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"Key-drivers of EU budget allocation: Does power matter?"

Maria Garcia-Valinas and Vera Zaporozhets

Toulouse School of Economics

Key-drivers of EU budget allocation: Does power matter?

María García-Valinas*

Vera Zaporozhets†

Abstract

We examine the determinants of the EU budget expenditures allocation among different countries. Following previous literature, we consider two alternative explanations for the EU budget distribution: political power vs. 'needs view'. Taking the original data set (1976-2001) from Kauppi and Widgrén (2004) we analyze whether their predictions stay robust while applying a different measure of power. We find that the nucleolus is a good alternative to the Shapley-Shubik index in the distributive situations such as the EU budget allocation. Our results also show that the relative weight of political power when explaining budget shares is lower than previous models' predictions.

Keywords: EU policies, budget allocation, political power, nucleolus, Shapley-Shubik index.

JEL codes: D72, D78, H61, O52

*University of Oviedo

†Toulouse School of Economics (LERNA, INRA)

1 Introduction

In 2013, the European Union (EU) expenditure budget was around 149 billion euro, with cohesion and agricultural and environmental resources being the main EU policies, with respective shares of 46.8% and 39.8%. Due to the magnitude of these figures, the budget allocation and the distribution among countries and sections emerge as significant issues, which are crucial to analyze past decisions and more importantly, they also help to predict future decisions. In this paper we examine how the budget in the EU is allocated among different EU countries. We also analyze the relative weights of different factors when it comes to explain the budget shares corresponding to each EU country member.

Previous literature (Courchene et al., 1993; Anderson and Tyers, 1995; Tangermann, 1997; Kandogan, 2000; Kauppi and Widgrén, 2004, 2007) has tested two alternative explanations of the EU budget distribution across the members' states. The first one is a 'needs view' of the budget, where members' allocations are determined by principles of solidarity. According to this hypothesis, the countries with a high weight of agriculture sector and/or a relative worse economic situation emerge as the most important recipients of the EU budget. In fact, some of the previous studies focused exclusively on this dimension (Courchene et al., 1993; Anderson and Tyers, 1995; Tangermann, 1997). The second one is that budget allocation across the members is reflected by the distribution of their political power, evaluated by traditional measures such as Shapley-Shubik power index. Thus, those countries with higher power in the allocation process could get extra shares of the EU budget. Thus, some studies combines both needs and power views (Kandogan, 2000; Kauppi and Widgrén, 2004, 2007; Aksoy, 2010). The empirical analysis of Kauppi and Widgrén (2004) shows strong prevalence of political power motives. Their results indicate that political power have higher weight than needs in the determination and allocation of budget expenditures among member states.

Our main purpose is to discuss the analysis of Kauppi and Widgrén (2004), which is based on 1976-2001 data on the patterns of the EU budget shares and in the measures of each member state's needs and the political power (expressed by Shapley-Shubik index). We compare their results with the predictions based on another power measure, the nucleolus, which has been argued as being an appropriate power measure in distributive situations as well as an alternative to traditional measures as the Shapley-Shubik index[1].

The outline of the paper is as follows. First of all, a brief introduction on the EU budget is presented, describing the process to design and allocate EU expenditures and revenues. Second, we discuss the theoretical properties of different power indexes frequently used in the previous literature. In this respect, the nucleolus emerges as a power measure with several advantages with respect to other indexes. Finally, a simple empirical model is specified, in order to find out the key-drivers for budget allocation. The paper concludes summarizing the main findings and some policy implications.

2 EU budget: procedure and evolution

As it was mentioned in the Introduction, the EU expenditure budget represents a significant amount of resources. In 2013, total expenditures come to 148,468 million euro. Although it is not a substantial amount in relative terms (1.13% of the 27 members Gross National Income, GNI), there are some crucial policies which are developed using the EU funding, such as the Common Agricultural Policy (nowadays part of a more extensive section on the preservation and management of natural resources) or several policies oriented towards the economic development of

[1] For example, Montero (2005), Montero (2013) and Le Breton et al. (2012) among others.

