Voting Power and Ideology in the

European Parliament

Thesis by

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ABSTRACT - This paper looks at several voting power indices based upon the Banzhaf power index that take into account the ideology of voters. It then applies these indices to a voting body that is divided ideologically, the European Parliament. The modified power indices tend to reduce the voting power of party groups in extreme ideological positions, to the benefit of the median party group.

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Introduction

The European Parliament (EP) is a curious institution; unlike most national parliaments it is not immediately obvious who wields power. At the national level, in two party systems, the largest party forms the government and holds all the cards. In multiparty systems, a group of parties join in coalition, form the government and share the responsibility of controlling parliament. In the EP a different situation exists – there is no government but there are many national parties. These parties have coalesced into groups with similar ideologies but no group comes close to a majority. To model the distribution of power in this situation a different approach needs to be taken. This paper will use voting power indices to examine how power is distributed in the EP.

Voting power indices look at voting bodies where there are a number of voters and where each voter holds a different but fixed number of votes – such as the Electoral College in the USA, or the Member States of the European Union (EU) when voting in the Council. Voting power indices consider both the number of votes a voter has and the possible coalitions that can form to reach the required number of votes to make a decision. They are mathematical constructs that examine where voters have the chance to reach key positions when forming winning coalitions. The results can frequently lead to situations where the voting power of a voter differs greatly from her share of votes.

The European Parliament is not a body governed by weighted voting in the same way as EU Member States in the Council. But each grouping of political parties, known as a European Party Group (EPG), votes more and more frequently in a disciplined manner; Members of the European Parliament (MEPs) do not vote independently on each vote, they normally vote in a bloc with their colleagues from the same EPG. In this way, the seven party

groups in the EP could be considered as individual voters, each holding a number of votes equivalent to their MEP membership, with each MEP voting for the preference of the party group. This allows voting power indices to be applied to the EP and will produce results pertaining to the relative power held by each EPG.

The results describe the structural power relationship in the EP, and this analysis has been done before (Hosli, 1997; Raunio & Wiberg, 2002). But unlike the Electoral College, where State votes are decided democratically by their populations; or Member States in the Council of the EU, where national governments decide which way to vote; in the EP the party groups represent ideological positions that can influence the coalitions that will form. For example, the centre right European Peoples Party (EPP) is unlikely to vote with the European United Left–Nordic Green Left (EUL-NGL) on economic issues in the same way that the pro-integrationist Alliance of Liberals and Democrats in Europe (ALDE) will not vote with the anti-EU Europe of Freedom and Democracy (EFD) on votes pertaining to European integration. Some coalitions will not (or are extremely unlikely to) form, and this will effect the distribution of power in the parliament.

Since the ideology of the party groups can be measured, this paper proposes to incorporate it into voting power indices used to measure power in the EP. The research question it will aim to answer then is:

Can power indices that account for ideology better represent the distribution of voting power in the European Parliament?

This paper will look at the three most recent European Parliamentary terms: 1999-2004, 2004-2009 and 2009-2014. By taking into account ideology when examining the distribution

of voting power in the EP it will repeat and expand on the work done by scholars looking at earlier parliaments (Hosli, 1997; Raunio & Wiberg, 2002). This could give a more accurate picture of the voting power distribution in the EP and will allow a better understanding of the weight each party group can hope to wield in each parliament.

Whilst this research is of academic interest, it may also be useful to party strategists who wish to understand their starting position prior to negotiating legislation. An understanding of the voting power your group holds in a particular policy area could shape your future ambitions for policy development. It may also be possible to make estimations of the influence party groups will have in upcoming parliaments if the share of seats changes notably, as has happened in the 2014 EP elections.

This paper will begin with a literature review of power index theories, coalition theory and the party system in the EP. It will then formally explain the simplest power indices and show how they produce limited results. Next it will examine ideology in the EP and use this data with a power index that takes ideology into account, the Edelman index. Next roll call voting data will be used with further modified power indices that give potentially more accurate results. The paper will end with a comparison of the indices and a discussion of their value.

Literature Review

Power indices

Voting power indices have been around since the 1940s and have fallen in and out of favour many times. Whilst many different varieties exist, the two most well known and most commonly used indices are the Banzhaf and Shapley-Shubik power indices. The two indices

come from different theoretical backgrounds and look at voting power in different ways. Before continuing, it is useful to look at the distinction between two types of voting power: I-power and P-power. I-power is voting power when it is thought of as a voter's potential influence over the outcome of a decision-making body: whether proposed bills are adopted or blocked. P-power is voting power when it is thought of as a voter's expected relative share of a fixed prize available to a winning coalition (Felsenthal & Machover, 2004, p. 10).

The Banzhaf index (initially developed by Penrose but referred to as the Banzhaf index in most of the literature, a custom this paper will continue) was developed to measure I-power. It measures a voter's influence over the outcomes of a voting body by looking at the number of winning coalitions a voter could destroy by leaving - those coalitions that would change from winning to losing if the voter was to change sides. This is an intuitive way of measuring voting-power and was independently 'developed' by Penrose, Banzhaf and Coleman (Penrose, 1946; Banzhaf, 1965; Coleman, 1971).

The Shapley-Shubik index comes from a game theory background, and measures P-power. It assumes that in each voting game there is a fixed prize (in utility), and that the Shapley-Shubik value is the share of that prize the voter can expect. This is calculated by looking at all permutations of coalitions, and counting the number of times a voter is pivotal, when the pivotal voter is the voter that turns a coalition from losing to winning. The two indices often give similar results but they come from different backgrounds, probability theory and cooperative game theory, and should be considered separately (Felsenthal & Machover, 2004, p. 11).

Both of these power indices can be referred to as *a priori* indices. In this context *a priori* means that the indices only look at the mathematical relationship that underpins the voting body. The only information that is required to calculate voting power is the decision rule (how many votes are required to win the vote), the number of voters and the voting

weight each voter carries. This makes the *a priori* indices both simple to use and easily applicable to many different institutions. But they do not represent the actual voting power voters have, as there are a large number of other real world factors that are not included in the calculations. Everything from the diplomatic skill of the negotiators to the contents of the bill are relevant, and much in between. Most of these external effects cannot be easily quantified, but in some voting bodies there is one aspect that it is possible to measure – ideology.

In many voting bodies, particularly political ones, the voters can be aligned along one ideological dimension. If voters (in the case of the European Parliament, party groups) represent particular ideological positions, the coalitions in which they will join should be, to a large extent, determined by these ideological positions. In a multiparty parliament, it is common to find left wing and centrist parties in coalition together, or right wing and centrist parties in coalition together, but very rare to see left wing parties in coalition with right wing parties with centrist parties excluded. Some coalitions will be more likely to occur than others and this could affect the voting power of voters that have extreme ideological positions. Some scholars have tried to take this type of relationship into account by modifying the *a priori* power indices. Guillermo Owen and Lloyd Shapley (Owen, 1971; Owen & Shapley, 1989) developed a variation of the Shapley-Shubik index that incorporated ideology across many different dimensions. They introduced the probability of a coalition forming into the index. In this way, coalitions containing members separated by ideology (eg between left and right wing parties) would be less likely to occur and carry less weight in the calculations than coalitions sharing similar ideologies (eg two right wing parties). Paul Edelman (1997) modified the Shapley-Shubik and Banzhaf indices to account for ideology on a single dimension. For Edelman, ideologically separate coalitions are not just less likely to

occur, they cannot occur. In this way only those coalitions containing parties that are ideologically adjacent are able to form.

Both sets of indices produces interesting results that tend to favour median parties when applied to parliament situations and both will be used in different parts of this paper. The Edelman index will be used as described by Edelman and some elements of the index developed by Owen and Shapley will be taken and applied to the Banzhaf index.

Coalition formation

Coalitions form the bedrock of many democratic systems. Whether they are created to form governments or required to pass particular legislation in parliament, they are essential for the success of democracy. It is not surprising then to discover that the literature on coalition formation is vast. This section will not be able to comprehensively conduct a literature review on coalition formation, rather it will summarise the work that is most relevant to coalitions from the perspective of the European Parliament.

Most early coalition formation literature was derived from cooperative game theory. Early game theorists like von Neumann and Morgernstern (1953) created coalition theories that focused around minimum winning coalitions. Riker, in his development of von Neumann and Morgernstern, looked at coalitions from the perspective of n-person games (1962). Riker considered that if actors were rational in wanting to maximise their payoffs, and the games in which they played were zero-sum, only minimum winning coalitions would form. That is, only those coalitions that just passed the threshold for success, as the winners would then share the 'prize' of winning between the smallest number of voters, maximising their gains (Riker, 1962, p. 62). Riker did not account for ideology in his model, although he recognised two scenarios where coalitions larger than minimum winning could form. These were in the case of roll call votes, where the leaders of coalitions cannot stop other members from

joining, and where information on voting intentions is imperfect, forcing leaders of coalitions to create breathing space in case of defection by increasing their majorities (Riker, 1962, pp. 44-88).

Further work in cooperative game theory has produced more complicated models with more variables and some of this work has taken into account the ideology of the players. Robert Axelrod suggested that politicians are interested in minimising transaction costs during coalition bargaining (1970). In order to achieve this, coalitions would only develop from parties that are ideologically adjacent to each other – eg party leaders would seek to minimise the ideological differences between the parties. Other scholars, such as De Swaan, developed this idea, stating that parties will form minimal winning coalitions with the smallest ideological range (1973).

Some work has approached coalition formation in government from an institutional perspective. But as the EP is dissimilar to most other parliaments in not forming a government, this is of less relevance. Nevertheless, some interesting literature surrounding the *formateur* of a coalition exists. The *formateur* is the party tasked by the president (or monarch) to form a government after an election in many European parliaments. This party is in a more powerful position, and coalitions are likely to form from parties with ideologically similar positions to the *formateur* (Austen-Smith & Banks, 1988; Baron, 1991). This is difficult to extend to the legislative process of the EP, as the Commission proposes legislation, but it may indicate a link between the party group of the MEP chosen as the *rapporteur* for the legislation, and the support for the legislation in plenary.

In much of the recent literature on coalition formation then, ideology (or the individual preferences of legislators) has played an important role. Interestingly, Martin and Stevenson tried to test how important several of these forces were in coalition formation by examining real world examples of government formation from parliaments after elections

(2001). They conducted a multivariate analysis of 14 developed Western democracies across 50 years, looking at all possible coalitions that could form a government. What they found was that both office benefits and ideology played a significant role in coalition formation. Whilst minimum winning coalitions were more likely to form than minority governments or excess majorities, there was a much greater effect from policy divisions on coalition formation. Any potential coalition was found to be less likely to form the greater the ideological incompatibility between the members, with coalitions containing the median party being more likely to form (Martin & Stevenson, 2001, pp. 41-42). Institutional effects that were found included that the largest party was likely to be chosen as the *formateur* and be included in the coalition and anti-system parties were almost never included in government coalitions (Martin & Stevenson, 2001, pp. 43-46). Whilst the office benefits are less relevant in the EP, the fact that ideology is strongly linked to government coalition formation is. The lack of anti-system parties in government coalitions is also paralleled in the EP by anti-European party groups not joining legislative coalitions.

What this review of coalition formation literature finds is that despite the heterodox nature of the research done on coalition formation, ideology is frequently stated either as an important variable, or the most important variable in determining the coalitions that form in political bodies. Whilst other factors are important, and in some cases can override ideology, ideology is essential to understand the formation of coalitions. It lends weight to the credibility of selecting ideology above other factors in coalition formation, and its application to voting power indices.

The European Parliament

The European Parliament (EP) is a unique institution; it is one of the three major organs of the European Union (EU), along with the Commission and the Council of the EU, and its

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powers have steadily increased since it became an elected chamber in 1979. Today, under the ordinary legislative procedure, the EP and the Council are jointly responsible for the vast majority of legislation produced by the EU (European Parliament, 2014) – and as such the EP is an important actor. Yet it is made up of transnational party groups that are not controlled by national or European governments. These party groups have come to dominate the EP, with their members coming from a variety of EU member states. The party groups have become more cohesive over time and, in order to pass legislation, have had to form coalitions with other EPGs within a multi-party parliament.

The EP hosts political parties from every one of the EU's 28 member states and these parties come from all sectors of the political divide. To coordinate this disparate group of parties, party groups take national political parties that share similar ideologies as members. For example, the Progressive Alliance of Socialist and Democrats (S&D) is made up of centre left socialist parties from across Europe, and the Greens – European Free Alliance (Greens-EFA) is made up both of traditional green parties and regionalist political parties. Other party groups contain national parties that share either socio-economic ideologies, or positions towards European integration, or both. The party groups are the main actors in the EP and have become more effective as units as time has passed.

Since 1989, in each parliament, EPGs have become more cohesive[1], and by the most recent parliament, four of the seven party groups scored 0.9 or higher (on a scale of 0 to 1) for cohesion with only the smallest group made up of anti-Europeans scoring less than 0.8. This increase in cohesiveness has come about at the same time as an increase in the number of member states in the EU, and is largely due to better organisation and whipping

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[1] Using the Rice Index to measure party cohesion, $AI_i = \frac{|Y_i - N_i|}{Y_i + N_i}$, where Y_i denotes the number of yes votes expressed by group i on a given vote and N_i is the number of no votes.

procedures, especially by the larger EPGs. As the party groups are the only access for MEPs to committee membership and positions of influence in the EP, party group whips are able to enforce discipline by using these positions as incentives. As such, party groups have come to largely vote as blocs, and they are the most important organisations within the EP (Hix, 2004, pp. 204-205).

The party groups frequently change their names or composition between and during parliamentary terms. Below is a list of the names of all the EPGs with their respective share of seats in the EP at the start of the 1999-2004, 2004-2009 and 2009-2014 EPs, excluding parties that are not members of an party group.

