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IS THE ALLOCATION OF VOTING POWER AMONG THE EU STATES FAIR ?

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ABSTRACT: The paper assesses the current distribution of voting power in the EU Council of Ministers in terms of fairness. The aim of this paper is three-fold. First, we define fairness in the European context and discuss on the potential definitions of the European Union: a state, an association of states or a federal state. Second, we look for a definition of the EU which, in terms of power allocation, corresponds the best to the respective fairness criteria and, third, we suggest an empirical method to determine fair power allocations with a given definition of the EU.

KEY WORDS: European Union, voting power, 1996 conference

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TIIVISTELMÄ: Tutkimus arvioi vaikutusmahdollisuuksien jakauman oikeudenmukaisuutta Euroopan unionin päätöksenteossa. Tutkimuksella on kolme tavoitetta. Ensiksi määritellään oikeudenmukainen valtajakauma EU:n päätöksenteossa ja tarkastellaan kolmea mahdollista määrittelyä Euroopan unionille: valtiota, valtioiden yhteisöä ja liittovaltiota. Toiseksi johdetaan se EU:n määritelmä, joka vastaa parhaiten nykyistä valtajakaumaa. Kolmanneksi esitetään empiirinen iteratiivinen menettely, jolla mikä tahansa haluttu oikeudenmukainen valtajakauma voidaan saavuttaa.

ASIASANAT: Euroopan unioni, Äänestysvoima, Hallitusten välinen konferenssi

SUMMARY

An often heard claim is that the current voting rules in the EU give too much weight to small countries by giving them more votes on proportion to their population than for the large countries. In this paper we question this argument by assessing the current distribution of power in the EU Council of Ministers more deeply.

The approach followed here is to model EU decision-making as a simple superadditive compound game. The actual distribution of power is then measured with the Banzhaf index which is a useful tool when voting bodies are designed as it does not take into account any prior information of voters. With regard to fairness considerations this is a desirable property since a fair voting body should be designed behind a veil of ignorance.

In order to define the fair allocation of power in the EU we have to first define the European Union. As there is no common agreement of this definition we consider three types of alternatives each of them having their own implications in terms of fairness. Basically, we distinguish between the extreme alternatives, namely the EU as a single state and the EU as an association of states. The third type definitions are always combinations of the extremes and here we refer to them as federal states with a certain degree of federalism. The closer to a state we are the higher is the degree of federalism.

The fair allocation of power is then defined on the basis of the principle "equal treatment of equals". Thus in an association of states each state should be treated equally and in a state each citizen should be treated equally. In the case of a federal state the degree of federalism determines how these two principles are weighted. The suggested way to define the nature of the EU allows us to define the fair distribution of power among the member states on a reasonable and transparent basis. The higher the degree of federalism is the more we should stress the equity of the citizens.

The first aim of this paper is to find out whether the current power distribution corresponds to any potential definition of the EU in terms of the fairness criteria. It turns out that in a strict and analytical sense this does not happen. The closer to the state extreme we put the fairness criteria the more the small states are over-represented and the closer to the association extreme we move the more the large states are over-represented. With an execption of the Netherlands we cannot find any systemacities in a sense that we can find on one hand definitions where some countries have excessive power and on the other hand definitions where they are under-represented when compared to the fair allocation of power. In statistical sense we could reach a very good fit with a weight 0.79 to "one man one vote" principle by regressing the current distribution of power on the fair distributions under the above-mentined extreme cases. This regression result thus shows that the current distribution of power under the qualified majority voting in the EU corresponds the best to the definition of the EU where it is 79 per cent of a state and 21 per cent of an association of states.

The second aim of the paper is to suggest a method to derive the distribution of votes in the Council which gives the fair allocation of power with a given prior definition of the EU. The iteration process we suggest shows up to be rather effective tool and we then derive fair allocations of votes in the EU Council under the most interesting alternative definitions of the Union.

The analysis of this paper gives three policy recommendations. First, before considering a re-distribution of votes among the states, the EU members should agree on the definition of the EU. Indeed the fair distribution of power depends crucially on the weight that the EU gives to the "One Man, One Vote" principle. Second, given that power indices are more appropriate measures of voters' influence than voting weights, small voters like the small countries of the EU should have more votes proportionate to their size than large voters like the large countries of the EU. Third, the calculations of this paper suggest that there are no serious fairness arguments to concentrate the current allocation of votes towards the largest countries in the EU Council of Ministers.

YHTEENVETO

Usein esitetty väite on, että Euroopan unionin nykyiset päätössäännöt antavat pienille maille liikaa vaikutusvaltaa antamalla niille asukaslukuun nähden suuremman edustuksen kuin suurille maille. Tässä tutkimuksessa analysoidaan esitettyä väitettä syvällisemmin kooperatiivisen peliteorian valtaindeksien avulla.

Lähestymistapana tässä tutkimuksessa käytetään kaksitasoista ositettua äänestyspeliä (compound game). EU-jäsenmaiden äänestysvoima on mitattu Banzhafin valtaindeksillä, joka sopii hyvin äänestyselinten tarkasteluun, kun mahdollista taustainformaatiota äänestäjistä ei haluta käyttää lainkaan hyväksi. Varsinkin, koska tutkimuksen tavoitteena on arvioida EU:n valtajakauman oikeudenmukaisuutta ja suhteellisuutta tämä on toivottava ominaisuus.

Jotta reilu valtajakauma voidaan määrittää, on aluksi määriteltävä, minkälaisia ominaisuuksia EU:ssa halutaan painottaa. Koska tästä ei vallitse yksimielisyyttä, tarkastellaan tutkimuksessa kolmea vaihtoehtoista määrittelyä Euroopan unionille. Ääritapauksina ovat EU yksittäisenä valtiona ja EU itsenäisten valtioiden yhteisönä. Välimuodot ääripäiden välillä tulkitaan eriasteisiksi liittovaltioiksi.

Oikeudenmukainen valtajakauma määritellään "samanarvoisten tasavertaisen käsittelyn" avulla. Valtiossa tämä merkitsee sitä, että kullakin kansalaisella on samanlaiset vaikutusmahdollisuudet ja valtioiden yhteisön tapauksessa kullakin jäsenmaalla on yhtäläinen vaikutusmahdollisuus. Käytännössä tämä seuraa yksimielisyyden vaatimuksesta, joka on itsenäisten valtioiden yhteisöjen tyypillinen tunnusmerkki.

Tutkimuksen ensimmäisenä tavoitteena on tarkastella, onko EU:n nykyinen valtajakauma riittävän lähellä mitään mainituista suhteellisuuskriteereistä. Osoittautuu, että tiukan analyyttisessa mielessä näin ei ole. Mitä lähemmäs kansalaisten tasavertaisuuden vaatimusta liikutaan, sitä enemmän pienet maat ovat yliedustettuja ja mitä lähemmäs jäsenmaiden tasavertaisuutta liikutaan, sitä enemmän suuret maat ovat yliedustettuina. Alankomaita lukuunottamatta Banzhafin indeksillä mitattu valta ei osoita millekään maalle systemaattista ali- tai yliedustusta kaikilla EU:n määritelmillä.

Tilastollisesti on mahdollista löytää painotus, joka vastaa oikeudenmukaisuuden mielessä erittäin hyvin aktuaalista ministerineuvoston valtajakaumaa. Tällöin kansalaisten tasavertainen kohtelu saa painon 0.79 ja jäsenmaiden tasavertainen kohtelu puolestaan painon 0.21. Toisin sanoen EU:n valtajakauman perusteella se on 79-prosenttisesti valtio ja 21-prosenttisesti valtioliitto.