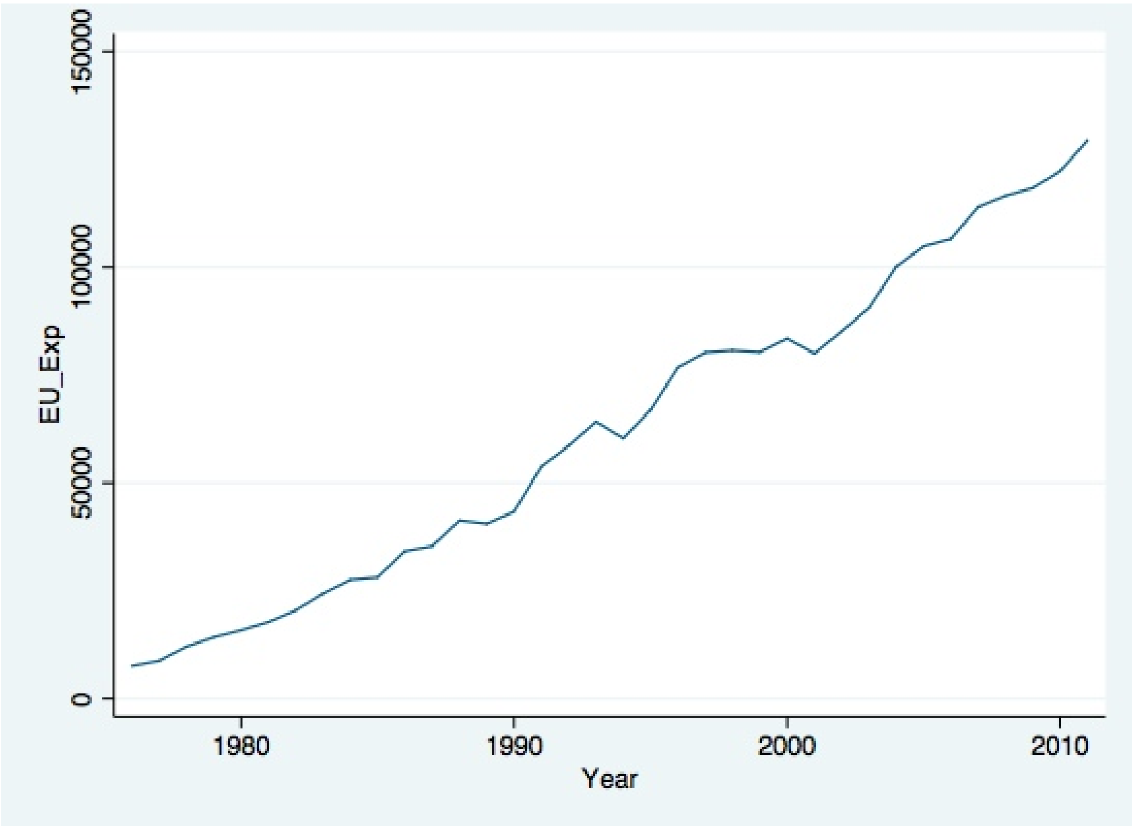
some target regions (cohesion and competitiveness policies). Each country member has also to contribute to the EU budget, basically by means of GNI-based (74.3%) and VAT-based own resources (9,5%) and traditional own resources (TOR, 10.4%).

Figure 1 shows the evolution of the EU expenditure from 1976 to 2011. This budget trend could be interpreted as a shot where the history of EU integration and several budgetary reforms were simultaneously captured. Regarding the enlargement process, there are some significant facts which could have impact on the EU expenditures evolution. Among others, in 1986, the EU is extended from 10 to 12 countries, with the integration of Portugal and Spain as new members. In a similar way Austria, Finland and Sweden were added to the EU/EC in 1995. Additionally, one of the largest extensions happened in 2004, when the EU grew from 15 to 25 countries[2].

Budget structure was also aimed at successive EU reforms. In this respect there are some facts which are worthy to mention. At the Brussels European Council of February 1988, a political agreement was reached on doubling the budget of the Structural Funds in real terms between 1987 and 1993. Subsequently, Member States agreed at the Edinburgh European Council in December 1992 that the budget for structural operations would be further increased, in particular for the cohesion countries (Greece, Ireland, Portugal and Spain). Also in Edinburgh, Member States decide to strengthen some particular policies, such as research and development, external actions and financial aid to Central and Eastern European countries. Although there were several agreements setting budgetary limits to expenditure's growth rate, the basis of a stringent budgetary discipline were established at Agenda 2000 agreements. All those reforms have impact on the level and the structure of budget expenditures, generating also some changes in the

[2]The new members were Check Republic, Cyprus, Slovak Republic, Slovenia, Estonia, Hungary, Latvia, Lithuania, Malta and Poland.

Figure 1: EU expenditure bugdet: 1976-2011 (EU million)



Source: Own elaboration

accounting system. Thus, the budget has experienced some structural reforms, especially significant in 1992 and 2006.

Regarding the procedure for elaboration and approval of the EU budget, there are several institutions which are involved. The European Commission, the Council and the Parliament participates in the process of elaborating the EU budget. However, during the last decades, the role of each institution and voting rules have experienced several changes (Kauppi and Widgrén, 2007). The relationship between the Council and the Parliament was difficult until 1992 at the Edinburgh meeting, where an Interinstitutional Agreement between both institutions was set, in order to facilitate the process of making budgetary decisions.

The budget elaboration process consists of different steps. First of all, and based on the multiannual financial framework in force and the budget guidelines for the coming year, the European Commission prepares a preliminary draft budget. In this stage, there are some spending priorities and also some caps or ceilings to limit the maximum growth rate of different budgetary sections and the total budget.

Once a preliminary draft is elaborated, the European Commission submits it to the Council and the Parliament. The budgetary authority, comprised of both institutions, amends and adopts the draft budget. The Council should adopt its position on the preliminary draft budget proposed by the Commission and elaborate and approve a definitive draft budget. Next, the Parliament could modify the draft, adopting its amendments on the Council's position, or proposing some amendments on particular expenses. The final document proposed should be approved by simple majority by the Parliament. Afterwards, the Council should give a second reading of the document, adopting it by a stronger majority then the one required at the Parliament level[3]. A second reading by the Parliament and a

[3]Usualy, at least a qualified majority is required to adopt budgetary decisions at the Council level.

definitive adoption should finish the process.