1999-2004 EP – Total Seats 626

Name	Abbreviation	Seats
European People's Party – European Democrats	EPP-ED	233
Party of European Socialists	PES	198
European Liberal Democrat and Reform Party	ELDR	50
The Greens – European Free Alliance	Greens-EFA	48
European United Left – Nordic Green Left	EUL-NGL	42
Union for Europe of the Nations	UEN	30
Europe of Democracies and Diversities	EDD	16

2004-2009 EP – Total Seats 732

Name	Abbreviation	Seats
European People's Party – European Democrats	EPP-ED	268
Party of European Socialists	PES	200
Alliance of Liberals and Democrats for Europe	ALDE	88
The Greens – European Free Alliance	Greens-EFA	42
European United Left – Nordic Green Left	EUL-NGL	41
Independence/Democracy	INDDEM	37
Union for Europe of the Nations	UEN	27

2009-2014 EP – Total Seats 736

Name	Abbreviation	Seats
European People's Party	EPP	265
Progressive Alliance of Socialists and Democrats	S&D	183
Alliance of Liberals and Democrats for Europe	ALDE	84
The Greens – European Free Alliance	Greens-EFA	55
European Conservatives and Reformists	ECR	54
European United Left – Nordic Green Left	EUL-NGL	35
Europe of Freedom and Democracy	EFD	32

Table 1: Breakdown of EPGs by parliament

The legislative process in the EP is also unusual. The main legislative procedure in the EP is known as the ordinary legislative procedure. Since the Treaty of Lisbon in 2009, the ordinary legislative procedure has been used for the vast majority of legislation that the EP considers. Prior to that it was called the co-decision procedure, but, since the Treaty of Amsterdam in 1999, it was still used for the majority of legislation in the EP. Whilst simpler than previous legislative procedures the EP has used it is not simple. In summary, the Commission (which is the only body that can propose legislation) submits a proposal to the EP, which scrutinises the legislation in committee. After scrutiny the committee may or may not produce an amendment to the Commission's proposal. Either way, the proposal is taken to plenary and a majority of those present is required for legislation to pass (EP Rules of Procedure, 2014, Ch 3).

After this the proposal is passed to the Council, who can accept the EP's position or produce its own position (by qualified majority voting). If the EP's position is accepted it passes, if not it is returned to the EP for a second reading. This again returns to committee in the EP before being put forward to plenary. In this second reading the EP can accept, reject or amend the Council's position, but on the second reading an absolute majority of MEPs is

required – which as the parliament rarely has full attendance requires more than half of those present to vote to amend the Council's position (EP Rules of Procedure, 2014, Ch 4).

This is then returned to the Council for their approval. If they do not approve the proposal is taken to a third 'conciliation' phase where the Council and EP are brought together. Approval of any final legislation from this conciliation must be voted for in the EP and Council before it is finally accepted (EP Rules of Procedure, 2014, Ch 5).

Previously the requirement for an absolute majority in the second reading in a low turnout environment had forced the largest two political groups to work together and cooperate from the earlier phases of the legislative process, encouraging a grand coalition of the centre left PES and centre right EPP-ED. However recent increasing turnout in the EP have made this less important (Hix & Høyland, 2011, p. 60).

These factors: the multi-party system, the lack of a government coordinating the parties, and the ideological differences and high cohesiveness of the EPGs, make the EP a excellent institution with which to test the validity of ideologically modified power indices.

Ideology

Downsian models of political competition commonly align parties along a single ideological axis from left to right, determined by their economic positions – those on the left preferring a state-planned economy and those one the right preferring deregulation (Downs, 1957). This scale has been used for countless national political parties, but it is also applicable to the EP. As EPGs are formed along ideological lines, they too can be placed along a left-right dimension from the EUL-NGL on the far left to the EFD on the far right. But other ideological dimensions exist also exist in the EP, with attitudes towards further European integration

being the most important. Some party groups' overriding goal is to stop further European integration (or reverse it altogether), whereas others are content to continue to integrate towards a federal Europe.

This link between the ideology of EPGs and their member parties has been demonstrated empirically by McElroy and Benoit using expert surveys. McElroy and Benoit showed that party groups share ideological positions across a range of policy areas with their member parties, and that the policy positions of the EPGs are generally placed at the centre of the distribution of their national party positions (2007, p. 21). They also identify two major dimensions on which policy is grouped in the EP, an economic (or tax vs spend) dimension and a dimension based on views towards European integration. Other studies have supported these findings. Using a spatial model to examine roll call votes, Simon Hix has demonstrated how voting in the EP is conducted by cohesive party groups who vote along one major dimension and one minor dimension. The major dimension is believed to be the Downsian left-right division with the smaller dimension thought to include attitudes towards European integration (Hix, 2001; Hix, Noury, & Roland, 2009).

But whilst it is accepted that ideological differences exist, it is not unproblematic to measure ideology. Expert judgements are one way of measuring ideology that rely on the opinion of a number of experts to judge the position of political parties on particular policy areas. They offer benefits in that they are simple, relatively inexpensive and provide immediately usable and scalable data that does not require interpretation, unlike spatial models (McElroy & Benoit, 2007, p. 9). But limitations can include the validity of the experts' judgements if the questions are not clearly phrased (Budge, 2000). Generally however, it is considered that expert surveys are a valid way of measuring party ideology and frequently more accurate than some other methods, such as comparative manifesto studies

(Steenbergen & Marks, 2007, pp. 361-362). This paper will use expert surveys as one way of measuring the ideology of EPGs.

Considerable research by experts specialising in European politics has also been conducted using spatial models of voting. Most of this research has been conducted using some form of the Nominate scaling method. Nominate examines roll call votes in a parliament and allows voters to be located in multidimensional space relative to each other. This is extremely useful for examining how MEPs behave in the EP. Nominate takes three assumptions, (1) legislators have an ideal point in multi-dimensional policy space, (2) legislators policy preferences are single peaked and symmetric when voting, and (3) the probability of a legislator voting for or against a particular proposal is determined by the cutting line that divides the legislators into 'yes' and 'no' camps. Nominate then uses standard logit arithmetic to determine the number of policy dimensions that exist in the legislature, the ideal point of each legislator and the cutting line of every vote. For many legislatures (including the EP) the results suggest two policy dimensions are dominant and legislators' ideal positions can be estimated in two-dimensional policy space (Hix, 2001, pp. 669-670).

There are several versions of Nominate that have been developed since its first use in 1982 to examine Congress in the USA. This paper will not discuss the technical differences between each method, but each method has been applied to the EP and provided results pointing to a two-dimensional policy space (Hix, 2001; Noury, 2002; Hix, Noury, & Roland, 2006; Hix & Noury, 2009). Some work has also been conducted using the optimal classification (OC) method. OC is a simpler method and unlike Nominate is non-parametric, but it still produces reliable results that are comparable to Nominate (Poole, 2005, p. 46). OC is advantageous in that, unlike Nominate, it does not assume all errors are identically

distributed across legislators and roll call votes. As different party groups in the EP are different sizes and have varying levels of cohesion this assumption is likely to be voided. The downside is that OC is not able to precisely locate legislators' positions in space, but relies on an estimation within a bounded area, but this is a problem that all spatial models of roll call voting suffer, including Nominate (Rosenthal & Voeten, 2004, pp. 6-9). For the advantages outlined above, and for its relative simplicity compared to the Nominate methods, OC will be used as an alternative to estimate EPG's ideological positions later in this paper.

Theory and Analysis

Assumptions

Before the different power indices are examined it is necessary to explain some of the assumptions that underpin their use. All the voting power indices considered in this paper assume that voters are unitary actors that hold a specific number of votes. In the case of the EP this would mean that the party groups control all of their MEPs – all of them vote and they always vote together on their party group's preferred position. The EP clearly does not act like this in practice. It is not an institution made up of homogenous party groups that always vote together in a bloc; each MEP holds a vote and can (and often does) vote against her party group, abstain or not turn up for a vote. However, as party groups are reasonably cohesive, and most MEPs vote with their party group most of the time (Hix, 2004), assuming complete cohesiveness is not unreasonable. Also, for important or close votes, MEPs would be expected to turn out and vote with their parties en masse. So it is also not unreasonable to assume, when measuring voting power, that the potential maximum turnout of the EPGs

should be used as the weighted value of votes, despite varying levels of absenteeism or rebellion across individual votes.

These assumptions mean that the voting power indices do not reflect the actual behaviour of the parliament, but rather allow an estimation of the voting power of the party groups under perfect conditions. Once these assumptions are accepted, an examination of the different power indices is possible.

A priori voting power

There are two *a priori* voting power indices that are frequently used to calculate voting power in legislatures: the Banzhaf and the Shapley Shubik power indices. For consistency and to allow comparison between different variations on these indices, this paper will focus its calculations on the Banzhaf power index. It is simpler than the Shapley-Shubik index, and measuring voting power as I-power (passage or defeat of the proposed bill) is less problematic than measuring P-power (the distribution of a fixed purse between the victors in case a bill is passed). For reference the Shapley-Shubik index is discussed in Appendix 1.

The Banzhaf index β takes a weighted voting assembly with *n* voters (v_1, v_2, …, v_n) with a decision rule ω. It can be displayed in the following format.

$$[\,\omega\,;v_1\,,v_2\,,\ldots\,,v_n\,]$$

Each voter v_i carries a non-negative number of votes, with the decision rule ω being the number of votes required to win. The Banzhaf index is simplest to explain through an example. If a three player assembly is considered, with voter A holding 3 votes, voter B holding 1 vote and voter C holding 5 votes, and if the majority required to pass a vote is 6 (the decision rule) the game can be displayed as such:

$$[\,6\,;3\,,1\,,5\,]$$

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To calculate the Banzhaf index the critical voter is important. The critical voter is the voter whose exclusion from a winning coalition would cause it to become a losing coalition. In the above example, if all three voters join in coalition ABC, collectively they have 9 votes, which is larger than the 6 required by the decision rule to make it a winning coalition. In this case voter C would be a critical voter, as if he left the coalition it would revert to a losing coalition (with only 4 votes), but voters A and B would not be critical as were either to leave, coalitions BC and AC would still be winning coalitions. If all the coalitions are examined there are found to be 3 winning coalitions and 5 critical voters.

AB	4 votes	not winning
AC	8 votes	critical voters A & C
BC	6 votes	critical voters B & C
ABC	9 votes	critical voter C

The Banzhaf power index is then calculated as the number of times a voter is critical c_i divided by the sum of the total number of times all voters are critical (Banzhaf, 1965).

$$\beta_i = \frac{c_i}{\sum [\, c_1 \, , \, c_2 \, , \ldots , c_n \,]}$$

For the above example this produces the following Banzhaf power index for each voter:

$$\beta_A = 1/5 \qquad\qquad \beta_B = 1/5 \qquad\qquad \beta_C = 3/5$$

If the *a priori* Banzhaf index is applied across the 1999-2004, 2004-2009 and 2009-2014 European Parliaments, the following results are found.

1999 EP

	EUL-NGL	Greens - EFA	PES	ELDR	EPP-ED	UEN	EDD	Majority*
Seats	42	48	180	50	233	31	16	314
Banzhaf	0.091	0.109	0.164	0.109	0.418	0.073	0.036	

2004 EP

	EUL-NGL	Greens - EFA	PES	ALDE	EPP-ED	UEN	INDDEM	Majority*
Seats	41	42	200	88	268	27	37	367
Banzhaf	0.064	0.083	0.174	0.156	0.413	0.046	0.064	

2009 EP

	EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD	Majority*
Seats	35	55	183	84	265	54	32	369
Banzhaf	0.047	0.084	0.159	0.140	0.439	0.084	0.047	

Table 2: *A priori* power index results in the European Parliament.

* The decision rule is equal to half plus one of the total membership of each EP.

The Banzhaf index allocates the greater share of voting-power to the largest (EPP-ED or EPP) party group, with the second largest party group (PES or S&P) holding less than half the voting power of the largest group. The smaller party groups also appear to hold more voting power than is conventionally attributed to them. In 1999 the EUL-NGL and Greens-EFA have voting power comparable to the centrist ELDR, which, at least in the case of EUL-NGL, is unlikely to translate into real world voting power due to the extreme position they take on economic issues. A similar picture is seen on the right with anti-European party groups (EDD, INDDEM & EFD) having been allocated a non-negligible amount of voting power. This does not correspond to the alienation and powerlessness they have in the EP currently.

The *a priori* indices calculate the voting-power that the specific decision rule gives voters, but they do not take into account external factors. In an ideologically organised organisation like the EP, voting power is not so simply divided. The centrist party groups do

cooperate with each other often, whilst the more extreme party groups, such as the anti-European EPGs, are largely marginalised irrespective of how many MEPs they have. This must effect the power arrangement in the EP. How this ideology might be incorporated into these power indices will now be investigated.

Taking ideology into account – the Edelman index

Several scholars have tried to incorporate ideology into the *a priori* power indices. In 1997 Paul Edelman modified the Shapley-Shubik and Banzhaf indices to incorporate the idea of convex geometries. Edelman supposes that in a voting body organised along ideological lines, it will only be possible to form certain coalitions. If the body is ideologically aligned along one dimension, only those parties that are ideologically adjacent to each other will be able to cooperate in coalition. This is analogous to the relationship predicted by Axelrod (1970) in government formation, that allowed policy makers to minimise decision making friction by only working with ideologically similar allies. For example, if there are three voters A, B and C and they are aligned along one dimension, they can be represented in the following manner.
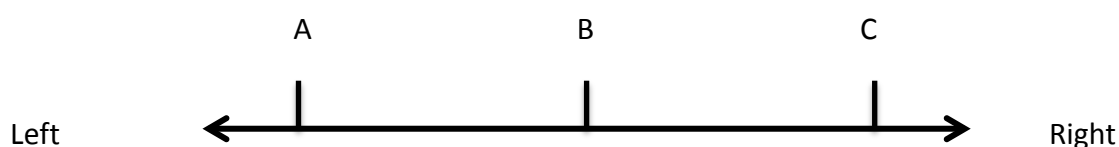

Figure 1: Simple ideological scale with three voters

For Edelman, the only coalitions that are permissible are those that are ideologically adjacent. So it is possible for A to join B in coalition, or B to join C, and even the grand coalition ABC, but never A with C. These possible coalitions can be represented with a Hasse diagram (Edelman, 1997, p. 41).
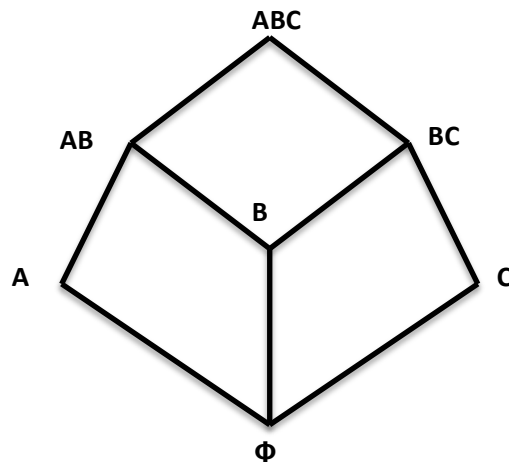
Figure 2: Hasse diagram with three voters

Edelman assumes coalitions form one voter at a time. From a position where there are no coalitions (the empty set Φ), three options are possible, voters A, B or C acting alone. From here the coalitions AB or BC can be formed by one adjacent voter joining voter A, B or C. If the final voter joins coalition AB or BC the grand coalition ABC is formed. When there are a larger number of voters the number of possible coalitions increases, but there are still significantly less viable coalitions than with the *a priori* indices (in which all coalitions are viable). In an organisation with seven voters such as the EP, the Banzhaf index looks at 128 possible coalitions (and selects the winning ones). The Edelman index only considers 29 coalitions to be feasible.