Tutkimuksen toisena tarkoituksena on esittää tapa, jolla tietty oikeudenmukainen valtajakauma voidaan saavuttaa jäsenmaille annettavien painojen avulla. Tutkimuksessa esitellään varsin tehokkaaksi osoittautuva iteratiivinen menettely tähän.

Tutkimuksesta voidaan vetää kolme politiikkasuositusta. Ensimmäiseksi suhteellisuuden tai oikeudenmukaisuuden arvioimiseksi Euroopan unionin päätöksenteossa, on EU:n luonne pyrittävä määrittelemään ensin. Toiseksi, jos Banzhaf-valtaindeksiä pidetään tyydyttävänä mittana valtajakaumalle EU:n pienille jäsenmaille tulee antaa enemmän painoarvoa kuin niiden asukasluku osoittaisi otettiin suhteellisuuskriteeriksi mikä tahansa tutkimuksessa esitetyistä.

Kolmanneksi tutkimus osoittaa, että ei ole olemassa vakavasti otettavia argumentteja EU:n nykyisen valtajakauman keskittämisen puolesta.

1 Introduction

This paper deals with fairness of national representation in EU decision making. An often heard argument is that in the current EU decision making the largest countries are under-represented while the reverse holds for the small ones. During the EFTA countries' accession talks there was some debate regarding the small versus the large countries' influence in the Union which is easy to understand as the EFTA countries' entry increased the relative proportion of small countries in the Union. As the Union is now taking the first steps of enlargement to the Central and Eastern Europe, where the potential candidates are in terms of population again smaller than the Union average, and as the Union has decided to reform its institutions before their entry, the question is once again very topical .

Clearly this problem could be addressed by a radical redistribution of votes among members. The counter-argument is that this could reduce the equity of the current arrangements. However, how fair these present arrangements are could be questioned, since the current distribution of votes is far from reflecting the relative sizes of the member countries. At the extremes, Germany for example has 8 millions electors per vote whereas Luxembourg has less than 200,000. The general feature of the current distribution of representation is that small countries are relatively over-endowed and their large counterparts have less than proportional weight.

In this paper we analyze this question more deeply. The approach of this paper is to model the voting process in the EU by a simple superadditive game, which allows us to measure the distribution of power by the Banzhaf index. The current indices within the Council of Ministers are computed and compared with indices which are considered as fair under different definitions of the nature of the EU. Therefore the results crucially depend on which definition of the EU is taken into account. As the definition of the EU is not quite clear, several possible assumptions are considered here. Comparing different definitions we make two arguments. First, we show that strictly and analytically speaking, the current distribution of votes cannot give rise to a fair allocation of power whatever definition of the EU we choose. Second, however, we note that in statistical sense, the current distribution of votes, although arbitrarily determined, could make sense.

We also propose a method to obtain a given distribution of power which corresponds to an arbitrary given definition of the EU. The method seems to be rather effective tool to correct the initially given votes distribution in a way that the desired allocation of power could be reached.

The rest of the paper is organized as follows. Section 2 models voting processes as simple games and defines the Banzhaf index of power. Section 3 presents the particular features of the EU and proposes the simple-game representation of the voting processes within the Council of Ministers. Section 4 derives the fair distributions of

power for different definitions of the EU. Section 5 computes the current distributions of power and deals with the question of fairness. Section 6 searches for distributions of votes that ensures fair allocation of power. Finally section 7 concludes.

2 Voting games and power indices

A (0-1)-game is defined as a pair (N, v) where $N = \{1, .., n\}$ denotes the set of players and v a real-valued function defined on the subsets of N to $\{0, 1\}$. Any non-empty subset of N is called a coalition.[1] Let us denote an arbitrary coalition by S. Without a loss of generality we can refer to coalitions with the property $v(S) = 1$ as winning while those with $v(S) = 0$ as losing. Function v defines a simple game when it is not identically 0 and is monotonic, i.e. $v(S) \leq v(T)$ whenever $S \subseteq T$. In this context, a game is superadditive if the complement of a winning coalition is always losing: $v(S) + v(N \setminus S) \leq 1$ for all $S \subset T$.

A voting process can be modelled as a (0-1)-game where the winning coalitions are defined as those which can make a decision without the vote of the remaining players. The coalitional form of a voting process can be described as follows:
1. Unanimity of players leads to the passage of a proposal: $v(N) = 1$.
2. A subset of a losing coalition is always losing: $v(T) = 0 \Rightarrow v(S) = 0$ for all $S \subset T$
3. Two nonintersecting coalitions are not winning at the same time: if $v(S) = 1$ then $v(T) = 0$ for all T such that $S \cap T = \emptyset$.
Properties 1 and 2 define a simple game. As the game is monotonic, property 3 is equivalent to say that the game is superadditive. Thus a voting process can be modelled as a simple superadditive game.

There are direct and indirect voting processes. In indirect cases individual players are partitioned into groups and each group selects a representative to vote for an outcome of the game. Let $M = \{1, ..., m\}$ be a set of players divided into n nonintersecting groups of players $(m_1 + m_2 + ... + m_n = m)$:

$$M = \left\{ \underbrace{1(1), ..., m_1(1)}_{M_1}, \underbrace{1(2), ..., m_2(2)}_{M_2}, ..., \underbrace{1(n), ..., m_n(n)}_{M_n} \right\}$$

In the first stage each group $M_j = \{1, ..., m_j\}$ elects its representative, i.e. the games (M_j, y_j) are played within groups j $(j = 1, ..., n)$. In the second stage, the representatives $N = \{1, ..., n\}$ vote for the outcome, i.e. the game (N, v) is played among n representatives. The indirect voting process among the individual players is called a compound game (M, u) having a coalitional form $u = v(y_1, ..., y_n)$.

A player is said to have influence on an outcome if his vote is crucial for a proposal to pass. In other words a player has power if the outcome depends on his vote, i.e.

[1] As (0-1)-games are usually interpreted as voting games a coalition can be defined as a set of voters who vote similarly.

player i exerts power in $S \Longleftrightarrow v(S) = 1$ and $v(S \backslash \{i\}) = 0$. It is easy to see that power depends on the probability of coalition formation. In the absence of information on these probabilities, we give an equal probability for all coalitions.[2] As there are 2^{n-1} coalitions including a given player, player i's power can be written as follows:

$$\widetilde{\beta_i}(v) = 2^{1-n} \cdot \sum_{\substack{S \subset N \\ i \in N}} [v(S) - v(S \setminus \{i\})] \tag{1}$$

which is referred to as the non-normalized Banzhaf index.[3] The following normalization is often used:[4]

$$\beta_i(v) = \frac{\widetilde{\beta_i}(v)}{\sum_{k \in N} \widetilde{\beta_k}(v)} \tag{2}$$

Owen (1975) has shown that the Banzhaf index of a compound game (M, u) can be defined as a product of indices of the stages and thus the following holds:

$$\widetilde{\beta_{i(j)}}(u) = \widetilde{\beta_j}(v) \cdot \widetilde{\beta_i}(y_j) \text{ for all } i \in M_j,\ j = 1, ..., n. \tag{3}$$

3 Voting within the EU as a simple game

3.1 Special features of the EU

The voting process in the EU involves mainly three institutions: the Parliament, the Commission and the Council of Ministers. Since this paper is devoted to the distribution of power among the member states we focus on the Council of Ministers, which represents the national interests. Indeed in the Parliament representatives' voting patterns are likely to be based on ideology rather than nationality and the Commission represents, at least theoretically, the supranational view.