So, it is clear that, although the Parliament role has increased in the last years[4], the approval procedure during the period analyzed in this research (1976-2001) and the qualified majority required at the Council to approve the final EU budget leads to consider the voting decisions of this institution (Kauppi and Widgrén, 2004).

3 Power indices: the nucleolus versus the Shapley-Shubik index

In recent decades there is growing literature, both theoretical and applied, on power measures. However, there is no consensus on what is the best way to measure power. While analyzing the distribution of the EU budget among different countries, previous studies have applied the Shapley-Shubik index (SSI) (Kauppi and Widgrén, 2004), one of the mostly used power measures in the literature. In contrast, in this study we apply an alternative measure, the nucleolus (Schmeidler, 1969). In what follows we provide strong arguments supporting our choice, and in the subsequent section, we compare performance of the two indices in practice, and analyze whether the conclusions of Kauppi and Widgrén (2004) are robust with respect to the choice of the power index.

The general discussion on which power measure is the best and which properties it should possess remains open. Thus, Napel and Widgrén (2004) divide existing studies on power indices into two “disjoint methodological camps”, and propose to take a unified framework linking them: “On the one hand, such framework

[4] The Treaty of Lisbon extended the role of Parliament. It was signed by the EU member states on 13 December 2007, and entered into force on 1 December 2009. From that moment, European Parliament could decide on both compulsory and non-compulsory expenses, extending its power and responsibilities in the budget elaboration.

should allow for predictions and ex post analysis of decisions based on knowledge of procedures and preferences. On the other hand, it must be open to ex ante and even completely a priori analysis of power when detailed information may either not be available or should be ignored for normative reasons". We address the discussion in a specific distributional setting: an allocation of a fixed budget across the members of an organization with the key assumption on preferences that each member cares only about her own share.

Following Napel and Widgrén (2004) let us consider two requirements in turn. First, the power measure should be based on the explicit decision-making procedures and the knowledge of the preferences. To this end, it is important that the political analysis takes into account game forms. In this respect, both the SSI and the nucleolus, are suitable measures to analyze bargaining situations such as the distribution of the EU budget. Each of two measures has foundations in a non-cooperative framework in a sense that any of them arises as a payoff from a well-specified bargaining game. For instance[5], Gul (1989) constructs a non-cooperative game mimicking bargaining process in the markets. One of the main results state that the payoffs associated with efficient equilibria converge to the agents' Shapley values as the time between periods of the dynamic game goes to zero. As for the nucleolus, it appears as the vector of expected payoffs in the legislative bargaining game with random proposers due to Baron and Ferejohn (1989), in which voters directly make proposals and vote over division of a budget. If proposal probabilities coincide with the nucleolus, then the nucleolus is the unique vector of expected payoffs (Montero, 2006). The equality of the expected payoffs to the nucleolus also hold for other proposal probabilities depending on the voting game.

According to the second requirement one would not want the power analysis to

[5] Other examples are Laruelle and Valenciano (2008), Laruelle and Valenciano (2001) and Pérez-Castrillo and Wettstein (2001).

be extremely sensitive to the details of the game form used to describe the non-cooperative decision process. In the following paragraphs we show that only the nucleolus passes this test.

In order to encompass the idea of robust and detailed-free power measure in our specific distributional framework, we address the bargaining set, a solution concept for coalitional games (Maschler et al., 2013). The idea behind the bargaining set is that when the players decide how to divide the worth of the coalition, the player who is not satisfied with the proposed share may object to it. The objection goes against another player, claiming this player to share his part with the objecting one. The player against whom the objection is made may have (or not) a counter objection. An objection which does not have a counter objection is called justified. The bargaining set consists of all imputations in which no player has a justified objection against any other player.

It seems that the bargaining set describes well the decision-making procedure in the EU institutions (see Section 2). On top of that, one of the nice properties of the bargaining set is that contrary to the core it is never empty. However, often the bargaining set is large, and then one faces the problem of choosing a unique outcome in it. In such cases the nucleolus is a good candidate, since it always exists, it is unique and it belongs to the bargaining set. On the contrary, in general the Shapley value is not in the bargaining set. The following example supports this argument. Let us consider three individuals with individual 1 being a vetoer. This means that a decision is passed only when player one is present in a group voting for the decision, however being alone she/he cannot get the decision passed. In such a situation the core, the nucleolus and the bargaining set coincide and attribute the whole surplus to player 1. On the contrary, the Shapley-Shubik index is $(2/3, 1/6, 1/6)$. One may check that under the distribution according to the Shapley-Shubik index, player one has an objection. For example, he/she can offer player two to share the part of player three. In this setting player one has a lot of power, and only one extra vote is needed to validate. The nucleolus models the process of Bertrand competiotion between player two and three. To summarize, both the SSI and the nucleolus have foundations in non-cooperative bargaining games, which make them suitable for ex post political analysis. However, only the nucleolus satisfies the requirement of being detailed-free measure open to an ex ante analysis of the distributive situations. Given our specific framework, these arguments allow us to favor the nucleolus versus the SSI in the empirical analysis of the EU budget distribution. In the Appendix we provide the formal definitions for the SSI and the nucleolus, as well as the figures for both power measures for the period 1973-2001 taken from Le Breton et al. (2012).