As the Edelman index just restricts the number of possible coalitions, it is relatively simple to apply this constraint to the Banzhaf index (this could also be done with the Shapley-Shubik index). Returning to the three voter example:

$$[\,6\,;3\,,1\,,5\,]$$

Where voter A has 3 votes, voter B has 1 vote and voter C has 5 votes, with a decision rule of 6. Assuming that the voters are aligned along a spectrum as in figure 1, the Edelman Banzhaf index can be calculated. As it is impossible for voters A and C to cooperate without voter B, this changes the power indices significantly. For the Banzhaf index the feasible winning coalitions are:

BC	6 votes	critical voters B & C
ABC	9 votes	critical voter C

So the Edelman-Banzhaf index distributes the voting power between voters B and C as follows:

$$\beta_A^E = 0/3 \qquad \beta_B^E = 1/3 \qquad \beta_C^E = 2/3$$

Voter A has become a dummy voter as all the voting power is shared between voters B and C. If these rules were applied to the EP they could return interesting results, but before it is possible to apply them, it is necessary to identify the ideological spectrum in which the party groups exist. For the EP there are several approaches towards this, this paper will first look at expert surveys.

Between April and June 2004, at the end of the 1999-2004 EP term, Gail McElroy and Kenneth Benoit conducted a survey of 36 academic experts on European politics, asking them to rank the EPGs and the national parties present in the EP by their ideological positions (McElroy & Benoit, 2007). The survey questions ranged over a number of policy areas, but the most important question pertained to the general left-right dimension. This question was: Please locate each political group on a general left–right dimension, taking all aspects of group policy into account. Left (1) Right (20) (McElroy & Benoit, 2007, p. 22).

But McElroy and Benoit only conducted these surveys for the 1999-2004 parliament, and the names and constituents of party groups frequently changed between (and during) EP terms. To enable a comparison between party groups across parliaments, an expert survey that has been conducted on a more regular basis can be used. The Chapel Hill surveys (Steenbergen & Marks, 2007) have asked political party experts roughly every four years to rank national political parties on a number of ideological positions. For this research the 2002, 2006 and 2010 surveys are of interest, as each survey is taken in the middle of a different EP term (1999-2004, 2004-2009 and 2009-2014).

To convert ideological positions of national parties from the Chapel Hill Surveys into the ideological positions of EPGs, the weighted mean of the ideological positions of the national party memberships are taken. The relevant question on the Chapel Hill surveys is: Please tick the box that best describes each party's overall ideology on a scale ranging from 0 (extreme left) to 10 (extreme right). Unfortunately, not all parties in the EP are included in the Chapel Hill surveys, as some of the smaller national parties were excluded, but information is available for 92% of MEPs. The data for the 1999-2004 EP is displayed below (the McElroy and Benoit data is included for comparison). The top bar represents data from the McElroy and Benoit survey and the bottom bar the Chapel Hill survey. As the EDD is largely made up of smaller parties, there was not enough information to generate their position in 2002 from the Chapel Hill Survey.
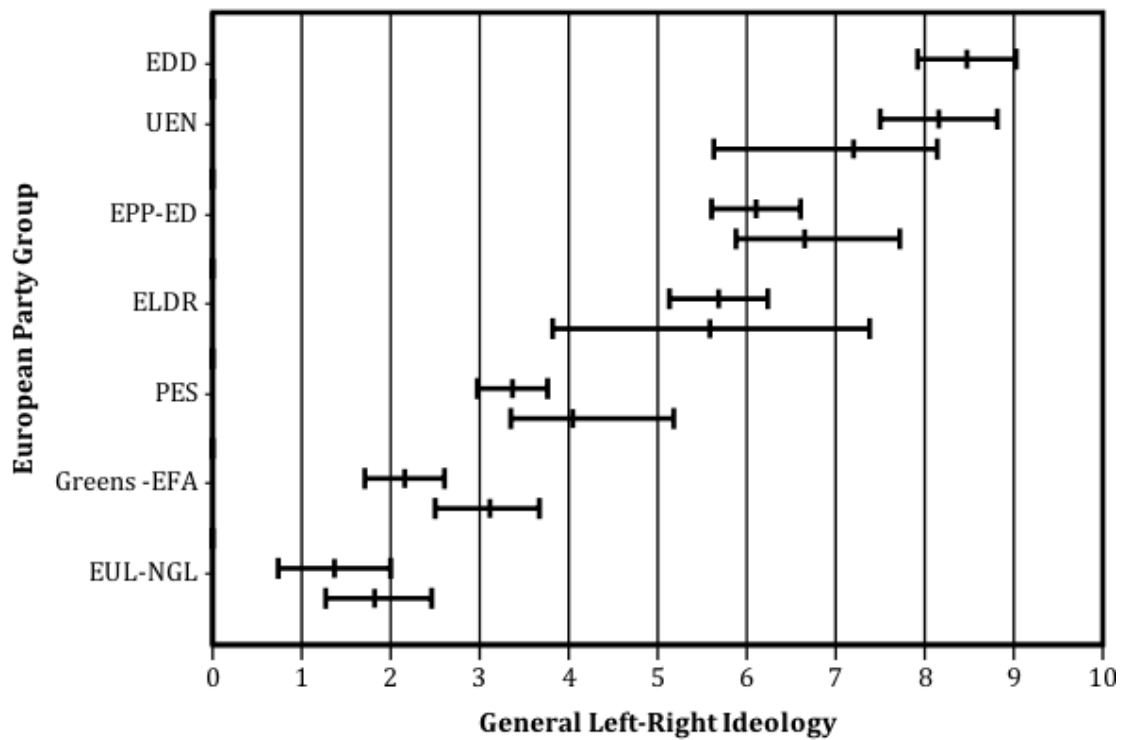
Figure 3: General Left-Right ideology of EPGs in the 1999-2004 EP from the Chapel Hill (Steenbergen & Marks, 2007) and McElroy and Benoit surveys (2007). The top line represents McElroy and Benoit data and the bottom line Chapel Hill data. For the Chapel Hill data the centre line represents the weighted mean of the EPG's national party positions and the bar represents a 90% confidence interval. For the McElroy and Benoit data the centre line represents the mean position with the bar representing one standard-deviation from the mean expert position.

The exact positioning of each EPG differs between the two surveys, with the McElroy and

Benoit surveys tending to place the party groups further to the margins than the weighted

Chapel Hill survey positions. But the relative alignment of the EPGs from both surveys is

exactly the same, with the EPGs aligned from the EUL-NGL on the far left to the EDD on the

far right. As for Edelman only the ordinal positions are important, not the ideological score

of each EPG, the EPGs can be aligned along a one-dimensional Left-Right ideological

spectrum as shown below.
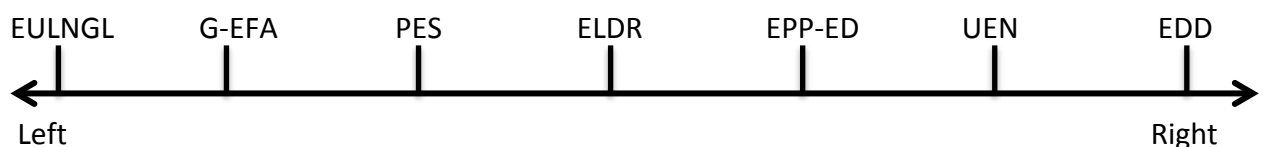
Figure 4: General Left-Right ideological spectrum in the 1999-2004 European Parliament

Similar spectrums can be produced from the positioning of the parties from the 2006 and 2010 Chapel Hill Surveys. On this page and the next are the results from the 2006 and 2010 surveys.
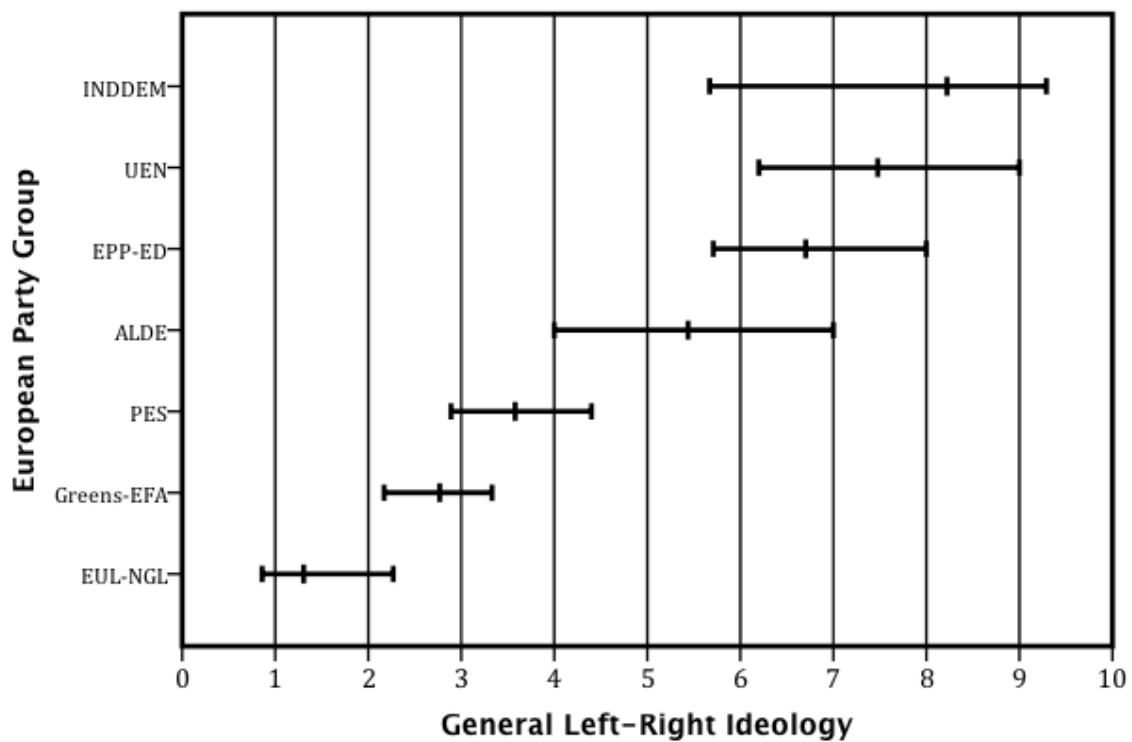
Figure 5: General Left-Right ideology of EPGs in the 2004-2009 EP from the Chapel Hill survey (Steenbergen & Marks, 2007) The centre line represents the weighted mean of the EPG's national party positions and the bar represents a 90% confidence interval.

What they show is a similar pattern from the 2002 survey; the mean positions of the party groups can be aligned from left to right. There is some overlap between the ideological positions of the constituent parties of some party groups, some members of the ALDE sit further to the right than some members of the EPP for example, but the mean positions of each party group are far enough apart to be identifiable. There also appears to have been a tendency for the party groups to become more ideologically coherent, as the make-up of the party groups in 2010 where more ideologically coherent than in 2002 or 2006.
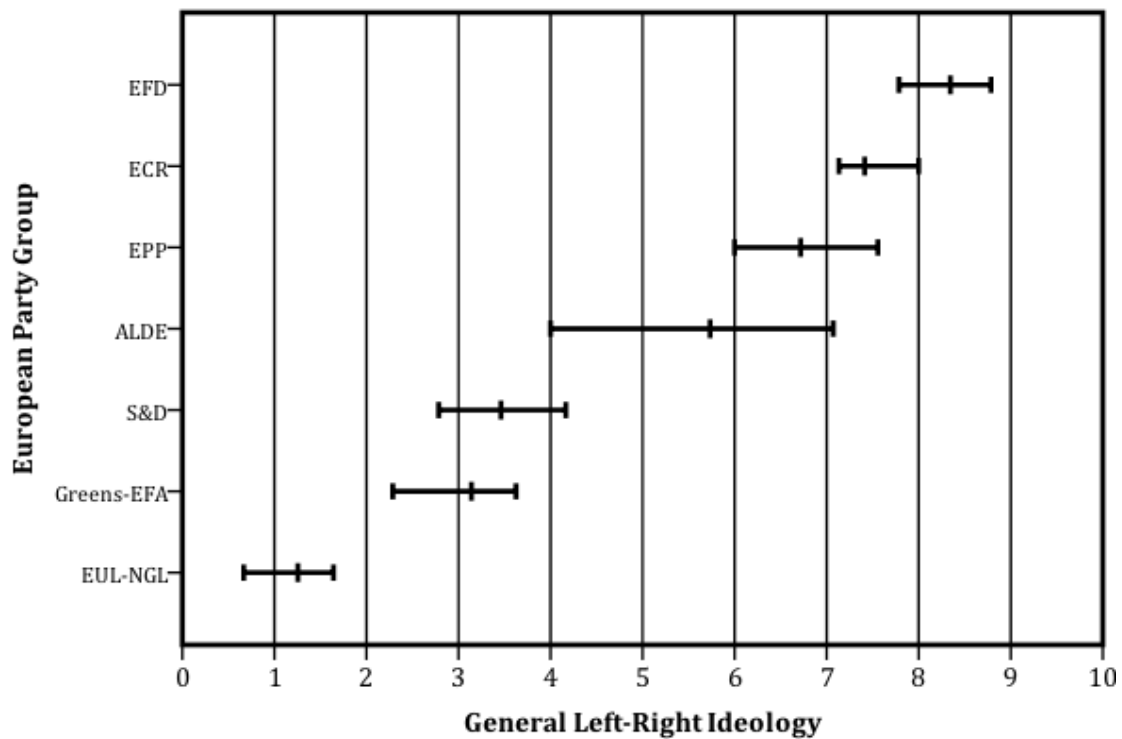
Figure 6: General Left-Right ideology of EPGs in the 2009-2014 EP from the Chapel Hill survey (Steenbergen & Marks, 2007) The centre line represents the weighted mean of the EPG's national party positions and the bar represents a 90% confidence interval.