There are several ways of making a decision in the Council of Ministers depending on the issue which is voted upon. These include: (1) unanimity, (2) simple majority of member states, (3) qualified majority with voting weights and (4) qualified majority with voting weights and a minimum number of states. Whenever a qualified majority is used the national voting weights are the following: 10 votes each for Germany, the United Kingdom, France and Italy; 8 votes for Spain; 5 votes each for the Netherlands, Greece, Belgium and Portugal; 4 votes each for Sweden and Austria; 3 votes each for Denmark, Finland and Ireland; and 2 votes for Luxembourg. A qualified majority

[2] Assuming that all the size are equiprobable and that coalitions of a given size have the same probability of forming leads to the Shapley-Shubik index.

[3] In behavioral sense the same formula may be obtained by assuming that each voter's probability of voting "yes" on a bill is chosen from the uniform distribution on [0,1]. As this paper deals with an abstract design of a voting body this behavioral background seems the most reasonable.

[4] However the probabilistic interpretation holds no longer.

can be reached by 62 votes out of 87. For some qualified majorities a minimum of 10 members out of 15 is required.[5]

In order to evaluate the fairness of the power distribution among member states, one has to define a criterion for fairness within the EU. This gives rise to a fair distribution of power which can then be compared to the current distribution. Since the definition of the EU determines the fairness criterion among the states, the nature of the EU must be taken into account. If the EU were a single state, all citizens should be treated equally. The "One Man, One Vote" principle should apply. If the EU were an association of states, no state should be treated differently from another. Thus the "One State, One Vote" should be applied. But the EU is neither a single state nor an association of states; the basic nature of the Union lies somewhere between these extremes. Hence in some sense the EU can be defined as a federal state, which means that both principles must be taken into account. The degree of federalism should determine the importance accorded to the "One Man, One Vote" principle relative to the "One State, One Vote" principle. We call these weighted averages of the extreme federal states (which are respectively a single state and an association of states). All this determines the fact that the vote within the EU Council must be approached from two point of view, the point of view of the member states and the point of view of the EU citizens.

3.2 Voting games among member states

Let $N = \{1, ..., 15\}$ be the set of member states. The four different voting rules in the Council of Ministers can be defined formally as follows:
1) Unanimity (N, v_u)

$$v_u(S) = \begin{cases} 1 & \text{if } S = N \\ 0 & \text{otherwise} \end{cases}$$

2) Simple Majority (N, v_{sm})

$$v_{sm}(S) = \begin{cases} 1 & \text{if } s \geq 8, \text{ where } s \text{ denotes the number of voters in } S \\ 0 & \text{otherwise} \end{cases}$$

3) Qualified Majority (N, v_{qm})

$$v_{qm}(S) = \begin{cases} 1 & \text{if } \sum_{j \in N} w_j \geq 62, \text{ where } w_j \text{ denotes state } j\text{'s number of votes} \\ 0 & \text{otherwise} \end{cases}$$

4) Qualified Majority with a minimum number of member states (N, v_{qm+})

$$v_u(S) = \begin{cases} 1 & \text{if } \sum_{j \in N} w_j \geq 62 \text{ and } s \geq 10 \\ 0 & \text{otherwise} \end{cases}$$

[5]These questions include decisions where the Commission is not competent to make proposals. In general a unanimous Council can amend proposals and thus has an effective right to make proposals.

3.3 Voting games among citizens

Let $M = \{1, ..., m\}$ be the set of the EU citizens. The citizens do not vote directly in the Council of Ministers. They are only represented via their national governments. Hence from the EU citizens' point of view the voting processes in the Council are indirect. We model them as compound games. The set of the EU citizens may be divided into 15 separate subgroups: $M = M_1 \cup ... \cup M_{15}$. In the first stage, the citizens elect their national government, i.e. the games (M_j, y_j) are played within states j $(j = 1, ..., 15)$. We assume that the government election games are simple majority games:

$$y_j(S) = \begin{cases} 1 & \text{if } s > m_j/2 \\ 0 & \text{otherwise} \end{cases}$$

In the second stage the member states representatives vote in the Council of Ministers, i.e. the game (N, v) is played among the member states. Then the coalitional forms of the compound games among the EU citizens are respectively as follows $u_u = v_u(y_1, ..., y_{15})$, $u_{sm} = v_{sm}(y_1, ..., y_{15})$, $u_{qm} = v_{qm}(y_1, ..., y_{15})$ and $u_{qm+} = v_{qm+}(y_1, ..., y_{15})$.

4 On Fairness within the EU

The way fairness is defined depends on the underlying conception of the EU. As it is not quite clear, several possible definitions of the EU are considered here. The following notational conventions are adopted: (N, v_α), $\widetilde{\alpha}$, α denote a fair game played among states in the Council, the fair non-normalized Banzhaf index and the fair normalized index respectively.

4.1 The case of an association of states

If the EU is an association of totally independent states, each state must have the same treatment. Thus in a fair game in the Council of Ministers (N, v_α) it means that each state must have the same probability of being crucial: $\widetilde{\alpha_1}(v_\alpha) = ... = \widetilde{\alpha_{15}}(v_\alpha)$ whatever this probability is.[6] It is equivalent to require that each player has the same normalized power index. Hence

$$\alpha_j(v_\alpha) = 1/15 \text{ for all } j \tag{4}$$

[6]Requiring a certain probability would imply a choice concerning the risk of status quo. The non-normalized Banzhaf index gives some information on the difficulty of making a decision : the higher the non-normalized Banzhaf index is, the easier it is to make a decision (see Widgrén (1994a)).

4.2 The case of a single state

If the EU is a single state, each individual citizen must be treated equally. It means that no citizen may exert more power than any other, regardless of his nationality in EU decisions.

Let (M, u_α) be a fair compound game of the EU decision making as outlined above. So we have $M = M_1 \cup ... \cup M_{15}$ and $u_\alpha = v_\alpha(y_1, ..., y_{15})$ where (M_j, y_j) $(j = 1, ..., 15)$ are the government election games in the member states and (N, v_α) is the voting game in the Council of Ministers that guarantees fairness in the compound game.

In the case of a single state, requiring the equal treatment of the EU citizens leads to the following property

$$\widetilde{\alpha}_{1(1)}\ (u_\alpha) = ... = \widetilde{\alpha}_{m_1(1)}\ (u_\alpha) = ... = \widetilde{\alpha}_{1(n)}\ (u_\alpha) = ... = \widetilde{\alpha}_{m_n(n)}\ (u_\alpha) \tag{5}$$

Since we are dealing with the Council of ministers we reduce the voting game of individual citizens to a voting game among the member states. Using (3), we obtain

$$\widetilde{\alpha}_j\,(v_\alpha) = \frac{\widetilde{\alpha}_{i(j)}\,(u_\alpha)}{\widetilde{\beta}_i(y_j)} \tag{6}$$

Then the following holds, as shown in the appendix:

$$\alpha_j(v_\alpha) = \frac{\sqrt{m_j}}{\sum_{k\,\in\,N}\sqrt{m_k}} \tag{7}$$

4.3 The case of a federal state

If the EU is a federal state, each state must be treated in accordance to a weighted average between the two extreme principles ("One Man, One Vote" and "One State, One Vote"). In the corresponding fair game in the Council of Ministers (N, v_α) it means that each state must have the following index of power:

$$\alpha_j(v_\alpha) = x \cdot \frac{\sqrt{m_j}}{\sum_{k\,\in\,N}\sqrt{m_k}} + (1-x) \cdot \frac{1}{15} \tag{8}$$

where $x \in (0, 1)$ represents the weight given to the "One Man, One Vote" principle. Figure 1 gives the fair distributions of power for different values of x.