3.1 Example

In this subsection we provide computations of the SSI and the nucleolus for the first EU Council of Ministers (1958 - 1972). During that period the Council consisted of the representatives of 6 countries: three "big" countries as Germany, Italy and France held 4 votes each, two "medium" countries as Belgium and Netherlands held 2 votes each and a "little" country, Luxembourg held 1 vote. A qualified majority was set at 12 out of 17, i.e., in order to pass a decision it was necessary to have at least 12 votes in favour of the decision. As was highlighted by many studies[6], Luxembourg was powerless in such a situation. Since other member states held an even number of votes, Luxembourg formally was never able to make any difference in the voting process.

The results are summarized in the following table.

According to the nucleolus a "medium" country receives twice as much as a "big" country. This is quite intuitive, since in a minimal winning coalition a

[6]For example, Felsenthal and Machover (1997), among others.

Table 1: **The Council of Ministers (1958 - 1973).**

Country	**weights**	**SSI**	**Nucl**
Germany	4	0.233	0.250
Italy	4	0.233	0.250
France	4	0.233	0.250
Belgium	2	0.150	0.125
Netherlands	2	0.150	0.125
Luxembourg	1	0	0
Quota	12		
Total votes	17		
Quota (%)	70.59		

"big" country can be replaced by two "medium" ones. Such substitutability often holds for the nucleolus in contrast to other power indices, but it does not hold in all cases[7]. As a consequence, the nucleolus treats all minimal winning coalitions equally in this case: it prescribes the total "wealth" for both types of coalitions as being equal 0.75. In contrast, according to the SSI the minimal winning coalitions of the first and the second type get different amount, 0.766 and 0.7 respectively.

We would like to point out another interesting feature of the nucleolus. In 1973, as compared to 1958, the "big" countries get the same power according to the nucleolus. However, other countries, even though they are not dummies, get zero. This is impossible for SSI or other power indices, but it is not unusual for the nucleolus[8]. As a result, the nucleolus is very different from SSI and other indices

[7]for more detailed discussion see, for example, Montero (2005).

[8]see, for example, Montero (2005)

in this example[9].

4 Empirical Application

4.1 Data and empirical model

As it was explained at the introduction, this research is aimed at the identification of significant key-drivers and trends of the EU budget allocation. In order to make a robust comparison with the empirical model proposed by Kauppi and Widgrén (2004), the sample includes observations for the same period which was used by the authors: 1976-2001. This period covers different stages in the EU composition: from 1976 to 1980 (EU-9), from 1981 to 1985 (EU-10), from 1986 to 1995 (EU-12) and from 1995 to 2001 (EU-15).

In this respect, a general and basic model will be proposed, where the budget share on the whole EU budget of each country, depends on the aforementioned index of political power, a set of variables representative of budgetary needs (population, economic activity indexes, etc.). The empirical model is presented as follows:

$$b_{it} = f(p_{it}, Z_{it}) + u_{it}, \tag{1}$$

[9] Both SSI and the nucleolus exhibit the paradox of new members: a member state's relative power increases although its relative weight decreases after the accession of the new members (see for example, Felsenthal and Machover (1998)). An occurrence of the paradox is indicated by an asterisk in the table in the appendix. One can notice that for SSI it happens for Luxembourg, Denmark and Ireland. Luxembourg gains in relative power three times: from 0 to 0.001 - in 1973, from 0.001 to 0.03 - in 1981, and from 0.012 to 0.02 - in 1995. Denmark and Ireland both gain in their relative power from 0.03 to 0.043 in 1986. For the nucleolus the paradox appears in 1986 for Belgium, Netherlands, Denmark, Ireland and Greece, and in 1995 - for Luxembourg.

where b_{it} is the percentage of the total EU expenditure budget allocate to each country in the year t, p_{it} is an index of political power for each country and period, and Z_{it} is a vector of factors representatives of countries' needs in each period. Finally, u_{it} represents the error term.

We have used three alternative specifications of dependent variable. With the first two indexes, we are following the procedure proposed by Kauppi and Widgrén (2004). On the one hand, we consider the total expenditure budget share that each country gets in the negotiation process (*exp*). On the other hand, an alternative variable is defined, introducing an adjustment to take into account the UK's budget rebate[10] (exp_{adj}). On top of that, we consider the difference between expenditures and contributions in percentual terms(*balance*

We also consider some of the original variables from Kauppi and Widgrén (2004) as independent variables. in. First of all, two different alternatives to measure political power discussed in the previous section are included into the analysis ($p_{ssi}; p_{nucl}$). Additionally, needs are shown using a set of variables (Z): each country's share of the total agricultural production (*agri*), and the ratio of each country's GDP per capita and the EU wide GDP per capita (*income*). Finally, due to the different size of member states, population is included as a control variable, and expressed in thousand millions (*pop*). Table 1 shows some descriptive statistics of the variables.