Both could be transformed into another ideological scale similar to figure 5, but the party group positions are apparent from the plots.

From these ideological scales the number of allowable coalitions can be defined by following Edelman's guidelines for adjacent coalitions. If applied, the following results are found.

1999-2004 EP

	EUL-NGL	Greens -EFA	PES	ELDR	EPP-ED	UEN	EDD	Majority*
Seats	42	48	180	50	233	31	16	314
A priori B	0.091	0.109	0.164	0.109	0.418	0.073	0.036	
Edelman B	0.063	0.063	0.125	0.188	0.438	0.125	0.000	

2004-2009 EP

	EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	INDDEM	Majority*
Seats	41	42	200	88	268	27	37	367
A priori B	0.064	0.083	0.174	0.156	0.413	0.046	0.064	
Edelman B	0.067	0.067	0.133	0.200	0.467	0.067	0.000	

2009-2014 EP

	EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD	Majority*
Seats	35	55	183	84	265	54	32	369
A priori B	0.047	0.084	0.159	0.140	0.439	0.084	0.047	
Edelman B	0.000	0.000	0.091	0.182	0.636	0.091	0.000	

Table 3: Edelman's power index results in the European Parliament.

* The decision rule is equal to half plus one of the total membership of each EP.

In each of these indices the extreme parties have lost a great deal of voting power. Looking first at the Edelman version of the Banzhaf index, the EPP has retained the most voting power, increasing slightly over the *a priori* index in 1999 and 2004. In 2009 this has increased substantially to holding well over half of the voting power in the EP. The anti-European party groups (EDD, INDDEM and EFD) have lost all of their voting power, and Greens-EFA and EUL-NGL retain a small amount until 2009 when they too lose all voting power. The other two centremost parties have also seen changes, with the liberal party group, being the beneficiary of some of the decreasing voting power of the extreme parties, now eclipsing the centre left PES in terms of voting power. In the EP, the Edelman Banzhaf index appears to allocate significantly more voting power to the median voter at the expense of the EPGs on the extremes.

Whilst these results are interesting, and point in the direction of how ideology could affect voting power, they only prove worthwhile if coalitions in the EP form in the manner expected by Axelrod and Edelman. This paper will now turn to that question.

Alternative ways to incorporate ideology – the modified Banzhaf index

To discover which coalitions form within the European parliament it is necessary to know the voting record of each MEP. Fortunately, the EP is one of the most transparent parliaments in the world and publishes all of its voting records. Of particular interest are roll call votes, which consist of approximately one third of the total number of votes. Roll call votes are the votes in which the position of every MEP is recorded and published. For the 1999-2004 and 2004-2009 parliaments this is available online from the LSE (Hix, Noury, & Roland, 2006), but at the time of writing, the 2009-2014 parliament's roll call votes are yet to be published in a consolidated format.

Using roll call votes the party group coalitions that formed for each vote can be calculated[2]. Coalitions that match Edelman's ideologically adjacent rule count for 65.4% of coalitions in the 1999-2004 EP and 77.9% in the 2004-2009 EP. So whilst most coalitions form in this manner it is a long way from these coalitions being the only possible coalitions to form. So Edelman's index is too strict in its restrictions in the EP. There must then be another relationship that better explains the link between ideology and coalition formation. Whilst it is intuitive to expect ideology to influence the coalitions that form, it is unlikely to have such an extreme effect. More likely a subtler relationship between ideology and coalition formation exists, with ideology being a significant factor but not the only or overwhelming one. Thus, following from Martin and Stevenson's work that found government coalitions were less likely to form the greater the ideological incompatibility between the members (Martin & Stevenson, 2001, pp. 41-42), it will be theorised that the probability of a coalition forming is negatively proportional to the ideological distance between the voters in that coalition.

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[2] EPGs were considered to have voted yes for a bill if twice as many of their members voted yes as voted no or abstained. EPGs were considered to have voted no for a bill if twice as many of their members voted no as voted yes or abstained.

To take this into account a new power index model is required. Several scholars have introduced ideological differences as variables affecting coalitions in power indices, the first being Owen (1971), who modified the Shapley-Shubik index to incorporate ideology as voter positions on a sphere. This paper will take an alternative approach, drawing from Mazurkiewicz and Mercik (2005), but basing its calculations on the Banzhaf index.

Before proceeding to define the modified index, some more assumptions need to be explained. The first assumption that will be made is that voters join a coalition one voter at a time. So, for example, in a two-voter coalition, coalition AB can be formed by either voter A joining voter B, or voter B joining voter A. For a three-voter coalition, voter A can join the coalition BC, voter B can join the coalition AC or voter C can join the coalition AB, and so on for increasing coalition sizes. For each coalition of n players, there will be n ways the coalition can form by adding one voter to an existing smaller coalition.

The second assumption that will be made is that the probability of a coalition forming is negatively proportional to the ideological distance between the voters. So if a one-dimensional spectrum is first considered.

Left ← | A | | B | C | → Right

Figure 7: Simple ideological scale with three voters asymmetrically aligned

It is intuitive that voters that are closer together would vote together more often than those that are far apart. So, in the above example, despite being positioned between voter A and voter C, voter B would cooperate more often with voter C than with voter A, as she is ideologically closer. Conversely it follows that voters who are ideologically further apart would vote together less often, and this will be assumed to fall towards 0 when the two voters are at opposite sides of the spectrum. So, on an ideological scale running from 0 to 1,

for a two-voter coalition, the probability of it forming, P_{AB}, will be taken as negatively proportional to the distance between each voter (for when either A joins B or B joins A):

$$P_{AB} \sim 1 - |I_A - I_B|$$

Where I_A and I_B are the respective ideological positions of the voters. The probability of a three-voter coalition forming, when voter C joins coalition AB, and when each voter has a number of votes V_n, would be proportional to:

$$P_{ABC} \sim P_{AB} \left(1 - \left|\left(\frac{I_A}{V_A + V_B} V_A + \frac{I_B}{V_A + V_B} V_B\right) - I_C\right|\right)$$

With

$$I_{AB} = \left(\frac{I_A}{V_A + V_B} V_A + \frac{I_B}{V_A + V_B} V_B\right)$$

I_{AB} representing the mean ideological position of the coalition AB. But as there are three options for forming this coalition, two more probabilities arise linked to the alternative ways in which the coalition can form:

$$P'_{ABC} \sim P_{BC} \left(1 - \left|\left(\frac{I_B}{V_B + V_C} V_B + \frac{I_C}{V_B + V_C} V_C\right) - I_A\right|\right)$$

$$P''_{ABC} \sim P_{AC} \left(1 - \left|\left(\frac{I_A}{V_A + V_C} V_A + \frac{I_C}{V_A + V_C} V_C\right) - I_B\right|\right)$$

It will be assumed that the probability of a particular coalition forming is the mean of these three probabilities. So for the coalition ABC.

$$P_{ABC} \sim 1 - \frac{P_{AB}|I_{AB} - I_C| + P_{BC}|I_{BC} - I_A| + P_{AC}|I_{AC} - I_B|}{3}$$

And for a four-voter coalition ABCD.

$$P_{ABCD} \sim 1 - \frac{P_{ABC}|I_{ABC} - I_D| + P_{ABD}|I_{ABD} - I_C| + P_{ACD}|I_{ACD} - I_B| + P_{BCD}|I_{BCD} - I_A|}{4}$$

And so on.

To apply this to the Banzhaf power index, the probability of each coalition forming is applied to each winning coalition as a modifier. So rather than each voter receiving a score of one for each winning coalition they are critical in, the voter will receive a score of the probability of that coalition forming. If she is critical in a winning coalition which is very likely to occur, she will receive a much higher score than if she is critical in a coalition that is unlikely to occur. Hence being critical in more ideologically feasible coalitions is 'worth more'. To standardise the index, as before, the score for each voter is divided by the sum of the scores of all voters, to give an index comparable to the standard Banzhaf index. So returning to the previous example where voter A has 3 votes, voter B has 1 vote and voter C has 5 votes with a decision rule of 6:

$$[6;3,1,5]$$

If the voters are aligned along an ideological spectrum as in figure 7 with the following ideological scores on a scale of 0 to 1.

Figure 7: Simple ideological scale with three voters asymmetrically aligned

$I_A = 0.1$ $I_B = 0.8$ $I_C = 0.9$

The modified Banzhaf scores then are:

$$\beta_A^M = 0.072 \qquad \beta_B^M = 0.324 \qquad \beta_C^M = 0.604$$

This index then shares more voting power amongst those voters able to form coalitions with ideologically close members than those that are more distant from the median position. It is also possible to increase the influence of the ideological difference by squaring the probability of each coalition occurring. So for a two-voter coalition:

$$P_{AB} \sim 1 - |I_A - I_B|^2$$

And for a three voter coalition:

$$P_{ABC} \sim 1 - \frac{P_{AB}|I_{AB} - I_C|^2 + P_{BC}|I_{BC} - I_A|^2 + P_{AC}|I_{AC} - I_B|^2}{3}$$

This decreases the likelihood of ideologically different coalitions occurring. So in the above example the probability of coalition AB occurring in the standard model was 0.3 (30%), but when the ideological difference is squared it drops to 0.09 (9%), which may better reflect the probability of such an ideologically different coalition occurring. This leads to the following modified Banzhaf scores:

$$\beta_A^M = 0.023 \qquad \beta_B^M = 0.475 \qquad \beta_C^M = 0.502$$

The voting power of those furthest from the median position has been reduced by a greater amount. As the coalition BC is much more likely than all other coalitions to form the voting power has been almost evenly divided between voter B and voter C, the two voters needed to form this coalition with voter A holding a negligible amount of voting power. This model could represent a more realistic assumption of the probabilities of coalitions forming in an ideological spectrum.

This index is also generalizable to more than one dimension. If the voters are located in Euclidean space in several dimensions, the ideological difference can reflect all of these

dimensions. So in two dimensions if voter A is at position i_A, j_A and voter B is at position i_B, j_B then the probability of coalition AB forming is proportional to the Euclidean distance between the two voters:

$$P_{AB} \sim 1 - \sqrt{(i_A - i_B)^2 + (j_A - j_B)^2}$$

This can then be extended to coalitions with more voters, or to more dimensions.

Measuring ideology with expert surveys

In order to measure voting power in this manner, not only are the ideological positions of the parties required, but also their magnitude. Theis can be measured along one major spectrum, the general left-right spectrum that has been considered up to now, but it may also be feasible to measure ideological spectrums in other policy areas. Whilst all votes in a parliament may fit most closely to the major dimension (or major two dimensions), in discrete policy areas, voters may align themselves differently, than on average across all votes. In the European Parliament, bills pertaining to environmental legislation could have different coalitions supporting them than bills pertaining to economics, integration questions, or any other policy domain.

At this stage then, not only the general left right positions of the EPGs will be taken into account, four further policy areas will be considered. These four areas are: economics, European integration, environment and agriculture. Whilst there are other policy areas these four represent an interesting cross section of votes in the EP. On economics bills, the ideology of the EPGs that is most important should be similar to their general left-right ideology, and hence similar coalitions should be expected to form. European integration is often considered as the second major dimension that underpins party groups' voting behaviour in the EP, so it will be of interest to see how the EPGs align themselves on these

votes. Environment policy is of interest as for one EPG, Greens-EFA, it is putatively their most important policy area, and so their voting behaviour should be different on these bills than in other policy areas. Finally, agriculture is a policy area where the party groups are relatively less cohesive, with some arguing that national affiliations are more important than party group affiliations. Here ideology should be less relevant in forming coalitions. Different coalitions forming in different policy areas would imply different ideologies being important in these areas, and as such different voting power distributions. This paper will now turn again to the measurement of ideology.

The simplest way to measure ideology is to take the scores from the Chapel Hill and McElroy and Benoit expert surveys mentioned earlier in the paper. The standardised ideological position of each party group is given below across two parliaments. For 1999-2004 the McElroy and Benoit data will be used (2007) and for the 2004-2009 and 2009-2014 parliaments the Chapel Hill data will be used (Steenbergen & Marks, 2007).

1999 EP

	EUL-NGL	Greens-EFA	PES	ELDR	EPP-ED	UEN	EDD
All	1.37	2.16	3.37	5.68	6.11	8.16	8.47
Economics	2.05	2.47	2.84	6.37	6.53	6.79	6.89
Integration	5.53	6.68	7.21	6.58	6.63	1.21	0.58
Environment	3.11	1.00	4.00	5.21	5.84	6.21	6.26

2004 EP

	EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	INDDEM
All	1.31	2.77	3.58	5.44	6.70	7.48	8.22
Economics	0.93	3.16	3.57	6.06	6.76	4.84	5.52
Integration	2.85	7.03	8.38	8.83	7.60	6.04	0.77

2009 EP

	EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD
All	1.26	3.14	3.46	5.73	6.72	7.41	8.34
Economics	0.99	3.21	3.37	6.27	6.34	6.33	7.06
Integration	3.00	7.85	8.52	8.46	8.13	2.97	1.81
Environment	4.40	1.70	4.83	5.64	6.70	6.80	7.46

Table 4: Ideological positions in the 1999-2004, 2004-2009 and the 2009-2014 European Parliaments on a 0 – 10 scale.

Unfortunately the survey questions did not cover all of the policy areas of interest. The survey questions asked in the McElroy and Benoit survey were (2007, pp. 21-22):

- All: Please locate each political group on a general left–right dimension, taking all aspects of group policy into account. Left (1). Right (20).

- Economics: Prefers raising taxes to increase public services (1) Prefers cutting public services to cut taxes (20)

- European Integration: Favours increasing the range of areas in which the EU can set policy (1). Favours reducing the range of areas in which the EU can set policy (20).