*Insert figure*1

Three general aspects may be underlined. First, as could be expected, the fair share increase with the weight given to the "One Man, One Vote" principle for the large states (from Germany to Spain), while the reverse holds for medium-sized countries (from the Netherlands to Portugal) and small states (from Sweden to Luxembourg). Second, the fair share of power varies widely with x for the four largest states (from

Germany to Italy) or for the two smallest states (Ireland and Luxembourg). For medium-sized countries the sensitivity to x is not that significant. In particular the Netherlands' fair share remains nearly constant irrespective of how the EU is defined. Third, when the "One Man, One Vote" principle is taken into account ($x > 0$), the United Kingdom, France, and Italy all have similar fair shares of power. This also holds for Greece, Belgium and Portugal or Denmark, and Finland.

5 Power distribution within the EU Council of Ministers

5.1 Current distribution of power

Table 1 shows the current non-normalized Banzhaf indices for each way of making a decision.

Insert table1

A striking feature of this table is the difference between the unanimity and the simple majority voting rules. In the former case the probability of being crucial is very small for any member while it is quite high in the simple majority. This may explain that when unanimity is required, decision making is far from being easy and therefore the status quo is very likely to be the outcome of such a vote (see Widgrén 1994a). Table 1 also shows that the requirement of at least 10 members in a qualified majority increases small states' power. The reverse holds for large states. The explanation of this phenomenon is the following. Because of this "minimum number" requirement, coalitions of 7-9 countries are no longer winning. Since these coalitions are mainly formed by large countries, small countries gain power from the minimum requirement, while large states lose.

In order to compare the distribution of power between members, the normalization of these indices seems more appropriate. Table 2 gives the current normalized Banzhaf indices within the Council of Ministers.

Insert table2

It can be seen that the distribution of power is the same when either unanimity or simple majority is required. Both rules are symmetric and thus treat all countries equally. In the qualified majorities, however, the power share increases with the state's population. Large states receive a bigger share in the qualified majorities than when symmetric rules are used. The opposite holds for medium-sized and small countries.

5.2 Are the current allocations of power fair?

The "One Man, One Vote" principle is obviously fulfilled when simple majority or unanimity is used.[7] The underlying definition of the EU is thus clearly an association of states. Therefore this analysis will now focus on the qualified majorities. Table 3 reports the difference between the fair power indices and the current indices in the two following cases:

1. the EU is a single state: application of the "One Man, One Vote" principle ($x = 1$).
2. the EU is a federal state: the average between the two extreme principles ($x = 1/2$).

*Insert table*3

5.2.1 The case of a single state

The following remarks could be made on the basis of the calculations. If the qualified majority is required the current index gives an excessive power to most medium-sized countries and to all small states (from Greece to Luxembourg). Large states and the Netherlands have less power than they should be entitled to. Luxembourg's power, as well as that of most medium-sized countries (Greece, Belgium and Portugal), is totally excessive compared with their population. On the contrary Germany is notably under-represented: in particular Germany's number of votes has not been adjusted to the new population's figure after German unification. For Denmark and Finland the current index seems to fit quite well. Table 3 also shows that the distortions significantly increase when there is a requirement concerning the minimal size of a winning coalition, except for the Netherlands, whose current index is then close fair.

5.2.2 The case of a federal state

As table 3 shows, the current distribution gives an unfairly big power to large states while small states suffer from a lack of power. Medium-sized countries have more or less a fair share of power, except the Netherlands which has less than the fair share. If a minimum number of members is required, the distortions are smaller with an exception of Greece, Belgium and Portugal; in which case Germany receives less power than it should.

Figure 2a (for the qualified majority) and 2b (for the qualified majority requiring a minimum number of members) present the results for the different degrees of

[7] As far as fairness is concerned, the simple majority of member states and the unanimity rules are equivalent since they are symmetric. The difference between the two procedures lies in the probability of making a decision which is higher in the simple majority case, as mentioned above. That is why a simple majority contradicts with the usual idea of an association of states where member countries have a right to veto.

federalistic definitions of the EU (x, the weight given to the "One Man, One Vote" principle varying on a range between 0 and 1).

Insert figure2a and 2b

On the basis of these figures, we may argue that the current distribution of votes is not fair when the two versions of qualified majorities are used and whatever definition of the EU is considered. However the current distribution of votes do not systematically give an excessive power to some small states. The favored and disfavored states depend on the chosen definition of the EU. Nevertheless the Netherlands are always under-represented (in the qualified majority).

5.3 To which definition of the EU do the current indices correspond the best?

Unanimity and simple majority processes fit perfectly with the definition of the EU as an association of states. On the other hand qualified majorities do not correspond to a particular conception of the EU. This means that the weight that the current distribution of power gives to the "One Man, One Vote" principle varies according to the state, which is illustrated in Figure 3.

Insert figure3

It is also shown that for large and small states more importance is currently accorded to the "One Man, One Vote" principle, while the reverse holds for most medium-sized countries (Greece,Belgium and Portugal). As previously mentioned the Netherlands's power index does not correspond to any of the weighted averages of the two extreme principles. Thus in a strict sense there exists no consistent definition of the EU that would give rise to the current distribution of power.[8]

However, it may be interesting to determine which definition of the EU would be best reflected by the current qualified majorities processes. This can be done by estimating simple regressions where the current index is the dependent variable and the square root share of the population is the independent variable. Then the fixed variable shows directly the share of the "One State, One Vote" principle. For the ordinary qualified majority rule we obtain the following equation[9]

$$\begin{aligned} \beta_j = \quad & 0.79 \cdot \frac{\sqrt{m_j}}{\sum_{k \in N} \sqrt{m_k}} + \quad 0.014 \\ & (0.037) \qquad\qquad (0.003) \qquad\qquad (9) \\ R^2 = 0.97 & \end{aligned}$$

[8]It is worth noting that the number of population has increased in the Netherlands quite significantly during her membership in the EU.

[9]where the standard errors of the regression coefficients are shown in parentheses.

and for qualified majority with the minimum requirement of member states we obtain

$$\begin{aligned} \beta_j = \quad & 0.60 \cdot \frac{\sqrt{m_j}}{\sum_{k \in N} \sqrt{m_k}} + \quad 0.026 \\ & (0.029) \qquad\qquad (0.002) \\ R^2 = 0.97 & \end{aligned} \tag{10}$$

Thus the respective estimated weights for the "One Man One Vote" principle are 0.79 for the qualified majority and 0.60 for the qualified majority with a number of members requirement.Table 4 presents the difference between the current index and the fair index for these weighted figures, i.e. the residuals of the regressions in (9) and (10).