Although it is possible to observe that the average values for both SSI and the nucleolus are really close, the latest index is showing higher dispersion levels. Additionally, we observe that the average expenditure budget percentage perceived

[10]This rebate was a compensation get by UK government in 1985. The main reason for the rebate was that a high proportion of the EU budget is spent on the Common Agricultural Policy (or CAP), which benefits the UK much less than other countries as it has a relatively small farming sector as a proportion of GDP. The compensation consists of reallocating some of the original UK monetary contributions to be paid by the remaining member states

Table 2: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
exp	0.0844	0.0626	0	0.2510
exp_adj	0.0844	0.0623	0	0.2510
balance	0.0041	0.0465	-0.1817	0.1274
p_ssi	0.0844	0.0501	0.0010	0.1790
p_nucl	0.0843	0.0779	0	0.25
agri	0.0844	0.0807	0.0010	0.3380
income	1.0160	0.2393	0.5810	1.967
pop	0.0270	0.0253	0.0004	0.0820

is around 8%, while the balance is positive and around 0.4%, which means that, in average, countries are receiving more resources than their contributions to the EU budget. Finally, it is worthy to mention that high levels of dispersion are registered for the three control variables included in the analysis. Thus, country members are heterogeneous in terms of size and economic structure.

The following table shows the correlations among variables. Let us note that population is highly correlated with both power indexes. Thus, multicolineality issues could probably emerge. However, dropping population from the analysis could lead to generate an ommited variables problem. As we will show later, in order to detect significant changes in the estimated coefficients, we have opted by including two separate estimates including and excluding *pop* variable.

4.2 Results

In order to carry out some sensitivity analysis, we have specified six different models, and for each one, we applied four different econometric techniques and two different scenarios. Estimates are presented in Tables 3 to 10. The six models are the result of combining three different dependent variables (*exp* in Models (1) and (3); exp_{adj} in Models (2) and (4); *balance* in Models (3) and (6)) with two different political power indexes (p_{ssi} in Models 1 to 3; p_{nucl} in Models (4) to (6)).

Regarding the econometric techniques, we include a pooled ordinary least squares specification (OLS, Tables 3 and 4), to compare it to some panel data methodologies, such as fixed effects (FE, Tables 5 and 6) and random effects (RE, Tables 7 and 8). Finally, we also present adjusted random effects (RE_{adj}, Tables 9 and 10), since we detected some autocorrelation problems. For convenience, the majority of tests to compare models and detect econometric problems are reported in Tables 7 and 8. On top of that, we consider two different scenarios, including (Tables 4, 6, 8, and 10) and excluding *pop* variable (Tables 3, 5, 7, and 9), in order to check the robustness of our findings[11].

The results show some general facts which are observed in the majority of cases. First of all, the specifications where the dependent variable is the expenditure budget share (with or without adjustments) perform better. Those models whose dependent variable is the balance between expenditures and revenues are weaker in terms of explanatory power. Secondly, both power and needs matter in getting extra resources. Thus, the higher political power is, the higher the expenditure/balance share is. Those countries with higher agricultural activity and lower relative income emerge as the beneficiaries of the EU policies, so they receive higher shares of the whole budget. However, the weight of political power is lower in the case of taking the nucleolus, while needs' indexes become more important. Definitively, political power matters, but not as much as the models which consider the

[11] Additional estimates were made, including some temporal dummies related to some historical facts (the fall of Berlin wall, or the EU enlargements). However, they did not emerge as significant factors to explain the budget/balance shares.

Table 3: Estimates using OLS, excluding population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.539**	0.774**	-0.585**			
p_nucl				0.208**	0.295**	-0.184**
agri	0.407**	0.255**	0.142*	0.534**	0.439**	-0.027
income	-0.025**	-0.021**	-0.093**	-0.039**	-0.041**	-0.077**
_cons	0.030**	0.019**	0.136**	0.061**	0.064**	0.100**
N	308	308	308	308	308	308
r2	0.88	0.88	0.31	0.86	0.84	0.25
F	733.89**	720.23**	45.78**	618.12**	513.32**	34.35**

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

SSI have shown. So the models based on nucleolus show a more balanced situation between power and needs.

In general, the inclusion of *pop* variable into the analysis does not lead to significant changes. Althought there is a high correlation among population and other variables, the problem has not important consequences. However, the gain in terms of information/explanation is not much higher, except in the case of Models (3) and (6), where balance is considered as dependent variable.

The analysis presented in the current paper suggests unobservable heterogeneity, due to the strong differences among country members from different points of view. Thus, the panel data methodologies lead to significant efficiency improvements in this context. Tables 5 to to 10 show the results obtained under different panel data techniques. Actually, Breusch and Pagan test for random effects reported in Tables 7 and 8 concludes that panel data models are preferred to pooled OLS model. In Tables 5 and 6, fixed effects models are presented. We observe significant changes

Table 4: Estimates using OLS, including population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.506**	0.668**	0.078			
p_nucl				0.149**	0.195**	0.048
agri	0.401**	0.237**	0.256**	0.462**	0.318**	0.255**
income	-0.026**	-0.024**	-0.079**	-0.038**	-0.040**	-0.080**
pop	0.088	0.284*	-1.778**	0.445**	0.758**	-1.760**
_cons	0.031**	0.024**	0.104**	0.059**	0.061**	0.107**
N	308	308	308	308	308	308
r2	0.88	0.88	0.47	0.87	0.86	0.47
F	549.71**	549.76**	66.97**	493.07**	455.89**	67.21**

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 5: Estimates using FE, excluding population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.752**	0.646**	0.230*			
p_nucl				0.221**	0.170**	0.095**
agri	0.143*	0.208**	0.144*	0.258**	0.323**	0.157*
income	-0.000	0.002	0.010	-0.019+	-0.014	0.004
_cons	0.009	0.011	-0.038**	0.063**	0.057**	-0.021+
N	308	308	308	308	308	308
r2_o	0.85	0.87	0.13	0.85	0.83	0.11
F	52.20**	48.96**	8.21**	36.50**	34.11**	8.54**

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

in the value of the coefficients, but not in the sign, which remains robust.