- Environment: Supports protection of the environment, even at the cost of economic growth (1) Supports economic growth, even at the cost of damage to the environment (20)

These scores were standardised to a 0 – 10 scale and the poles were reversed to match the Chapel Hill surveys where required. The survey questions asked in the Chapel Hill surveys were (Steenbergen & Marks, 2007):

- All: Position of the party in YEAR in terms of its overall ideological stance. 0 = Extreme left, 5 = Center, 10 = Extreme right.

- Economics: Position of the party in YEAR in terms of its ideological stance on economic issues. Parties can be classified in terms of their stance on economic issues.

Parties on the economic left want government to play an active role in the economy. Parties on the economic right emphasize a reduced economic role for government: privatization, lower taxes, less regulation, less government spending, and a leaner welfare state. 0 = extreme left, 5 = center, 10 = extreme right.

- European Integration: Overall orientation of the party leadership towards European integration in YEAR. 1 = Strongly opposed, 2 = Opposed, 3 = Somewhat opposed, 4 = Neutral, 5 = Somewhat in favour, 6 = In favour, 7 = Strongly in favor

These again were standardised to the 0 – 10 scale where required. Using these scores with the modified Banzhaf index returns the following results. Listed are the results if the probability of coalitions forming is proportional to the ideological difference between the members (δ) and the result if the probability is proportional to the square of the ideological difference (δ^2).

1999 EP

		EUL-NGL	Greens-EFA	PES	EDLR	EPP-ED	UEN	EDD	Majority
Seats		42	48	180	50	233	31	16	314
A priori Banzhaf		0.091	0.109	0.164	0.109	0.418	0.073	0.036	
All	δ	0.090	0.096	0.192	0.122	0.424	0.046	0.030	
	δ^2	0.079	0.090	0.214	0.129	0.430	0.040	0.019	
Economics	δ	0.095	0.098	0.175	0.126	0.407	0.059	0.040	
	δ^2	0.085	0.091	0.171	0.144	0.404	0.071	0.034	
Integration	δ	0.106	0.109	0.185	0.117	0.435	0.026	0.021	
	δ^2	0.107	0.115	0.193	0.121	0.446	0.009	0.008	
Environment	δ	0.097	0.083	0.191	0.116	0.417	0.055	0.040	
	δ^2	0.091	0.064	0.207	0.119	0.427	0.057	0.035	

2004 EP

	EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	IND DEM	Majority
Seats	41	42	200	88	268	27	37	367
A priori Banzhaf	0.064	0.083	0.174	0.156	0.413	0.046	0.064	
All δ	0.056	0.071	0.178	0.168	0.426	0.048	0.052	
δ^2	0.046	0.064	0.180	0.184	0.423	0.053	0.050	
Economics δ	0.054	0.073	0.179	0.167	0.419	0.048	0.060	
δ^2	0.040	0.068	0.179	0.182	0.415	0.051	0.065	
Integration δ	0.055	0.071	0.197	0.142	0.454	0.048	0.033	
δ^2	0.037	0.065	0.228	0.134	0.473	0.047	0.016	

2009 EP

	EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD	Majority
Seats	35	55	183	84	265	54	32	369
A priori Banzhaf	0.047	0.084	0.159	0.140	0.439	0.084	0.047	
All δ	0.035	0.082	0.160	0.154	0.442	0.087	0.041	
δ^2	0.024	0.077	0.157	0.171	0.440	0.092	0.039	
Economics δ	0.034	0.082	0.155	0.154	0.443	0.089	0.043	
δ^2	0.023	0.076	0.144	0.177	0.441	0.096	0.043	
Integration δ	0.033	0.085	0.187	0.133	0.462	0.070	0.030	
δ^2	0.021	0.088	0.229	0.122	0.478	0.047	0.015	
Environment δ	0.048	0.066	0.168	0.148	0.441	0.081	0.048	
δ^2	0.050	0.048	0.176	0.155	0.445	0.077	0.049	

Table 5: Modified Banzhaf power index results in the European Parliament using expert survey judgments of ideology. Top scores representing ideological difference (δ), bottom scores representing the square of the ideological difference (δ^2).

For the EPP, introducing the modified Banzhaf index does not create a large change to its voting power. The EPP still holds the most voting power in all areas, and has more voting power on European integration policy than other policy areas. Across all votes the PES's (or S&D's) voting power has increased in 1999-2004 but hardly changed in the 2004-2009 and 2009-2014 parliaments, where it still holds less than half of the voting power of the EPP, although it too holds noticeably more voting power on integration questions than under the *a* priori index. The ALDE (or ELDR) has benefitted in most areas from the change, receiving an increase in voting power in all policy areas except European integration in 2004 and 2009.

This may be due to it representing a more pro-integration position in these parliaments, relative to the other party groups. For the smaller party groups it is also a mixed picture. The anti-European party groups (EDD, INDDEM & EFD) tend to lose some voting power across the parliaments with the loss being most significant in the integration policy area. The UEN loses some voting power in 1999 but gains some in 2004. The ECR holds broadly the same amount voting power in most areas, but also loses out on integration policy issues. The EUL-NGL and Greens-EFA broadly maintain the same amount of voting power across most areas but the Greens-EFA is weakest in the environment policy area, as it holds the most extreme ideological position of the EPGs.

The effect of squaring the ideological differences between the EPGs emphasizes the ideological differences between party groups and makes it less likely that those further apart will cooperate. Under these conditions the median party groups, which in most areas are the three largest groups, benefit at the expense of the smaller EPGs, although the difference is only pronounced at the extremes.

Measuring ideology with spatial models

An alternative way to measure the ideological positions of parties is to use spatial models of voting. Various types of spatial model have been used to analyse the roll call voting behaviour of MEPs and party groups in the EP (Hix, 2001; Noury, 2002; Hix, Noury, & Roland, 2006; Hix & Noury, 2009). These analyses have tended to use Nominate software to analyse the results. This paper will use optimal classification (OC); an alternative spatial model to Nominate that takes a non-parametric approach (Poole, 2005).

From a large data set of roll call votes each MEP can be positioned in n-dimensional space (n tends to be 2 in the EP). Using OC and all the roll call votes from the EP for the 1999-2004 parliament the ideal points of every MEP can be found in n-dimensions. But

before the ideal points of the MEPs are analysed the number of dimensions of policy space need to be ascertained. They can be estimated by examining a scree plot. For the 1999-2004 parliament the following scree plot is generated by OC:
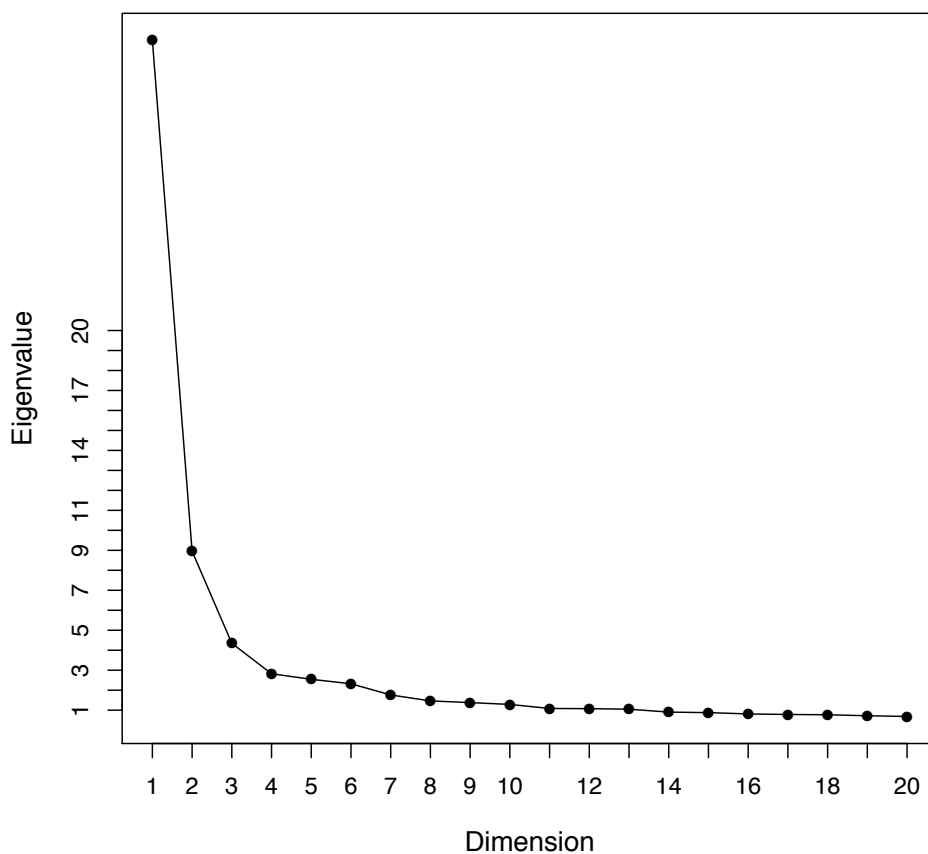
Figure 8: Scree plot for all roll call votes in 1999-2004 EP

The number of dimensions can be estimated by examining where the larger eigenvalues lie. Where difference in eigenvalues between dimensions is low it indicates that these dimensions are of less importance. This does not give an absolute level of dimensionality but gives an indication, that combined with researcher knowledge, can be used estimate the number of dimensions (Poole, 2005, pp. 141-155). In this case, in the 1999-2004 EP across all roll call votes, the scree plot indicates that there are two major dimensions to voting (or possibly three). This lines up with previous research pointing to the general left-right and European integration dimension being the most important dimensions in the European

Parliament. In this case it will be assumed that voting is conducted across these two dimensions.

Using OC, if all the roll call votes from the 1999-2004 parliament are plotted across two dimensions the following results are found:
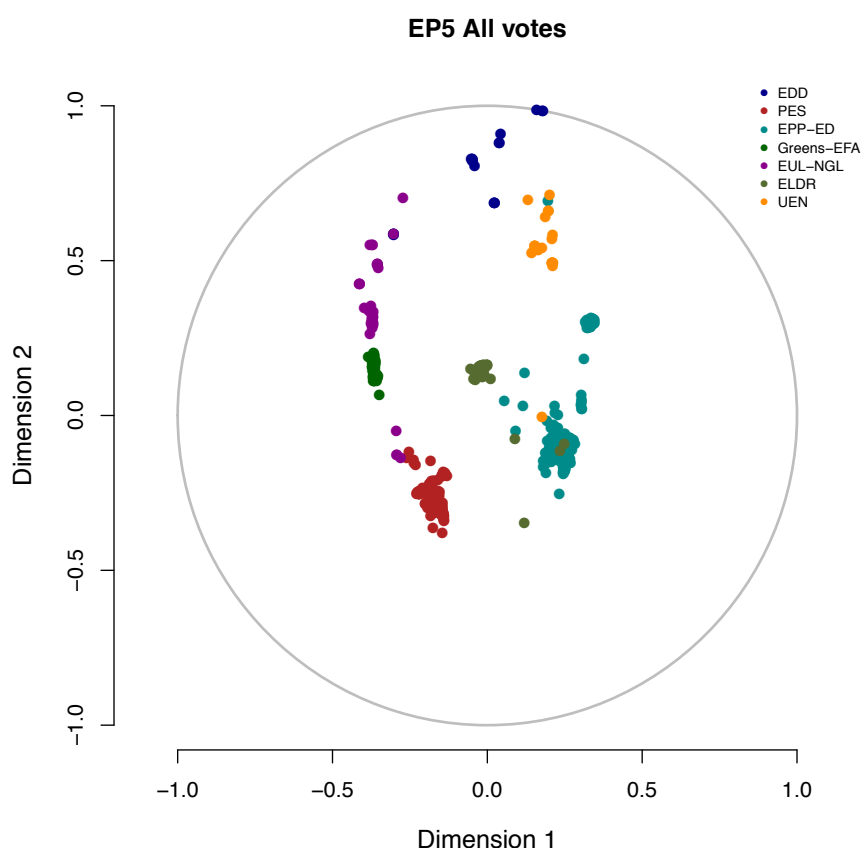
Figure 9: OC analysis of all roll call votes in the 1999-2004 EP

When looking at all votes it can be seen that MEPs from particular party groups are clustered around parts of the plot. The PES MEPs are clustered around the bottom left, the EPP-ED MEPs bottom right and ELDR MEPs in the centre. The smaller parties MEPs are to be found higher in the plot. Greens-EFA centre left, EUL-NGL top left, UEN top right and EDD top centre. The first dimension can then be intuitively interpreted as either a general left-right or an economic left-right dimension. Looking at data from the expert surveys, the EPGs that are more left wing are found on the left hand side of the plot and EPGs that are more right wing

are found on the right hand side of the plot. Also intuitively dimension 2 is a pro-anti European integration dimension. The larger pro-integration party groups are all clustered around the bottom of the plot, with the smaller less positive party groups higher, with the Eurosceptics at the top of the plot. It can reasonably be considered that this plot represents MEPs ideal positions across the two major dimensions effecting voting in the EP.

The same process can be repeated across the policy areas. Displayed below are the OC plots in two dimensions of roll call votes pertaining to four policy areas: economics, European integration, environment and agriculture[3]. If the scree plots (not displayed here) for each of these policy areas are examined economic votes and European integration votes are estimated to have two clear dimensions, environment is estimated to have two (and possibly a third) dimensions and agriculture is estimated to have at least five dimensions. Without attempting to define these dimensions, the OC plots for each policy area in two dimensions are displayed below.

Figure 10: OC results for economic votes in the 1999-2004 EP
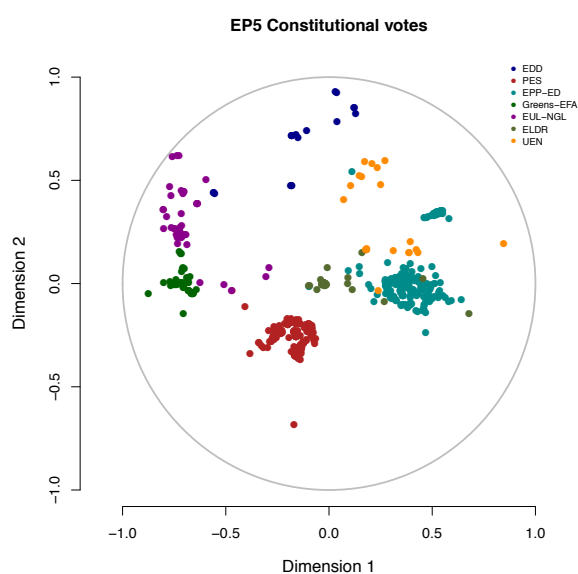
Figure 11: OC results for constitutional and inter-institutional affairs in the 1999-2004 EP

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[3] All roll call votes were categorised in the 1999-2004 parliament. The four policy areas under consideration pertain to those votes classified as: economic, constitutional and inter-institutional affairs, environment and public health, and agriculture.