Insert table 4

Given the high values of R^2 we could expect small residuals and not any systematics in their behavior. The absolute values are, indeed, quite small and one cannot find systematic fluctuation in their values.[10] It can be seen, however, that the relative differences are far from being negligible. Germany is still largely under-represented, which is also the case in relative terms for Denmark and Finland, while most medium-sized states (Greece, Belgium and Portugal) have excessive power. This still emphasizes that the current distribution of votes under the qualified majorities is inappropriate to ensure a fair distribution of power among the member states.

6 Searching for fair allocation of power

The previous sections have shown that the current distribution of votes is not fair, in the sense that it does not ensure a fair distribution of power. Then the following question to pose is whether there exists a fair distribution of votes. In other words, given a distribution of power considered as fair, is there a distribution of votes that gives rise to this distribution of power? In this section we try to give an empirical answer to this question.

We start by computing the Banzhaf index obtained when the fair distribution of power is used as distribution of votes. The derivative power index fits better to the fair distribution of power than the current index. Then we derive the power coefficient, defined as the ratio between the corresponding Banzhaf index and the fair distribution of power. The comparison of this coefficient with the unit vector indicates which countries are over-endowed and which countries are under-endowed. We use this information by deriving a distribution of vote which is the fair distribution of power divided by the power coefficient. The corresponding Banzhaf index is still

[10] So in statistical sense we may argue that the current distribution of vote could make sense when a weight of 0.79 is given to the "One Man, One Vote" principle.

closer to the fair distribution of power. This suggests the following iteration process in order to achieve the fair distribution of power.

Let β_{fair} be the fair distribution of power. We start with a distribution of votes equal to the fair distribution of power $\omega_{(0)} = \beta_{fair}$ to compute $\beta(\omega_{(0)})$, the Banzhaf index. The corresponding power coefficient is

$$r_0 = \frac{\beta_{(\omega_{(0)})}}{\beta_{fair}} = \frac{\beta_{(\omega_{(0)})}}{\omega_{(0)}} \tag{11}$$

Then we define the first adjusted vector of voting weights as follows:

$$\omega_{(1)} = \frac{\omega_{(0)}}{r_0} = \frac{\omega_{(0)}}{\beta_{(\omega_{(0)})}/\omega_{(0)}} = \frac{(\omega_{(0)})^2}{\beta(\omega_{(0)})} \tag{12}$$

If $\beta(\omega_{(1)})$ denotes the Banzhaf index, the corresponding lagged power coefficient is

$$r_1 = \frac{\beta_{(\omega_{(1)})}}{\beta_{fair}} = \frac{\beta_{(\omega_{(1)})}}{\omega_{(0)}} \tag{13}$$

We thus correct the distribution of votes with the lagged power coefficient. The second step is now the following

$$\omega_{(2)} = \frac{\omega_{(1)}}{r_1} = \frac{\omega_{(1)}}{\beta(\omega_{(1)})/\omega_{(0)}} = \frac{(\omega_{(0)})^3}{\beta(\omega_{(0)})\beta(\omega_{(1)})} \tag{14}$$

Generally the kth step can be written

$$\omega_{(k)} = \frac{(\omega_{(0)})^{k+1}}{\prod_{i=0}^{k}\beta(\omega_{(i)})} \tag{15}$$

Basically the aim of equations (11)-(15) is that the kth vector of lagged power coefficient converges to the unit vector. Note that the special case is a symmetric game where the fair distribution of votes and power are equal. In this case the zero order lagged power coefficient is unit vector. So if the EU is defined as an association of states an equal distribution of votes ensures an equal distribution of power. For the other possible definitions of the EU the above described iteration process must be applied. In this section we still focus on three possible definitions:
1) the EU is a state $x = 1$
2) the EU is a federal state $x = 1/2$
3) the EU is a modified federal state $x = 0.79$
Table 5 reports the calculation of the iteration towards the fair distribution of power in the case of a state and compare this with countries' population shares.

Insert table 5

From table 5 we see that r_0 varies on a range from 0.872 to 1.095 . Thus the differences are quite moderate in the EU Council game. It can also be seen that the convergence

towards the fair allocation of power is fast and that only two adjustments are required when we start from the given fair allocation of votes. The comparison between the population share and the fair distribution of votes shows that large countries should have a weight less than proportional to their population while the reverse holds for medium-sized and small countries. This result reflects the well-known fact that in weighted voting power tends to exceed voting weight for large voters as the reverse holds for small ones. Table 6 gives the fair distribution of votes depending on the definition taken into account for the EU (in the sense that they lead to the fair distribution of power).

Insert table 6

The results shows that the fair distribution of votes depends on the definition of the EU and that it can not be asserted that small countries have an excessive share in the current distribution of votes. However it can be mentioned that the Netherlands has a too small share.

7 Conclusion

This paper has provided a game theoretic framework to analyze fairness within the EU Council of Ministers. The quantitative results of this paper are the following: What can be considered as a fair distribution of power among states depends on how the EU is defined. The unanimity and simple majority processes can be evaluated be fair if the EU is defined as an association of states. The qualified majorities do not lead to a fair distribution of power whether the EU is defined as a single state, or as an association of states or as a federal state (whatever the degree of federalism is). Moreover the Netherlands is always under-represented when the qualified majority is used. However it can not be argued that the current voting process has a systematic bias in favor of some states, in that the definition of EU can not be made precise. So a redistribution of the votes among the states -even if necessary- would require first an agreement concerning the definition of the EU that should be reflected in the distribution of power. Seemingly such agreement would be very difficult to reach, but it is the only way to guarantee a fair distribution of power among states. In section 6 we suggest a method by which fair power allocations can be obtained. The results show that the fair distribution is rather easy to reach with an iterative process by taking the fair allocation as the base in terms of the distribution of votes. The distribution of power and the distribution of votes are generally the same only in symmetric games. This paper suggests that even a very small move away from the equal division of voting shares leads to the usually observed result: voters with high shares of votes tend to have more power relative to their voting share than the small ones. Detailed analysis of this important phenomenon is left for future research. The analysis of fair allocations of power gives two policy recommendations for the case of the EU, first, given that power indices are more appropriate measures for voters'

influence than voting weights, voters with small shares of votes should have more votes than their fair share of influence would suggest and, second, with regard to the current distribution of votes there are no reasonable fairness arguments to concentrate the allocation of votes towards the largest member states.