Basic random effects models are presented in the tables below. Hausman test results leads to identify random effects model as a preferred alternative in some cases, especially when explaining expenditure budget shares adjusted to the UK rebate, and population is used as an additional control variable.

In Tables 9 and 10 (and also in OLS estimations), it is possible to observe that random effect models adjusted by autocorrelation keep showing the higher weight of the SSI variable when the UK's rebate correction is implemented. In models (4) (5) and (6), which consider the nucleolus, the majority of variables are significant, and chi-2 test shows better results than in the models where the SSI was included and autocorrelation was corrected, specially when population is included into the analysis. Moreover, comparing with previous estimates, more coefficients are now significant. Additionally, note again that power index coefficient is not so high as in the previous estimates, reflecting the lowest value of all the estimates and

Table 6: Estimates using FE, including population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.771**	0.656**	0.164+			
p_nucl				0.216**	0.163**	0.075*
agri	0.166*	0.220**	0.068	0.238**	0.292**	0.070
income	0.002	0.003	0.004	-0.020+	-0.016	-0.000
pop	0.361	0.182	-1.195*	-0.280	-0.443	-1.223*
_cons	-0.006	0.003	0.013	0.074**	0.074**	0.025
N	308	308	308	308	308	308
r2_o	0.85	0.87	0.29	0.81	0.74	0.29
F	39.21**	36.64**	7.38**	27.37**	25.73**	7.75**

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 7: Estimates using RE, exluding population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.740**	0.710**	0.153+			
p_nucl				0.217**	0.180**	0.088*
agri	0.256**	0.258**	0.087	0.426**	0.424**	0.076
income	-0.009	-0.006	0.001	-0.027**	-0.022*	-0.003
_cons	0.007	0.007	-0.014	0.054**	0.051**	-0.003
N	308	308	308	308	308	308
r2_o	0.87	0.87	0.11	0.86	0.83	0.08
chi2	436.99	380.78	11.71	289.43	216.28	14.35
BreuschPagan_t	18.22**	66.72**	930.91**	17.98**	145.04**	1122.37**
Hausman_t	14.22**	8.91*	122.96**	29.18 **	30.49**	68.87**
Wooldridge_t	46.09**	47.18**	51.63**	24.17**	48.73**	50.46**

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 8: Estimates using RE, including population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.709**	0.674**	0.156+			
p_nucl				0.205**	0.185**	0.074*
agri	0.229**	0.235**	0.079	0.384**	0.379**	0.087
income	-0.007	-0.005	-0.004	-0.028**	-0.021*	-0.008
pop	0.300+	0.361*	-1.247**	0.588**	0.643**	-1.192**
_cons	0.003	0.001	0.022	0.045**	0.038**	0.030*
N	308	308	308	308	308	308
r2_o	0.86	0.87	0.33	0.86	0.85	0.33
chi2	420.97	371.50	35.92	493.87	300.38	37.33
BreuschPagan_t	19.40**	68.42**	840.48**	16.75**	86.44**	834.71**
Hausman_t	66.83**	3.42	11.73*	8.59+	7.01	12.28*
Wooldridge_t	46.08**	47.10**	46.58**	25.25**	48.43**	47.31**

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 9: Estimates using RE_adj, excluding population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.626**	0.792**	-0.001			
p_nucl				0.197**	0.251**	0.125+
agri	0.324**	0.213**	-0.184*	0.506**	0.439**	-0.286**
income	-0.016	-0.013	-0.051**	-0.035**	-0.037**	-0.042*
_cons	0.019	0.012	0.072**	0.060**	0.063**	0.061**
N	308	308	308	308	308	308
chi2	454.59	461.27	18.96	474.31	435.13	17.94

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Table 10: Estimates using RE_adj, including population

	(1)	(2)	(3)	(4)	(5)	(6)
	exp	exp_adj	balance	exp	exp_adj	balance
p_ssi	0.484**	0.585**	0.274+			
p_nucl				0.126**	0.150**	0.144*
agri	0.278**	0.144*	0.021	0.368**	0.244**	0.025
income	-0.018	-0.016	-0.054**	-0.032**	-0.033**	-0.060**
pop	0.489*	0.713**	-1.421**	0.776**	1.090**	-1.312**
_cons	0.024+	0.019	0.073**	0.054**	0.054**	0.086**
N	308	308	308	308	308	308
chi2	471.77	470.78	48.99	525.34	493.57	49.49

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

reinforcing the idea that the impact of political power on the budget shares is not as important as Kauppi and Widgrén (2004) predicted.