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EP5 Environment votes

EP5 Agriculture votes
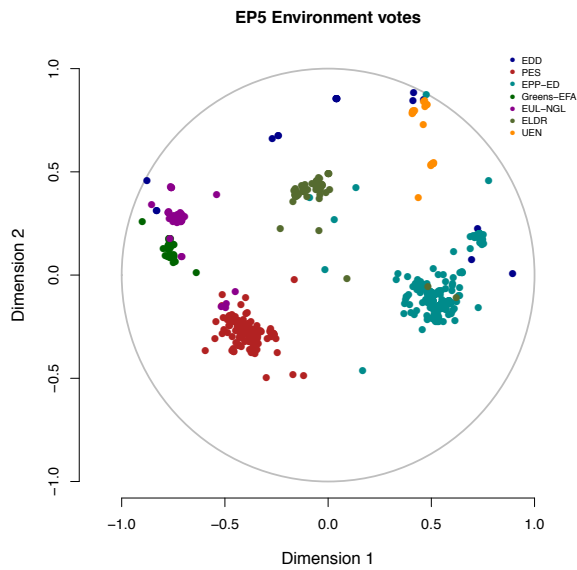
Figure 12: OC results for environment and public health in the 1999-2004 EP
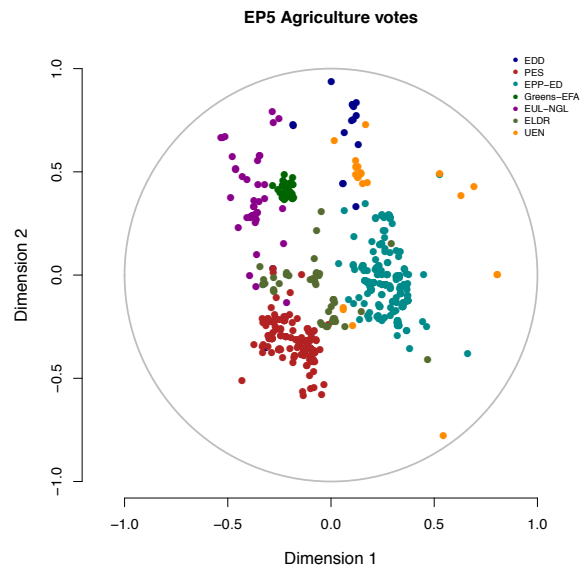
Figure 13: OC results for agriculture votes in the 1999-2004 EP

In both the economic and European integration policy areas the EPGs are displayed in the groups in similar (but not the same) positions to the plot with all votes. This could indicate that the same dimensions are at play in these plots as in the plot containing all votes. Looking at the environment plot the positioning is somewhat different to that found on the plot containing all votes. The first dimension has similar placements to the general left-right dimension predicted in the plot with all votes, but the second dimension has EPGs in slightly different positions, with ELDR higher in the plot. This could indicate that, in the 1999-2004 parliament, the second dimension on environment votes is different to the second dimension in economic and European integration policy areas. Finally, the agriculture plot has MEPs much more dispersed when looked at in two dimensions. This would indicate that EPGs vote less coherently on agriculture bills (which they do) and that there are more than two dimensions on which they vote in this area, possibly due to differing national interests (which is predicted by the scree plot).

Looking at the 2004-2009 parliament the scree plot also estimates that, for all votes, MEPs vote along two major dimensions, so a two-dimensional OC plot will again be used. The OC plot for all votes in two dimensions in the 2004-2009 parliament is:
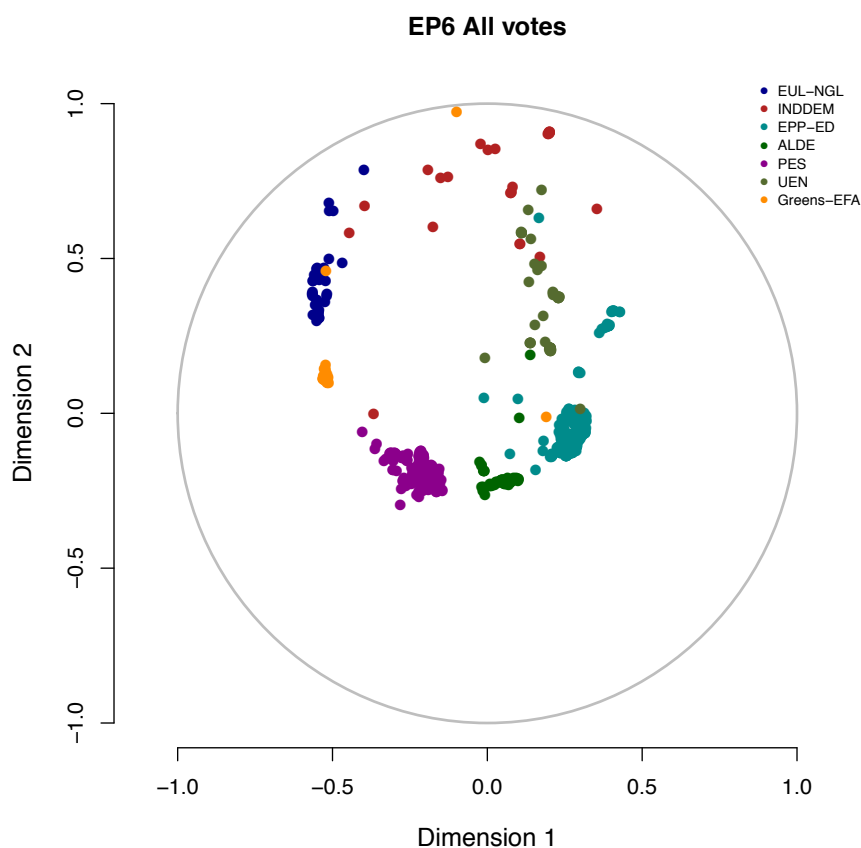
EP6 All votes

Figure 14: OC analysis of all roll call votes in the 2004-2009 EP

The placement of party groups across all votes in the 2004-2009 parliament fits a similar pattern to the 1999-2004 parliament with EPGs being arranged from left to right according to their general left-right orientation and from top to bottom according to their position towards European integration. The largest three EPGs and the Greens-EFA group have their MEPs positioned closer together than the smaller groups indicating that they vote together more often.

Looking at the scree plots for the same four policy areas, it is again estimated that two dimensions dominate economic and European integration policy areas. Environment

still has two major and one notable but less important dimension and agriculture appears to have at least seven dimensions. For simplicity, MEPs ideal positions will again be plotted in the two most dominant dimensions of each policy area's votes.
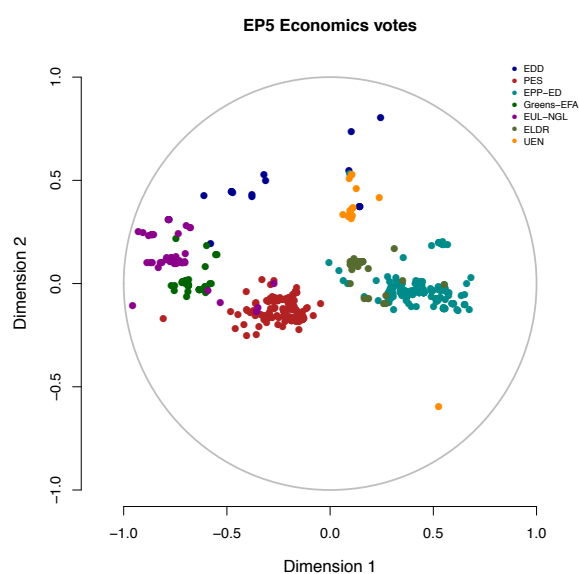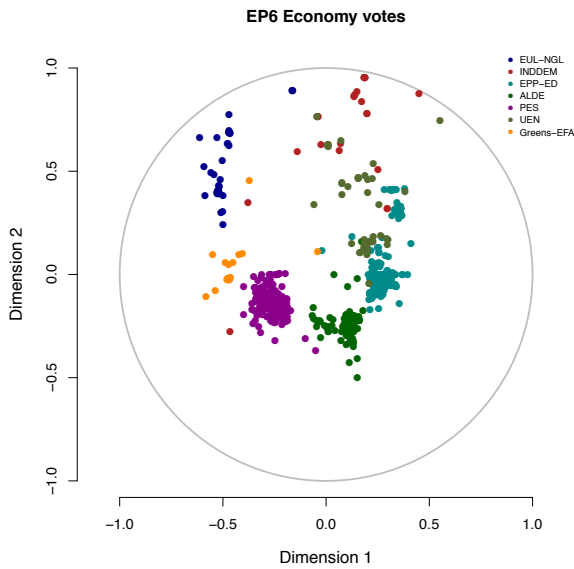

Figure 15: OC results for economic votes in the 2004-2009 EP
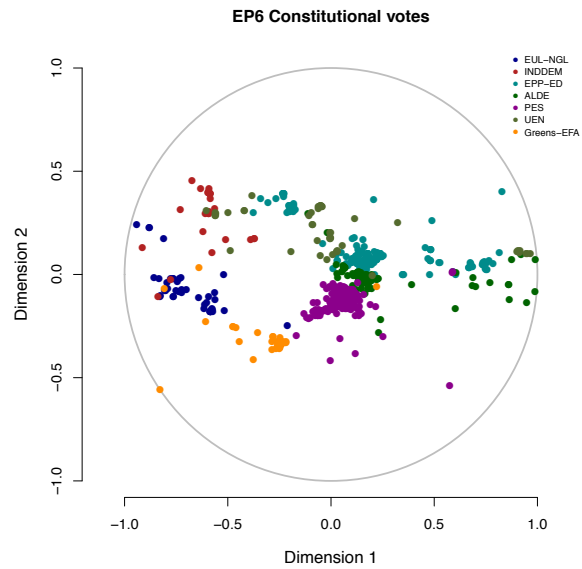
Figure 16: OC results for constitutional and inter-institutional affairs in the 2004-2009 EP
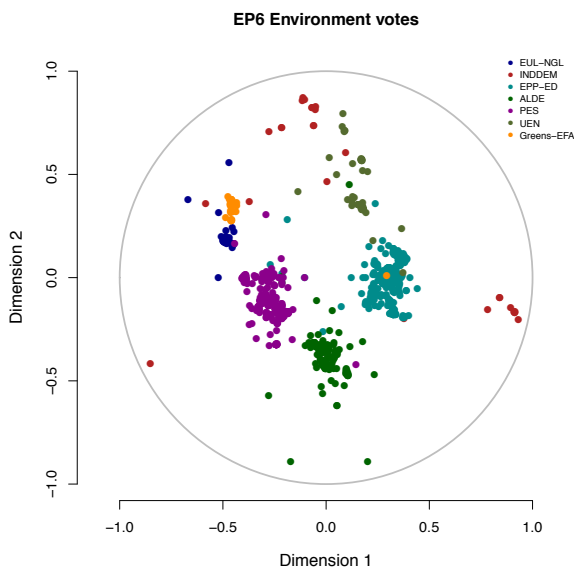
Figure 17: OC results for environment and public health in the 2004-2009 EP
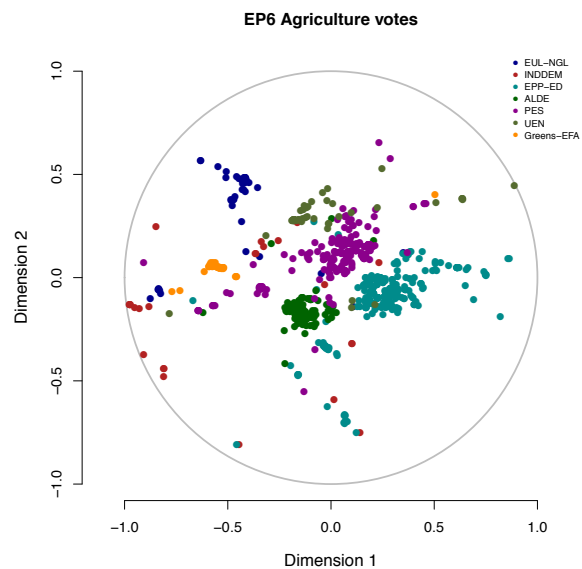
Figure 18: OC results for agriculture votes in the 2004-2009 EP

On economics votes in the 2004-2009 parliament the MEPs are somewhat more dispersed but the positioning of the EPGs is similar to that across all votes. On European integration votes, unlike in the 1999-2004 parliament, the first and most important dimension now appears to be the pro-anti European integration dimension with more eurosceptic parties appearing to the left of the plot and more pro-European parties appearing to the right, with a large spread of the MEPs in each party group on this dimension. The second dimension in this case appears to be the normal left-right dimension. On environmental votes the dimensions that MEPs vote in appear to be closer again to the pattern shown across all votes. Finally the agriculture plot is more incoherent, indicating that each party group's MEPs vote together less often on agriculture bills and there are more than two dimensions on which they vote in this area (as indicated by the scree plot).

To obtain ideological positions from OC is not without problems. The plots of individual MEPs do not reflect their actual real world positions on the dimensions that have been predicted. They do however give a 'best guess' of where individual MEPs may lie if each policy area is considered to contain their preferences in two dimensions. It may be a closer reflection of MEPs preferences than those identified by expert surveys, and by adding an extra dimension will give a more nuanced picture of their position.