Appendix

Let C denotes a individual citizen's probability of being crucial. Hence

$$C = \widetilde{\alpha}_{1(1)}(u_\alpha) = ... = \widetilde{\alpha}_{m_n\ (n)}(u_\alpha). \tag{16}$$

The computation of $\widetilde{\beta}_i(y_j)$ will allow us to derive $\widetilde{\alpha}_j(v_\alpha)$ from (6), which can be rewritten as

$$\widetilde{\alpha}_j(v_\alpha) = \frac{C}{\widetilde{\beta}_i(y_j)} \tag{17}$$

The games (M_j, y_j) $(j = 1, ..., n)$ are symmetric since they have been defined as simple majority games. Moreover a player is only crucial in coalitions whose sizes is such that $s > m_j/2$ and $s - 1 \leq m_j/2$. Hence $s = \frac{m_j+1}{2}$ if m_j is odd while $s = \frac{m_j}{2}$ if m_j is even.
By definition of the non-normalized Banzhaf index, we obtain
if m_j is odd:

$$\begin{aligned}\widetilde{\beta}_i(y_j) &= \frac{1}{2^{m_j-1}} \begin{pmatrix} \frac{m_j-1}{2} \\ \\ m_j-1 \end{pmatrix} \\ \\ &= \frac{1}{2^{m_j-1}} \cdot \frac{(m_j-1)!}{\left(\frac{m_j-1}{2}\right)! \left(\frac{m_j-1}{2}\right)!}\end{aligned}$$

By Stirling's approximation, we get

$$\widetilde{\beta}_i(y_j) = \frac{\sqrt{2.\pi.(m_j-1)}\ (m_j-1)^{m_j-1}\ e^{\frac{m_j-1}{2}}\ c^{\frac{m_j-1}{2}}}{2^{m_j-1}\ e^{m_j-1}\ \sqrt{2.\pi.\left(\frac{m_j-1}{2}\right)}\sqrt{2.\pi.\left(\frac{m_j-1}{2}\right)}\ \left(\frac{m_j-1}{2}\right)^{\frac{m_j-1}{2}}\ \left(\frac{m_j-1}{2}\right)^{\frac{m_j-1}{2}}}$$

This expression may be reduced to

$$\widetilde{\beta}_i(y_j) = \frac{\sqrt{2}}{\sqrt{\pi}\sqrt{m_j}} \tag{18}$$

if m_j is even

$$\widetilde{\beta_i}(y_j) = \frac{1}{2^{m_j-1}} \begin{pmatrix} \frac{m_j}{2} \\ \\ m_j-1 \end{pmatrix}$$

$$= \frac{1}{2^{m_j-1}} \cdot \frac{(m_j-1)!}{\left(\frac{m_j}{2}\right)! \left(\frac{m_j-2}{2}\right)!}$$

By Stirling's approximation, we get

$$\widetilde{\beta_i}(y_j) = \frac{\sqrt{2.\pi.(m_j-1)}\ (m_j-1)^{m_j-1}\ e^{\frac{m_j}{2}}\ e^{\frac{m_j-2}{2}}}{2^{m_j-1}\ e^{m_j-1}\ \sqrt{2.\pi.\left(\frac{m_j-2}{2}\right)}\sqrt{2.\pi.\left(\frac{m_j}{2}\right)}\ \left(\frac{m_j-2}{2}\right)^{\frac{m_j-2}{2}}\ \left(\frac{m_j}{2}\right)^{\frac{m_j}{2}}}$$

$$= \frac{\sqrt{2}}{\sqrt{\pi}} \cdot \frac{\sqrt{m_j-1}}{\sqrt{m_j-2}\sqrt{m_j}} \cdot \frac{(m_j-1)^{m_j-1}}{\left(\frac{m_j-2}{2}\right)^{\frac{m_j-2}{2}}\ \left(\frac{m_j}{2}\right)^{\frac{m_j}{2}}}$$

Since m_j is sufficiently large, this expression may be approximated by

$$\widetilde{\beta_i}(y_j) = \frac{\sqrt{2}}{\sqrt{\pi}\sqrt{m_j}} \tag{19}$$

Using (18) or (19) in (17), we obtain

$$\widetilde{\alpha_j}(v_\alpha) = \frac{C.\sqrt{\pi}\sqrt{m_j}}{\sqrt{2}}$$

Thus

$$\alpha_j\,(v_\alpha) = \frac{\sqrt{m_j}}{\sum_{k\ \in\ N} \sqrt{m_k}} \tag{7}$$

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	U	SM	QM	QM+
Germany	0.000061	0.209	0.113	0.098
United Kingdom	0.000061	0.209	0.113	0.098
France	0.000061	0.209	0.113	0.098
Italy	0.000061	0.209	0.113	0.098
Spain	0.000061	0.209	0.093	0.083
Netherlands	0.000061	0.209	0.059	0.059
Greece	0.000061	0.209	0.059	0.059
Belgium	0.000061	0.209	0.059	0.059
Portugal	0.000061	0.209	0.059	0.059
Sweden	0.000061	0.209	0.048	0.051
Austria	0.000061	0.209	0.048	0.051
Denmark	0.000061	0.209	0.036	0.042
Finland	0.000061	0.209	0.036	0.042
Ireland	0.000061	0.209	0.036	0.042
Luxembourg	0.000061	0.209	0.023	0.030

Table 1: Current non-normalized Banzhaf indices for the unanimity (U), the simple majority(SM), the qualified majority (QM) and the qualified majority with at least ten countries (QM+).

	U	SM	QM	QM+
Germany	0.067	0.067	0.112	0.101
United Kingdom	0.067	0.067	0.112	0.101
France	0.067	0.067	0.112	0.101
Italy	0.067	0.067	0.112	0.101
Spain	0.067	0.067	0.092	0.085
Netherlands	0.067	0.067	0.059	0.061
Greece	0.067	0.067	0.059	0.061
Belgium	0.067	0.067	0.059	0.061
portugal	0.067	0.067	0.059	0.061
Sweden	0.067	0.067	0.048	0.052
Austria	0.067	0.067	0.048	0.052
Denmark	0.067	0.067	0.036	0.043
Finland	0.067	0.067	0.036	0.043
Ireland	0.067	0.067	0.036	0.043
Luxembourg	0.067	0.067	0.023	0.031

Table 2: Current normalized Banzhaf indices for the unanimity (U), the simple majority(SM), the qualified majority (QM) and the qualified majority with at least ten countries (QM+).

	QM (x=1)	QM+(x=1)	QM (x=.5)	QM+ (x=.5)
Germany	-0.028	-0.039	+0.009	-0.002
United Kingdom	-0.007	-0.018	+0.019	+0.008
France	-0.006	-0.017	+0.020	+0.009
Italy	-0.006	-0.017	+0.020	+0.009
Spain	-0.005	-0.012	+0.010	+0.003
Netherlands	-0.002	+0.0001	-0.005	-0.003
Greece	+0.009	+0.011	+0.0003	+0.003
Belgium	+0.009	+0.012	+0.0007	+0.003
Portugal	+0.010	+0.012	+0.0009	+0.003
Sweden	+0.002	+0.006	-0.008	-0.004
Austria	+0.004	+0.008	-0.007	-0.003
Denmark	+0.0005	+0.008	-0.015	-0.008
Finland	+0.0009	+0.008	-0.015	-0.008
Ireland	+0.007	+0.014	-0.012	-0.005
Luxembourg	+0.013	+0.021	-0.016	-0.007

Table 3: The difference between the current index and the fair one when the EU is defined as a state ($x = 1$) or as a federal state ($x = 0.5$) for the qualified majority (QM) and the qualified majority with at least ten countries (QM+).

	QM	%	QM+	%
Germany	-0.013	-10	-0.010	-8.7
United Kingdom	+0.004	+3.8	+0.003	+3.3
France	+0.004	+4.1	+0.003	+3.5
Italy	+0.005	+4.5	+0.004	+3.9
Spain	+0.001	+1.6	+0.0004	+0.4
Netherlands	-0.003	-5.4	-0.002	-3.4
Greece	+0.005	+9.8	+0.004	+7.6
Belgium	+0.006	+11	+0.005	+8.4
Portugal	+0.006	+12	+0.005	+9
Sweden	-0.002	-4.6	-0.002	-3.6
Austria	-0.0007	-1.5	-0.0007	-1.4
Denmark	-0.006	-14	-0.005	-9.8
Finland	-0.006	-13	-0.004	-9.4
Ireland	-0.001	-3	-0.001	-2.4
Luxembourg	+0.001	+5.3	-0.001	-4.5

Table 4: The absolute and relative error terms for equations (9) and (10).