5 Discussion and future extensions

The main contribution of this paper focuses on finding out the role of political power on the EU budget decisions. Some key-drivers of budget shares allocated to each EU member country have been identified. Both power and needs are significant factors which lead expenditure budget allocation at the European institutions. Some previous empirical analysis (Kauppi and Widgrén, 2004, 2007) have shown strong prevalence of political power motives. Their results indicate that huge percentage of the budget expenditures can be attributed to selfish power politics, leaving a small contribution to the declared benevolent EU budget policies based on needs.

We propose an alternative power index based on Schmeidler (1969) research. The nucleolus has emerged as the most adequate alternative in this context. On the one hand, it performs better from a theoretical point of view, displaying some nice properties. On the other hand, it is a significant factor when it comes to explain the budget shares got by each EU country. We carry out an empirical study using the same data set of Kauppi and Widgrén (2004), using the different alternative political power measures.

Our findings show that the model which considers the nucleolus fits better to the data, showing higher values at global significance tests. On top of that, we found that the relative weight of political power when explaining budget shares is lower than other models' predictions. Needs also matter, and countries with lower relative income levels and higher weight of irrigation sector are recipients of a significant amount of EU resources. These findings are consistent with the idea that the EU budget is allocated to develop key policies such as the common agricultural policy and the structural funds. Although political power has impact on the EU budgetary decisions, this impact is more moderate that previous literature has estimated.

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Appendix 1: SSI and the nucleolus in the Council of Ministers 1958-2003

Country	1958 – 1972		1973 – 1980		1981 – 1985		1986 – 1994		1995 – 2003	
	SSI	**Nucl**	**SSI**	**Nucl**	**SSI**	**Nucl**	**SSI**	**Nucl**	**SSI**	**Nucl**
France	0.233	**0.250**	0.179	**0.250**	0.174	**0.250**	0.134	**0.138**	0.117	**0.115**
Germany	0.233	**0.250**	0.179	**0.250**	0.174	**0.250**	0.134	**0.138**	0.117	**0.115**
Italy	0.233	**0.250**	0.179	**0.250**	0.174	**0.250**	0.134	**0.138**	0.117	**0.115**
Belgium	0.150	**0.125**	0.081	**0**	0.071	**0**	0.064	**0.069***	0.056	**0.057**
Netherlands	0.150	**0.125**	0.081	**0**	0.071	**0**	0.064	**0.069***	0.056	**0.057**
Luxembourg	0	**0**	0.001*	**0**	0.030*	**0**	0.012	**0**	0.021*	**0.023***
UK	–	–	0.179	**0.250**	0.174	**0.250**	0.134	**0.138**	0.117	**0.115**
Denmark	–	–	0.057	**0**	0.030	**0**	0.043*	**0.034***	0.035	**0.034**
Ireland	–	–	0.057	**0**	0.030	**0**	0.043*	**0.034***	0.035	**0.034**
Greece	–	–	–	–	0.071	**0**	0.064	**0.069***	0.056	**0.057**
Spain	–	–	–	–	–	–	0.111	**0.103**	0.095	**0.092**
Portugal	–	–	–	–	–	–	0.064	**0.069**	0.056	**0.057**
Austria	–	–	–	–	–	–	–	–	0.045	**0.046**
Sweden	–	–	–	–	–	–	–	–	0.045	**0.046**
Finland	–	–	–	–	–	–	–	–	0.035	**0.034**

*S*ource: Adapted from Le Breton et al. (2012b).

Appendix 2

6.1 Technical preliminaries

In this section we introduce some basic notions commonly used to model voting situations and then briefly discuss the nucleolus and the Shapley-Shubik index.

We consider a set $N = \{1, ..., n\}$ of n players or voters, which is often referred as *an assembly.* The power set 2^N collects all the subsets of N. A non-empty subset $S \subseteq N$ is called a *coalition.* The coalition N is said to be the *grand coalition.*

A *cooperative game with transferable utility in characteristic function form,* is a pair (N, v) with N the set of players and

$$v : 2^N \longrightarrow \mathbb{R} : S \longmapsto v(S),$$

a map that satisfies $v(\emptyset) = 0$. The map v is called the *characteristic function.* The value $v(S)$ is said to be the value or the *worth* of coalition S. For simplicity we refer to these games as "games in TU form".

The game (N, v) is said to be *simple* if:

· the value of a coalition either 0 or 1: $v(S) \in \{0, 1\}$ for all $S \subseteq N$,

· the value of grand coalition is 1: $v(N) = 1$.

A coalition with a value equal 1 is said to be *winning*, and a coalition with a value equal 0 is said to be *loosing.* A winning coalition S is *minimal* if it does not contain any other winning coalition: $v(S) = 1$ and $v(T) = 0$ for all $T \subset S$. Further, the set of winning coalitions is denoted by $\mathcal{W}$ and the set of minimal winning coalitions is denoted by $\mathcal{W}^m$. The simple game (N, v) is completely determined through the pair $(N, \mathcal{W})$.