To estimate EPG positions from this data, the mean position of the party groups' MEPs are taken across the two dimensions. This only makes sense in those areas where MEPs are voting coherently in two dimensions, so the agriculture policy area will not be included. The mean positions of each party group in each policy area is given below:

1999 EP

		EUL-NGL	Greens-EFA	PES	EDLP	EPP-ED	UEN	EDD
All	1D	-0.363	-0.364	-0.172	-0.009	0.254	0.188	-0.027
	2D	0.333	0.148	-0.258	0.124	-0.046	0.530	0.798
Economics	1D	-0.748	-0.667	-0.222	0.158	0.435	0.126	-0.287
	2D	0.127	0.011	-0.126	0.081	-0.005	0.326	0.451
Integration	1D	-0.694	-0.703	-0.180	0.006	0.402	0.267	-0.150
	2D	0.290	-0.003	-0.252	-0.001	0.034	0.298	0.680
Environment	1D	-0.711	-0.762	-0.381	-0.063	0.539	0.457	0.031
	2D	0.253	0.117	-0.283	0.390	-0.063	0.702	0.618

2004 EP

		EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	INDDEM
All	1D	-0.544	-0.511	-0.221	0.048	0.291	0.183	0.049
	2D	0.390	0.143	-0.180	-0.210	-0.023	0.341	0.789
Economics	1D	-0.494	-0.471	-0.271	0.101	0.275	0.177	0.124
	2D	0.502	0.003	-0.144	-0.236	0.018	0.297	0.776
Integration	1D	-0.683	-0.309	0.045	0.221	0.156	0.057	-0.582
	2D	-0.079	-0.312	-0.130	-0.017	0.095	0.210	0.299
Environment	1D	-0.480	-0.459	-0.270	0.003	0.303	0.154	0.246
	2D	0.187	0.345	-0.123	-0.359	-0.013	0.444	0.415

Table 6: EPG mean ideological positions from OC

Using these coordinates with the two-dimensional modified Banzhaf power index the following results are found:

1999 EP

		EUL-NGL	Greens-EFA	PES	ELDR	EPP-ED	UEN	EDD
A priori Banzhaf		0.091	0.109	0.164	0.109	0.418	0.073	0.036
All	δ	0.100	0.102	0.185	0.114	0.409	0.050	0.040
	δ^2	0.098	0.101	0.198	0.115	0.412	0.043	0.033
Economics	δ	0.098	0.099	0.190	0.119	0.409	0.047	0.037
	δ^2	0.093	0.095	0.209	0.124	0.414	0.038	0.027
Integration	δ	0.092	0.093	0.204	0.116	0.407	0.050	0.038
	δ^2	0.079	0.080	0.242	0.113	0.417	0.043	0.027
Environment	δ	0.104	0.102	0.203	0.129	0.379	0.048	0.035
	δ^2	0.105	0.101	0.235	0.139	0.359	0.039	0.023

2004 EP

		EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	INDDEM
A priori Banzhaf		0.064	0.083	0.174	0.156	0.413	0.046	0.064
All	δ	0.064	0.073	0.183	0.155	0.426	0.049	0.050
	δ^2	0.060	0.068	0.197	0.157	0.425	0.052	0.042
Economics	δ	0.063	0.072	0.181	0.155	0.430	0.050	0.050
	δ^2	0.056	0.066	0.192	0.159	0.431	0.053	0.042
Integration	δ	0.068	0.075	0.178	0.154	0.426	0.047	0.051
	δ^2	0.069	0.074	0.185	0.155	0.425	0.046	0.046
Environment	δ	0.065	0.074	0.181	0.160	0.415	0.049	0.057
	δ^2	0.063	0.070	0.190	0.166	0.404	0.051	0.056

Table 7: Modified Banzhaf power index results in the European Parliament using OC positions of ideology in two dimensions. Top scores representing ideological difference (δ), bottom scores representing the square of the ideological difference (δ^2).

Analysing these results reveals that there is not as great a difference in voting power between policy areas as in the expert survey models. When looking at all votes in each parliament there is a small increase in voting power for the PES compared to the *a priori* Banzhaf index, but no large changes to the distribution of voting power elsewhere. Looking at individual policy areas, the only notably different results are on environmental policy in the 1999-2004 and integration policy in 2004-2009. On environmental policy the EPP-ED is relatively isolated in both dimensions from other EPGs, and is therefore predicted to have more difficulty forming coalitions, leading to a lower voting power score on this index. On integration policy the PES sits close to the EPP and has seen a subsequent large increase in voting power. If the index is used with the square of the ideological difference (δ^2) the centremost parties tend to benefit, but again the result is not a large change to the power distribution.

A posteriori voting power in the European Parliament

One final analysis will be conducted incorporating the information from the actual coalitions that formed in the EP. This could be thought of as an *a posteriori* measurement of voting power. Returning to the roll call data from the two parliamentary terms, each roll call vote was analysed to find which party groups voted together[4]. From this data the actual coalitions that formed can be found. If the number of times a specific coalition formed as a percentage of the total number of coalitions that formed is used as the probability of that coalition forming, the probabilities can be used to weight the relative importance of each coalition on the voting power indices. The results are given below when applying these probabilities to the coalitions in the Banzhaf index.

1999 EP

	EUL-NGL	Greens-EFA	PES	ELDR	EPP-ED	UEN	EDD
A priori Banzhaf	0.091	0.109	0.164	0.109	0.418	0.073	0.036
All	0.150	0.156	0.212	0.155	0.280	0.028	0.019
Economics	0.077	0.104	0.208	0.104	0.459	0.027	0.022
Integration	0.129	0.129	0.182	0.129	0.387	0.025	0.020
Environment	0.164	0.169	0.233	0.158	0.222	0.031	0.025
Agriculture	0.146	0.153	0.146	0.146	0.336	0.036	0.036

2004 EP

	EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	INDDEM
A priori Banzhaf	0.064	0.083	0.174	0.156	0.413	0.046	0.064
All	0.101	0.113	0.167	0.163	0.400	0.043	0.012
Economics	0.090	0.090	0.122	0.155	0.486	0.053	0.004
Integration	0.035	0.043	0.152	0.087	0.645	0.030	0.009
Environment	0.140	0.167	0.178	0.208	0.207	0.065	0.035
Agriculture	0.037	0.032	0.212	0.083	0.581	0.037	0.018

Table 8: Modified Banzhaf power index results in the European Parliament using actual coalitions.

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[4] EPGs were considered to have voted yes for a bill if twice as many of their members voted yes as voted no or abstained. EPGs were considered to have voted no for a bill if twice as many of their members voted no as voted yes or abstained.

When the Banzhaf index is examined with the actual coalitions that formed, the power relationship changes dramatically between policy areas. First, in 1999 the EPP-ED loses significant voting power to the left wing party groups. This seems to be as many of the coalitions that formed in the 1999 parliament were clustered around the left wing. The EPP-ED regains its voting power on economic issues, but is at its weakest on environmental issues. Looking at the 2004 parliament the EPP-ED is in a stronger position across all votes, placing its power at a similar level to the *a priori* indices. The ALDE holds almost the same amount of voting power as the PES, this is may be due to the PES needing the ALDE to form coalitions from the left. In the *a posteriori* analysis the Greens-EFA hold their largest voting power on environmental votes. This may be due to them setting the agenda in a policy domain that interests them but that is not significantly at odds with the position taken by larger EPGs. Conversely, the EUL-NGL has its least voting power on economics issues in 1999-2004 (although not in 2004-2009) and INDDEM has a greatly reduced amount of amount of voting power on European integration issues. This is likely to be due to their preferred positions on these subjects being completely unacceptable to the larger EPGs making it difficult for them to find voting partners.

Comparison of results

This paper has presented a selection of different ways to measure voting power when ideology is considered relevant in forming coalitions, and applied them to the European Parliament in the 1999-2004, 2004-2009 and 2009-2014 terms. The *a priori* indices represent the standard way to measure voting power, but by definition they do not take into account anything outside of the voting weights of the party groups when calculating their voting power, and as such can only offer a simplistic picture of the power arrangement in the EP.

Edelman's index disallows coalitions that are not formed between ideologically adjacent neighbours. These indices produce results that are quite different than the *a priori* indices and have the effect of drastically reducing the voting power of parties far from the median position. Unfortunately Edelman's assumptions do not prove accurate in the EP as a significant number of coalitions form that do not match his restrictions.

The modified-Banzhaf index that this paper has presented is an attempt to account for ideology in a more measured manner. Two ways are suggested to quantify ideology, through expert surveys and by using the optimal classification scaling method. Using the ideological positions produced by these methods, coalitions are then graded in terms of the probability of them occurring, before voting power is then calculated. The weight given to ideological differences in these models can be altered and two options are presented with results lying someway between the *a priori* and the Edelman index.

Finally the *a posteriori* indices use information on the actual coalitions that formed in the parliament to generate voting power. These indices take into account more factors could have affected the formation of coalitions, not only ideology, but a plethora of other reasons such as: the contents of each individual bill, the diplomatic skill of the leaders of party groups, internal party group issues and everything else. They are not perfect, as they assume party groups are homogenous units and so do not account for levels of attendance or partial defections, but they probably represent a judgement of voting power that is closest to reality from the indices presented here.

Do any of these methods improve on the *a priori* voting power indices? This is difficult to answer, but if the *a posteriori* voting power indices are used as a benchmark, some judgements can be made. If the *a posteriori* power indices are taken as the best representation of voting power, the accuracy of the other power indices can be judged by

comparing them to this index. One simple method of doing this is by taking the mean absolute deviation (MAD) between each index and the *a posteriori* index. The MAD is the sum of the difference between the voting power of each party group in two different power indices (in this case one of the indices and the *a* posteriori index) divided by the number of party groups (seven in each of these parliaments). This will show how close each index is to the *a posteriori* index, with the score representing the average difference each EPG has from the *a posteriori* score. This means the MAD represents how close the different indices come to predicting the actual coalitions that formed in each parliament.

Looking at the MAD scores for the 1999-2004 and 2004-2009 parliaments (it was not possible to calculate the MAD for the 2009-2014 parliament as the roll call data was not yet available) the voting power index that sits closest to the *a posteriori* index can be found. All of the voting power scores will be collated across the next few pages, with the MAD of each being recorded in the right hand column. This is an unfortunately large volume of information, but it allows for direct comparisons between each index.

1999 – 2004 EP   **Majority** 314

		EUL-NGL	Greens-EFA	PES	ELDR	EPP-ED	UEN	EDD		MAD
Seats		42	48	180	50	233	31	16		

All votes

		EUL-NGL	Greens-EFA	PES	ELDR	EPP-ED	UEN	EDD	MAD
A priori Banzhaf		0.091	0.109	0.164	0.109	0.418	0.073	0.036	0.064
Edelman Banzhaf		0.063	0.063	0.125	0.188	0.438	0.125	0.000	0.093
Modified Banzhaf	δ	0.090	0.096	0.192	0.122	0.424	0.046	0.030	0.056
Expert	δ^2	0.079	0.090	0.214	0.129	0.430	0.040	0.019	0.055
Modified Banzhaf OC	δ	0.102	0.103	0.183	0.120	0.412	0.044	0.035	0.052
	δ^2	0.101	0.104	0.196	0.127	0.414	0.034	0.025	0.047
A posteriori	B	0.150	0.156	0.212	0.155	0.280	0.028	0.019	

Economics

A priori Banzhaf		0.091	0.109	0.164	0.109	0.418	0.073	0.036	0.026
Modified Banzhaf	δ	0.095	0.098	0.175	0.126	0.407	0.059	0.040	0.027
Expert	δ^2	0.085	0.091	0.171	0.144	0.404	0.071	0.034	0.033
Modified Banzhaf OC	δ	0.094	0.097	0.205	0.119	0.390	0.054	0.041	0.023
	δ^2	0.084	0.089	0.236	0.119	0.388	0.050	0.034	0.027
A posteriori Banzhaf		0.077	0.104	0.208	0.104	0.459	0.027	0.022	

Integration

A priori Banzhaf		0.091	0.109	0.164	0.109	0.418	0.073	0.036	0.029
Modified Banzhaf	δ	0.106	0.109	0.185	0.117	0.435	0.026	0.021	0.018
Expert	δ^2	0.107	0.115	0.193	0.121	0.446	0.009	0.008	0.022
Modified Banzhaf OC	δ	0.094	0.093	0.201	0.119	0.405	0.050	0.037	0.024
	δ^2	0.082	0.082	0.234	0.120	0.412	0.043	0.026	0.033
A posteriori Banzhaf		0.129	0.129	0.182	0.129	0.387	0.025	0.020	

Environment

A priori Banzhaf		0.091	0.109	0.164	0.109	0.418	0.073	0.036	0.082
Modified Banzhaf	δ	0.097	0.083	0.191	0.116	0.417	0.055	0.040	0.076
Expert	δ^2	0.091	0.064	0.207	0.119	0.427	0.057	0.035	0.079
Modified Banzhaf OC	δ	0.104	0.101	0.206	0.127	0.381	0.047	0.034	0.060
	δ^2	0.104	0.099	0.241	0.134	0.364	0.036	0.021	0.051
A posteriori Banzhaf		0.164	0.169	0.233	0.158	0.222	0.031	0.025	

Agriculture

A priori Banzhaf	0.091	0.109	0.164	0.109	0.418	0.073	0.036	0.046
A posteriori Banzhaf	0.146	0.153	0.146	0.146	0.336	0.036	0.036	

Figure 19: Summary of all power index scores for 1999-2004 EP

First, in the 1999-2004 EP, looking at the *a priori* Banzhaf power index a MAD score of 0.064 is returned. This shows that, on the *a priori* index, each party group's voting power differs on average by 0.064 from the *a posteriori* index. As the voting power of the party groups runs from 0.036 to 0.418, this can be considered to be a large difference.

The Edelman index's predictions are further from the *a posteriori* index than the *a priori* index. The power of extreme parties is underestimated quite considerably, as is the PES, whilst the EPP-ED and ELDR are given much more power than the *a posteriori* index.

If the modified indices are considered, across all votes, each produces results that are closer to the *a posteriori* index than the *a priori* index, but not by much. All of the modified Banzhaf indices tend to give more voting power to the EPP-ED than that given to it by the *a*

posteriori index. Of the four alternatives, the OC model taking into account the square of the ideological difference (δ^2) comes closest to the *a posteriori* index.

If policy areas are examined individually, the results differ. On economics policy, the expert survey models prove further from the *a posteriori* indices than the *a priori* models, with one of the OC models being slightly closer. On integration policy this pattern is reversed with only the expert survey models predicting voting power closer to the *a posteriori* index than the *a priori* models. On the environment there is a substantial improvement from both models over the *a priori* ones, with OC (δ^2) producing the closer results.