	$\%\ pop$	$w_{(0)}$	$\beta(w_{(0)})$	r_0	$w_{(2)}$	$\beta(w_{(2)})$	r_2	$\beta(w_{(2)})/w_{(2)}$
Germany	0.219	0.140	0.153	1.095	0.129	0.140	0.999	1.079
United Kingdom	0.157	0.119	0.124	1.049	0.113	0.119	1.000	1.045
France	0.156	0.118	0.124	1.048	0.113	0.118	1.000	1.044
Italy	0.155	0.118	0.123	1.047	0.113	0.118	1.000	1.043
Spain	0.106	0.097	0.098	1.008	0.096	0.097	1.000	1.011
Netherlands	0.041	0.061	0.058	0.947	0.064	0.061	1.000	0.955
Greece	0.028	0.050	0.047	0.931	0.053	0.050	1.000	0.938
Belgium	0.027	0.049	0.046	0.930	0.053	0.049	1.000	0.937
Portugal	0.027	0.049	0.045	0.929	0.052	0.049	1.000	0.936
Sweden	0.024	0.046	0.042	0.924	0.049	0.046	1.000	0.932
Austria	0.022	0.044	0.041	0.921	0.047	0.044	1.000	0.929
Denmark	0.014	0.035	0.032	0.909	0.039	0.035	1.000	0.915
Finland	0.014	0.035	0.032	0.908	0.038	0.035	1.000	0.915
Ireland	0.010	0.029	0.026	0.900	0.032	0.029	1.000	0.906
Luxembourg	0.001	0.010	0.009	0.872	0.011	0.010	1.000	0.875

Table 5: The iteration towards the fair allocation of power when the EU is defined as a state.

	current	x=0.5	x=0.79	x=1
Germany	0.115	0.098	0.117	0.129
United Kingdom	0.115	0.090	0.103	0.113
France	0.115	0.089	0.103	0.113
Italy	0.115	0.089	0.103	0.113
Spain	0.092	0.081	0.090	0.096
Netherlands	0.057	0.065	0.064	0.064
Greece	0.057	0.060	0.056	0.053
Belgium	0.057	0.059	0.055	0.053
Portugal	0.057	0.059	0.055	0.052
Sweden	0.046	0.058	0.053	0.049
Austria	0.046	0.057	0.051	0.047
Denmark	0.034	0.053	0.045	0.039
Finland	0.034	0.053	0.044	0.038
Ireland	0.034	0.050	0.040	0.032
Luxembourg	0.023	0.041	0.024	0.011

Table 6: The current distribution of votes and the shares of votes that lead to the fair distribution of power for three possible definitions of the EU.

Figure 1 : Fair power indices (depending on the weight accorded to the "One Man, One Vote" principle)

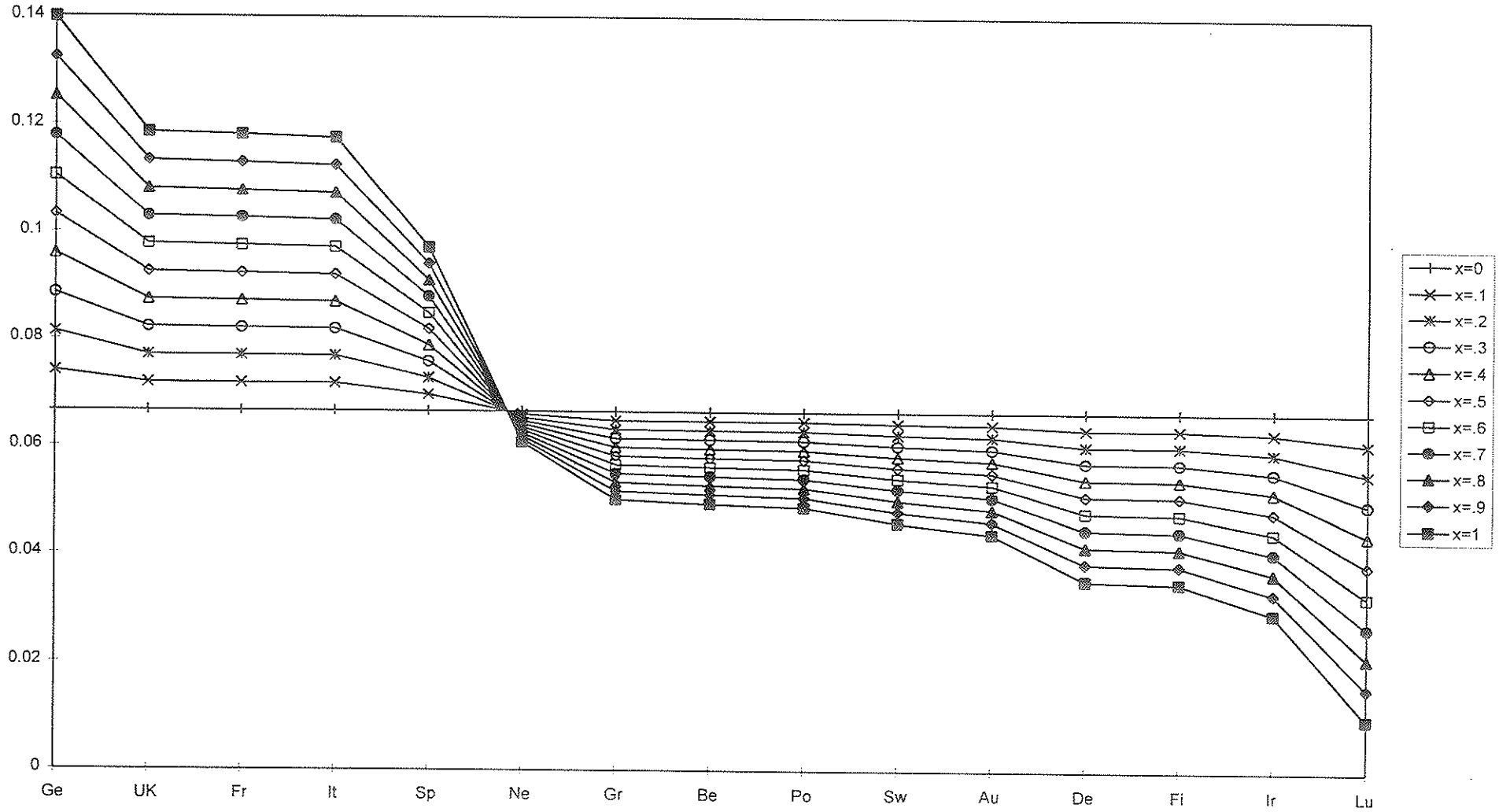


Figure 2a : Difference between the current index and the fair index (depending on the weight accorded to the "One Man, One Vote" principle) for the qualified majority