Furthermore, the simple game is said to be *monotonic* if supersets of winning coalitions are winning, i.e., if $S \in \mathcal{W}$ and $T \supset S$, then $T \in \mathcal{W}$. A monotonic simple game is also called a *simple voting game.*

Very often voting situations are described by *weighted majority* games, for example the one in the EU Council of Ministers. The game (N, v) is said to be a *weighted majority game* if there exists an n-tuple $w = (\omega_1, ..., \omega_n)$ of nonnegative weights with $\omega_1 + \omega_2 + ... + \omega_n = 1$ and a nonnegative quota q such that $v(S) = 1$ if and only if the total weight of the players in S exceeds the quota q, i.e.,

$$v(S) = 1 \text{ if and only if } \sum_{i \in S} \omega_i \geq q.$$

The pair $[q; \omega]$ is called a *representation* of the game (N, v). Typical examples of weighted majority games are:

$\cdot$ the majority game: $w = (\underbrace{1, 1, ..., 1}_{n})$ and $q = (n + 1)/2$,

$\cdot$ the unanimity game: $w = (1, 1, ..., 1)$ and $q = n$,

$\cdot$ the dictator game: $w = (1, 0, 0, ..., 0)$ and $q = 1$ (player 1 is the dictator).

A measure of power is a map ξ from the set of simple voting game (N, v) to the set of n-tuples of real numbers. The value $\xi_i = \xi_i (N, v)$ is the power of player i in the game (N, v), and it satisfies $0 \leq \xi_i \leq 1$.

6.2 Shapley-Shubik Index

One of the most famous power measures used in the literature is the Shapley-Shubik indice[12]. There are several approaches to present and to interpret the Shapley-Shubik index in the literature. Shapley and Shubik (1954) apply the following scheme to introduce their index. The players vote in order and as majority is reached the bill passes. The critical[13] voter is assumed to get the credit for having

[12]For the definitions and the properties see for example, Felsenthal and Machover (1998).

[13]Player i in coalition S is said to be *critical* in S if without player i the coalition left behind is loosing, i.e.

$$i \text{ is critical in } S \qquad \text{if} \qquad i \in S \in \mathcal{W} \text{ and } S \setminus \{i\} \notin \mathcal{W}.$$

If i is not critical in any $S \in \mathcal{W}$, then i is a dummy.

passed the bill. The index is then determined through the assumption of a random voting order.

Let (N, v) be a simple voting game. The Shapley-Shubik index (SSI) of player i is defined by

$$\phi_i = \phi_i(N, v) =_{S:\, i \text{ is critical in } S} \frac{(|S|-1)!\,(n-|S|)!}{n!} \text{ for all } i \in N. \qquad (2)$$

The advantage of this approach is that it is very simple and non-technical. However, the authors emphasize the fact that this scheme "is just a convenient conceptual device". The main shortcoming of this scheme is that this voting model cannot be considered realistic: there is no reason why the pivot should get all the credit, or why the order of the grand coalition formation should matter[14].

6.3 The Nucleolus

The nucleolus is a solution concept for cooperative games, which was first formulated by Schmeidler (1969). In order to introduce it let us consider a characteristic function game (N, v). For convenience, for some vector x we define:

$$x(S) \equiv \sum_{i \in S} x_i \text{ for any } S \subseteq N.$$

A payoff vector $x = (x_1, ..., x_n)$ with $x_i \geq v(i)$ and $x(N) = v(N)$ is called an *imputation*. We denote by $X(N, v)$ the set of all imputations of the game (N, v).

Let x be an imputation, then for any coalition S the *excess* of S is defined as

$$e(S, x) = v(S) - x(S).$$

One may interpret this number as a measure of "dissatisfaction" for coalition S at imputation x. For any imputation x let $S_1, ..., S_{2^n - 1}$ be an ordering of the

[14]For more detailed discussion, see Felsenthal and Machover (1998).

coalitions for which $e(S_l, x) \geq e(S_{l+1}, x)$ for $l = 1, ..., 2^n - 2$. Let $E(x)$ be the vector of excess defined as $E_l(x) = e(S_l, x)$ for all $l = 1, ..., 2^n - 1$. We say that $E(x)$ is *lexicographically* less than $E(y)$ if:

$$E_l(x) < E_l(y) \text{ for the smallest } l \text{ for which } E_l(x) \neq E_l(y).$$

We denote this relation by $E(x) \prec_{lex\,\min} E(y)$.

The *nucleolus* is the set of imputations x for which the vector $E(x)$ is lexicographically minimal:

$$\nu = \nu(N, v) = \{x \in X(N, v) : \nexists y \in X(N, v) : E(y) \prec_{lex\,\min} E(x)\}.$$

The following recursive procedure is used to characterize the nucleolus. By definition $E_1(x)$ is the largest excess of any coalition relative to x. At the first step of the procedure we find the set X_1 of all imputations x that minimizes $E_1(x)$:

$$\begin{array}{l} \min \epsilon \\ \text{s.t. } e(S, x) \leq \epsilon \text{ for all } S, \ \emptyset \subset S \subset N \ \cdot \\ \text{and } x(N) = v(N) \end{array}$$

The set X_1 is called the *least core* of c. If it is not a unique point, we find the set X_2 of all x in X_1 that minimizes $E_2(x)$, the second largest excess and so on. This process eventually leads to an X_k consisting of a single imputation, called the *nucleolus* (Maschler et al. (1979), Schmeidler (1969)). The nucleolus minimizes recursively the "unsatisfaction" of the worst treated coalitions.

It appears that the nucleolus of a game in coalitional form exists and it is unique. If the core is not empty, the nucleolus is in the core. Like the Shapley value the nucleolus can be obtained as the unique value satisfying a set of axioms.