In the 1999-2004 parliament, the OC models have tended to provide results closer to the *a posteriori* predictions of voting power in all areas except for integration, where the expert survey model is closer to the *a posteriori* model. In most cases the voting power results returned are closer to the *a posteriori* index than those returned from *a priori* index, but there are several that are not – so either there are other forces affecting the formation of coalitions, or the models could be improved.

2004 – 2009 EP   **Majority**   367

		EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	IND DEM	MAD
Seats		41	42	200	88	268	27	37	

All votes

		EUL-NGL	Greens-EFA	PES	ALDE	EPP-ED	UEN	IND DEM	MAD
A priori Banzhaf		0.064	0.083	0.174	0.156	0.413	0.046	0.064	0.016
Edelman Banzhaf		0.067	0.067	0.133	0.200	0.467	0.067	0.000	0.040
Modified Banzhaf	δ	0.056	0.071	0.178	0.168	0.426	0.048	0.052	0.022
Expert	δ^2	0.046	0.064	0.180	0.184	0.423	0.053	0.050	0.029
Modified Banzhaf OC	δ	0.063	0.071	0.186	0.157	0.426	0.050	0.048	0.023
	δ^2	0.056	0.064	0.203	0.161	0.425	0.054	0.038	0.028
A posteriori Banzhaf		0.101	0.113	0.167	0.163	0.400	0.043	0.012	0.000

Economics

A priori Banzhaf		0.064	0.083	0.174	0.156	0.413	0.046	0.064		0.028
Modified Banzhaf	δ	0.054	0.073	0.179	0.167	0.419	0.048	0.060		0.032
Expert	δ²	0.040	0.068	0.179	0.182	0.415	0.051	0.065		0.038
Modified Banzhaf OC	δ	0.061	0.071	0.183	0.157	0.428	0.051	0.049		0.028
	δ²	0.053	0.064	0.196	0.162	0.428	0.057	0.040		0.034
A posteriori Banzhaf		0.090	0.090	0.122	0.155	0.486	0.053	0.004		0.000

Integration

A priori Banzhaf		0.064	0.083	0.174	0.156	0.413	0.046	0.064		0.068
Modified Banzhaf	δ	0.055	0.071	0.197	0.142	0.454	0.048	0.033		0.059
Expert	δ²	0.037	0.065	0.228	0.134	0.473	0.047	0.016		0.056
Modified Banzhaf OC	δ	0.057	0.068	0.188	0.151	0.440	0.049	0.048		0.062
	δ²	0.045	0.057	0.208	0.149	0.451	0.052	0.037		0.060
A posteriori Bamzhaf		0.035	0.043	0.152	0.087	0.645	0.030	0.009		0.000

Environment

A priori Banzhaf		0.064	0.083	0.174	0.156	0.413	0.046	0.064		0.074
Modified Banzhaf OC	δ	0.065	0.072	0.185	0.152	0.421	0.049	0.055		0.077
	δ²	0.062	0.066	0.201	0.152	0.416	0.050	0.053		0.080
A posteriori Banzhaf		0.140	0.167	0.178	0.208	0.207	0.065	0.035		0.000

Agriculture

A priori Banzhaf		0.064	0.083	0.174	0.156	0.413	0.046	0.064		0.061
A posteriori Banzhaf		0.037	0.032	0.212	0.083	0.581	0.037	0.018		0.000

Figure 20: Summary of all power index scores for 2004-2009 EP

In the 2004-2009 parliament the results are less close. Across all votes the *a priori* indices produce results closer to the *a posteriori* indices than all the alternatives. As the 2004-2009 EP was disrupted in 2007 with two countries, Bulgaria and Romania, joining the EU and sending parliamentarians to the EP, some of whom formed a new EPG, this could have affected the results. However if the same analysis is conducted in just the first half of the parliamentary term (up to 1 Jan 2007) the same pattern appears, so this is unlikely. It may be then that the ten new member states' MEPs that joined in 2004 took a while to settle into their party groups, as there is some evidence that they were more likely to vote along national lines than MEPs from older states (Hix & Noury, 2009, p. 172), but the precise reason is unclear.

Of the different indices, across all the votes the Edelman index is again the least close to the *a posteriori* results, returning more voting power to the EPP-ED and ALDE, and less voting power to the extreme parties. All the modified Banzhaf indices return results that are slightly further from the *a posteriori* results than the *a priori* indices and there is not a great deal to choose between them. It seems here that the *a posteriori* indices return much lower voting power scores for the anti-European INDDEM, and much higher results for the smaller left wing party groups, EUL-NGL and Greens-EFA. This probably represents a lack of willingness to cooperate by the INDDEM with other party groups, despite the ideological similarities it may have in some areas with them. The greater voting power attributed to the small left wing parties may represent a greater willingness to compromise on certain legislation, particularly those policy areas that could be considered to be outside of the economic or integration dimensions.

Looking then at individual policy areas in this parliament, on economics and environment the modified Banzhaf indices returns results that are further from the *a posteriori* indices than the *a priori* ones. Only on integration policy are the modified indices better at predicting the outcome than the *a priori* indices, but here all are still quite a long way off the result. On economics votes the same pattern seems to be apparent as that across all votes. On integration votes, the *a posteriori* index gives an much larger amount of voting power to the EPP-ED that is not matched by the modified indices. This could represent again a reluctance of the smaller party groups to vote with the EPP-ED in this area. Finally on environment votes, voting power is more evenly spread between the parties and this is not reflected in the modified indices.

It seems clear that there were other forces in the 2004-2009 EP that were important in the forming of coalitions. This may be in part due to the large number of new MEPs joining from new member states, or other, unaccounted for forces.

2009 – 2014 EP		**Majority**	369					
		EUL-NGL	**Greens-EFA**	**S&D**	**ALDE**	**EPP**	**ECR**	**EFD**
Seats		35	55	183	84	265	54	32

All votes

		EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD
A priori Banzhaf		0.047	0.084	0.159	0.140	0.439	0.084	0.047
Edelman Banzhaf		0.000	0.000	0.091	0.182	0.636	0.091	0.000
Modified Banzhaf	δ	0.035	0.082	0.160	0.154	0.442	0.087	0.041
Expert	δ^2	0.024	0.077	0.157	0.171	0.440	0.092	0.039

Economics

		EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD
A priori Banzhaf		0.047	0.084	0.159	0.140	0.439	0.084	0.047
Modified Banzhaf	δ	0.034	0.082	0.155	0.154	0.443	0.089	0.043
Expert	δ^2	0.023	0.076	0.144	0.177	0.441	0.096	0.043

Integration

		EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD
A priori banzhaf		0.047	0.084	0.159	0.140	0.439	0.084	0.047
Modified Banzhaf	δ	0.033	0.085	0.187	0.133	0.462	0.070	0.030
Expert	δ^2	0.021	0.088	0.229	0.122	0.478	0.047	0.015

Environment

		EUL-NGL	Greens-EFA	S&D	ALDE	EPP	ECR	EFD
A priori Banzhaf		0.047	0.084	0.159	0.140	0.439	0.084	0.047
Modified Banzhaf	δ	0.048	0.066	0.168	0.148	0.441	0.081	0.048
Expert	δ^2	0.050	0.048	0.176	0.155	0.445	0.077	0.049

Figure 21: Summary of all power index scores for 2009-2014 EP

In the 2009-2014 parliament, the roll call data was not available at the time this paper was written, so there are unfortunately no *a posteriori* indices to compare to. This is disappointing as it does not allow a third comparison that may have indicated whether party groups were voting more in line with the modified indices predictions (as in 1999-2004) or less (as in 2004-2009). The expert survey information that is available has not greatly changed the voting power arrangement across all votes compared to the *a priori* index. This

is similar across the different policy areas, with the EUL-NGL being noticeably weaker on economics issues, Greens-EFA noticeably weaker on environment issues, and on integration votes, the EFD noticeably weaker and the two largest party groups stronger.

Discussion

The power indices that are presented in this paper do not represent the actual voting power party groups have in the EP, that much is clear from comparisons with power indices based on actual coalitions that formed. What they do represent is how voting power can be distributed in a legislature if ideology is taken into account. Returning to the research question of this paper:

> Can power indices that account for ideology better represent the distribution of voting power in the European Parliament?

The answer appears to be still unclear. The Edelman index does not look like a credible way to measure voting power, as it greatly underestimates the voting power of small parties, but the modified-Banzhaf indices have produced voting power predictions closer to the *a posteriori* indices in some areas. In the 1999-2004 EP they represent a small improvement over the *a priori* indices, with ideology measured over two dimensions with OC producing results closer to the *a posteriori* indices. That pattern is not seen in 2004-2009 though, with the *a priori* indices producing results closer to the *a posteriori* indices than any that are based on ideology. Clearly there are other forces than ideology at play in the formation of coalitions.

Also, whilst the indices as presented here represent a development from the *a priori* indices, they can be improved. The modified Banzhaf index based on the expert surveys is a useful tool as it is relatively simplistic, but it does not accurately reflect the way that party groups may have policy preferences across more than one dimension. It also would have been better to use scores based on one survey conducted across several parliaments, but in the absence of that opportunity the combination of the McElroy and Benoit, and Chapel Hill Surveys serves as an acceptable substitute. Expert surveys may present the best measure of ideology in legislatures where large amounts of voting information is not readily available.

The multidimensional indices solve this problem to some extent and the optimal classification (OC) method offers one way of generating party group ideological coordinates. It is less satisfactory in a number of areas however. OC does not present, as the expert surveys do, set policy positions along a defined ideological scale. Rather it produces the dimensions revealed in a legislature by the voting activity of all its members. This produces both more and less information than the expert surveys. More in that it can find the many dimensions along which MEPs vote and plot them according to their actions (not just what experts think their actions are), but less in that it cannot identify these dimensions as this is left to interpretation. The scale produced is also somewhat arbitrary; what a position of +/- 0.5 on a particular dimension corresponds to is unclear, and which dimensions are more important is not accounted for.

One improvement that may be possible in the OC models is including the saliency of a particular dimension. The current plots have taken both dimensions as equally important, but the second dimension (or third if it was to be included) may be significantly less important. This may be possible to ascertain from the eigenvalues that OC generates, and if included in the calculation may provide a different picture. Also, it may be possible to

include other factors, such as average attendance or cohesion rates, but this may over-complicate an already complicated model.

Rather than just comparing these models to the *a posteriori* results and commenting on how good they are at predicting actual coalitions, it may be more sensible to look at these modified indices more as a guide to how the power relationship in a legislature divided by ideology could be modelled, other things being equal. A step further on than the *a priori* indices, so to speak. In a parliament divided by ideology, where all parties participate equally, they could accurately represent the division of voting power. But in the EP other factors: party group cohesion, national politics, changing public opinion, and the actions of the other organs of the EU still remain important.

In this way they could prove to be more than just an academic exercise. They could give new party groups forming in the aftermath of the 2014 European Elections a picture of the voting power they could hope to wield if they were to participate fully in the EP. A fully coherent eurosceptic bloc of MEPs would hold significant voting power in the EP if they were to cooperate, and could be a formidable force. Unfortunately (or fortunately, depending on your view) if the previous parliaments are taken as a measure this is unlikely to happen. In any case, they are unlikely to read this particular thesis.

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Appendix 1: The Shapley-Shubik Index

The Shapley-Shubik power index comes from cooperative game theory and takes a different approach to the Banzhaf index. The Shapley-Shubik index φ, takes a specific type of cooperative game, a simple game, and considers voters in the assembly as players in this game. A play of the game consists in bringing about a division of the assembly. If the outcome of a division is positive, the camp of 'yes' voters is awarded a fixed prize, in so-called transferable utility. This is derived from the Shapley value, which calculates a probabilistic estimate of the payoff a player can expect, on average (Felsenthal & Machover, 2004, p. 8).

The Shapley-Shubik index φ, needs the same information as the Banzhaf index to calculate, but also takes into account the ordering of the voters. To calculate the index, the pivotal voter is important. The pivotal voter is the voter that in a specific sequence turns the coalition from a losing coalition to a winning coalition. Returning to the previous example.

$$[\,6\,;3\,,1\,,5]$$

The first permutation of voters would be ABC, and in this case the pivotal voter would be voter C, as voter C turned a losing coalition of 4 votes into a winning coalition of 9 votes. The second permutation would be ACB and again the pivotal voter would be voter C. All of the possible permutations of voters are given below:

ABC   pivotal voter C

ACB   pivotal voter C

BAC   pivotal voter C

BCA	pivotal voter C
CAB	pivotal voter A
CBA	pivotal voter B

The Shapley-Shubik index of a player is then the number of times that voter *i* is pivotal - p_i , divided by the total number of permutations (*n*!).

$$\psi_i = \frac{p_i}{n!}$$

In this example the Shapley-Shubik index for each voter is:

$$\psi_A = 1/6 \qquad \psi_B = 1/6 \qquad \psi_C = 4/6$$

If the *a priori* Shapley Shubik index is applied across the 1999-2004, 2004-2009 and 2009-2014 European Parliaments, the following results are found.

1999 EP

	EUL-NGL	Greens - EFA	PES	ELDR	EPP-ED	UEN	EDD	Majority*
Seats	42	48	180	50	233	31	16	314
Shapley - Shubik	0.086	0.102	0.186	0.102	0.419	0.069	0.036	

2004 EP

	EUL-NGL	Greens - EFA	PES	ALDE	EPP-ED	UEN	INDDEM	Majority*
Seats	41	42	200	88	268	27	37	367
Shapley - Shubik	0.057	0.074	0.191	0.157	0.424	0.041	0.057	

2009 EP

	EUL-NGL	Greens- EFA	S&D	ALDE	EPP	ECR	EFD	Majority*
Seats	35	55	183	84	265	54	32	369
Shapley- Shubik	0.043	0.076	0.176	0.143	0.443	0.076	0.043	

Table 9: *A priori* **Shapley-Shubik power index results in the European Parliament.**

* The decision rule is equal to half plus one of the total membership of each EP.

In the EP the Shapley-Shubik index tends to award slightly more voting power to the larger parties (and so slightly less voting power to the smaller parties) than the Banzhaf index, but the difference is not great.