governance Issues, OECD Publishing.

Gallup, J., A. Mellinger and J. Sachs (2001), Geography Datasets, Center for International Development (CID) at Harvard University.

Grier, K. B. and G. Tullock (1989), An Empirical Analysis of Cross-National Economic Growth, *Journal of Monetary Economics*, 24(2), 259-276.

Heston, A., R. Summers and B. Aten (2011), Penn World Table Version 7.0, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

Hoeting, J. A., D. Madigan, A. Raftery and C. Volinsky (1999), Bayesian Model Averaging: A Tutorial. Statistical Science, 14(4), 382-417.

Iimi, A. (2005), Decentralization and Economic Growth Revisited: An Empirical Note, *Journal of Urban Economics*, 57, 449 – 461.

Joumard, I. and P.M. Kongsrud (2003), Fiscal relations across government levels, *OECD Economic Studies*, 36, 155–228.

Keefer, P. (2010), Database of Political Institutions: Changes and Variable Definitions,The World Bank, Development Research Group.

Kormendi, R. and P. Meguire (1985), Macroeconomic determinants of growth, cross-country evidence. *Journal of Monetary Economics*, 16, 141-163.

Levine, R. and R. Renelt (1992), A sensitivity analysis of cross-country growth regressions, *American Economic Review*, 82, 942-963.

Ley, E. and M. Steel (2009), On the Effect of Prior Assumptions in Bayesian Model Averaging with Applications to Growth Regression, *Journal of Applied Econometrics*, 24(4), 651-674.

Lovell, M. (2008), A Simple Proof of the Frisch-Waugh-Lovell Theorem, *Journal of Economic Education*, 39(1), 88-91.

Lucas, R. E. (1988), On the Mechanics of Development Planning, *Journal of Monetary Economics*, 22, 3-42.

Madigan, D. and J. York (1995), Bayesian graphical models for discrete data, *International Statistical Review*, 63, 215-232.

McNab, R. (2001), An Empirical Examination of the Outcomes of Fiscal Decentralization. Ph.D. Dissertation, Georgia State University.

Moral-Benito, E. (2011), Determinants of Economic Growth: A Bayesian Panel Data Approach, *The Review of Economics and Statistics*, forthcoming.

Musgrave, R. (1959), *The Theory of Public Finance*, McGraw-Hill, New York.

Oates, W. E. (1972), *Fiscal Federalism*, Harcourt Brace, London.

Oates, W. E. (1989), Searching for Leviathan: A Reply and Some Further Reflections, *American Economic Review*, 79, 578-583.

Oates, W. E. (1994), *Federalism and Government Finance, Modern Public Finance, J. Quigley and E. Smolensky*, eds. Cambridge, MA: Harvard U. Press: 126-151.

Oates, W. E. (1999), An Essay on Fiscal Federalism, *Journal of Economic Literature*, 37, 1120-1149.

Oates, W. E. (2002), Fiscal Federalism and European Union: Some Reflections, Working Paper, University of Pavia.

Oates, W.E. (2005), Toward a Second-Generation Theory of Fiscal Federalism, *Journal of International Tax and Public Finance*, 12(4), 349-373.

OECD, 1999. Taxing Powers of State and Local Government. OECD Tax Policy Studies, 1.Prud'homme, R., 1995. The dangers of decentralization. World Bank Research Observer 10, 201-220.

Raftery, A. (1995), Bayesian Model Selection in Social Research, *Sociological Methodology*, 25, 111-163.

Prud'homme, R. (1995), The Dangers of Decentralization, World Bank Research Observer, 10(2). 201-220.

Rodden, J. (2002), The Dilemma of Fiscal Federalism: Grants and Fiscal Performance around the World, *American Journal of Political Science*, 46(7), 670-687.

Rodden, J. (2003), Reviving Leviathan: Fiscal Federalism and the Growth of Government, *International Organization*, 57(3), 695-729.

Rodden, J. (2004), Comparative Federalism and Decentralization: On Meaning and Measurement, *Comparative Politics*, 36(4), 481-500.

Rodriguez-Pose, A. and R. Ezcurra (2010), Is Fiscal Decentralization Harmful for Economic Growth? Evidence from the OECD Countries, *Journal of Economic Geography*, 10(3), 3-34.

Romer, P. M. (1990), Endogenous Technological Change, *Journal of Political Economy*, XCVIII, 71-102.

Sachs, J and A Warner (1996), Natural Resource Abundance and Economic Growth, National Bureau of Economic Research Working Paper no. 5398.

Sala-i-Martin, X. (1997), I just ran two million regressions, *American Economic Review*, 87, 178-183.

Sala-i-Martin, X. (1997a), *I just ran four million regressions*, Mimeo, Columbia University.

Sala-i-Martin, X., G. Doppelhofer and R. Miller (2004), Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach, *The American Economic Review*, 94(4), 813–835.

Sarel, M. (1995), Non-linear Effects of Inflation on Economic Growth, IMF Working Paper No WP/95/56.

Schwarcz, S. L. (2002), Global Decentralization and the Subnational Debt Problem, *Duke Law Journal*, 51(4). 1179-1250.

Stegarescu, D. (2005), Public Sector Decentralization: Measurement Concepts and Recent International Trends, *Fiscal Studies*, 26, 301–333.

Tanzi, V. (1995), Fiscal Federalism and Decentralization: a Review of Some Efficiency and Macroeconomic Aspects. Annual World Bank Conference on Development Economics, 295-316.

Tanzi, V. (2000), On Fiscal Federalism: Issues to Worry About, IMF Conference on Fiscal Decentralization, Working Paper Nr. 4:41, Washington DC.

Tanzi, V. (2008), The Future of Fiscal Federalism, *European Journal of Political Economy*, 24, 705-712.

Ter-Minassian, T. (1997), Decentralization and Macroeconomic Management, IMF, Working Paper 97/155.

Thiessen, U. (2003), Fiscal Decentralization and Economic Growth in High Income OECD Countries, *Fiscal Studies*, 24(3), 237-274.

Thiessen, U. (2003a), *Fiscal Federalism in Western European and Selected Other Countries: Centralization or Decentralization? What Is Better for Economic Growth*, Mimeo, DIW Berlin.

Thornton, J. (2007), Fiscal decentralization and economic growth reconsidered, *Journal of Urban Economics,* 61(1), 64-70.

Tiebout, C. (1956), A pure theory of local expenditures, *Journal of Political Economy*, 64, 416-424.

Weingast, B. R. (1995), The Economic Role of Political Institutions: Market-Preserving Federalism and Economic Development, *Journal of Law, Economics and Organization*, 11(4), 1-31.

Weingast, B. R. (2004), The Performance and Stability of Federalism: An Institutional Perspective. C. Menard and M. Shirley (eds.), Handbook of New Institutional Economics, Dordrecht, Kluwer.

Woller, G.M. and K. Phillips (1998), Fiscal Decentralization and LDC Economic Growth: An Empirical Investigation, *Journal of Development Studies*, 34. 139 –148.

Yilmaz, S. (2000), The Impact of Fiscal Decentralization on Macroeconomic Performance. National Tax Association, Proceedings of the 92nd Annual Conference on Taxation 1999, Washington, DC, 251 – 260.

Zellner, A. (1986), On Assessing Prior Distributions and Bayesian Regression Analysis with g-Prior Distributions. Prem Goel and Arnold Zellner, eds., Bayesian inference and decision techniques: Essays in honor of Bruno de Finetti. Studies in Bayesian Econometrics and Statistics Series, 6, 233-43.