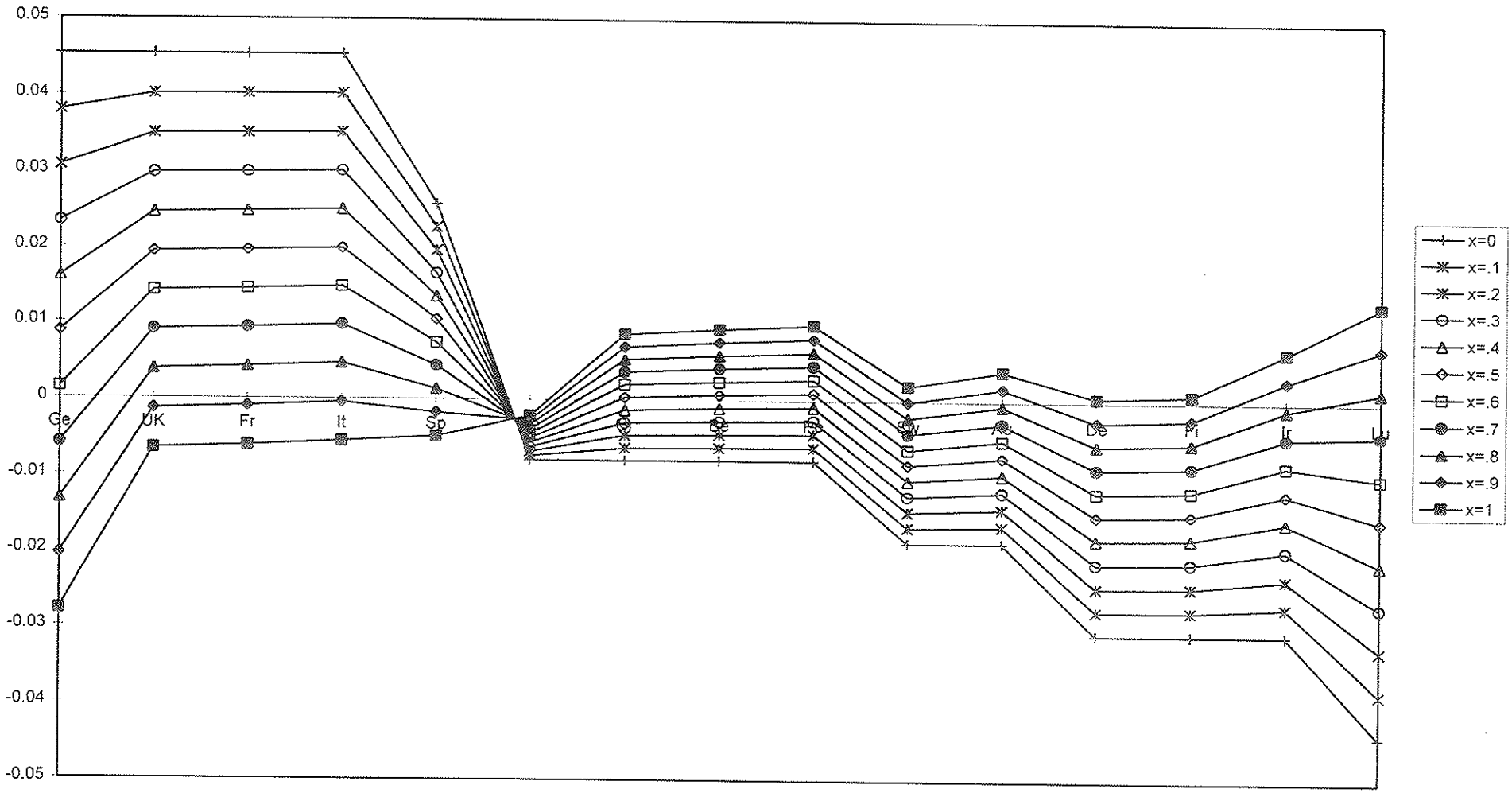


Figure 2b : Difference between the current index and the fair index (depending on the weight accorded to the "One Man, One Vote" principle) for the qualified majority +

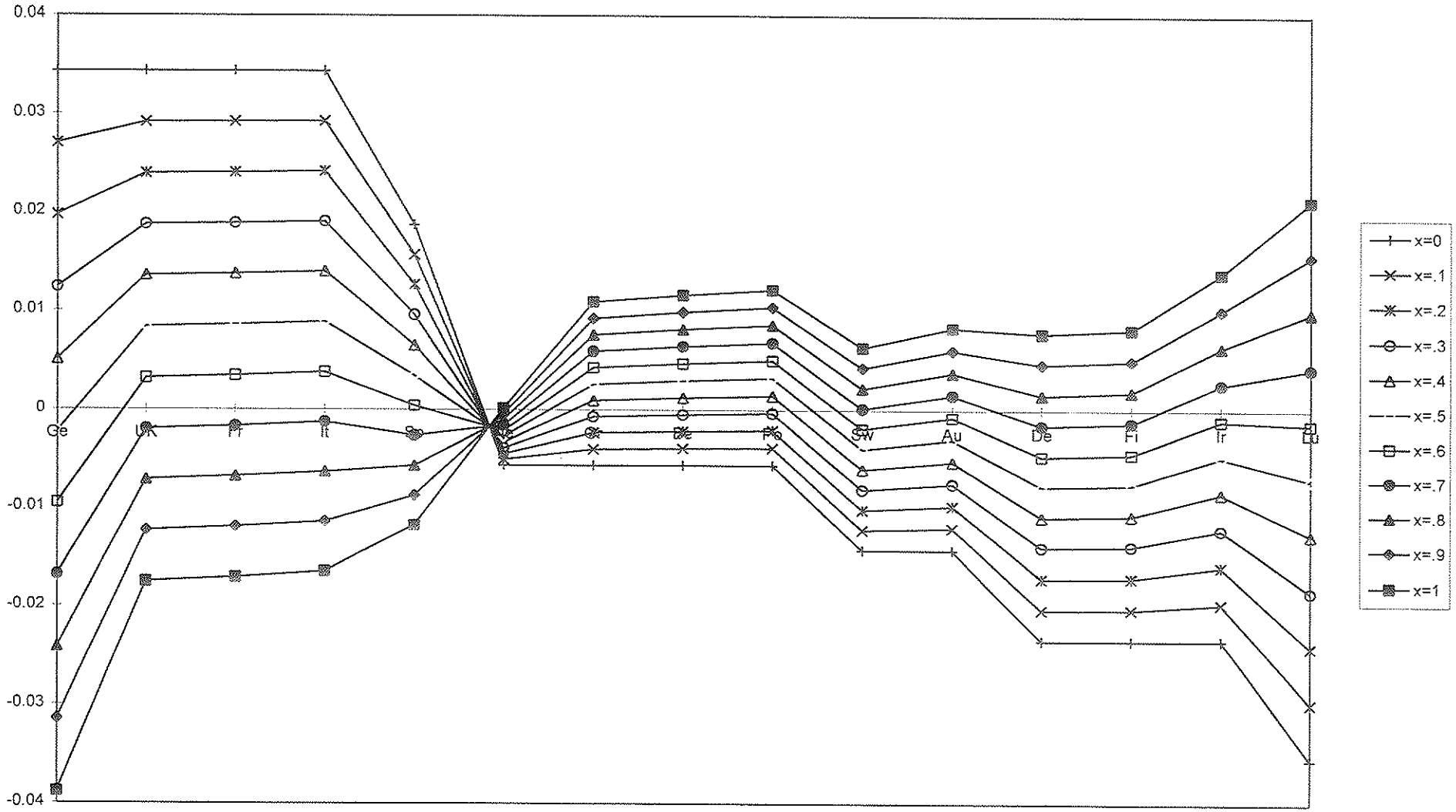
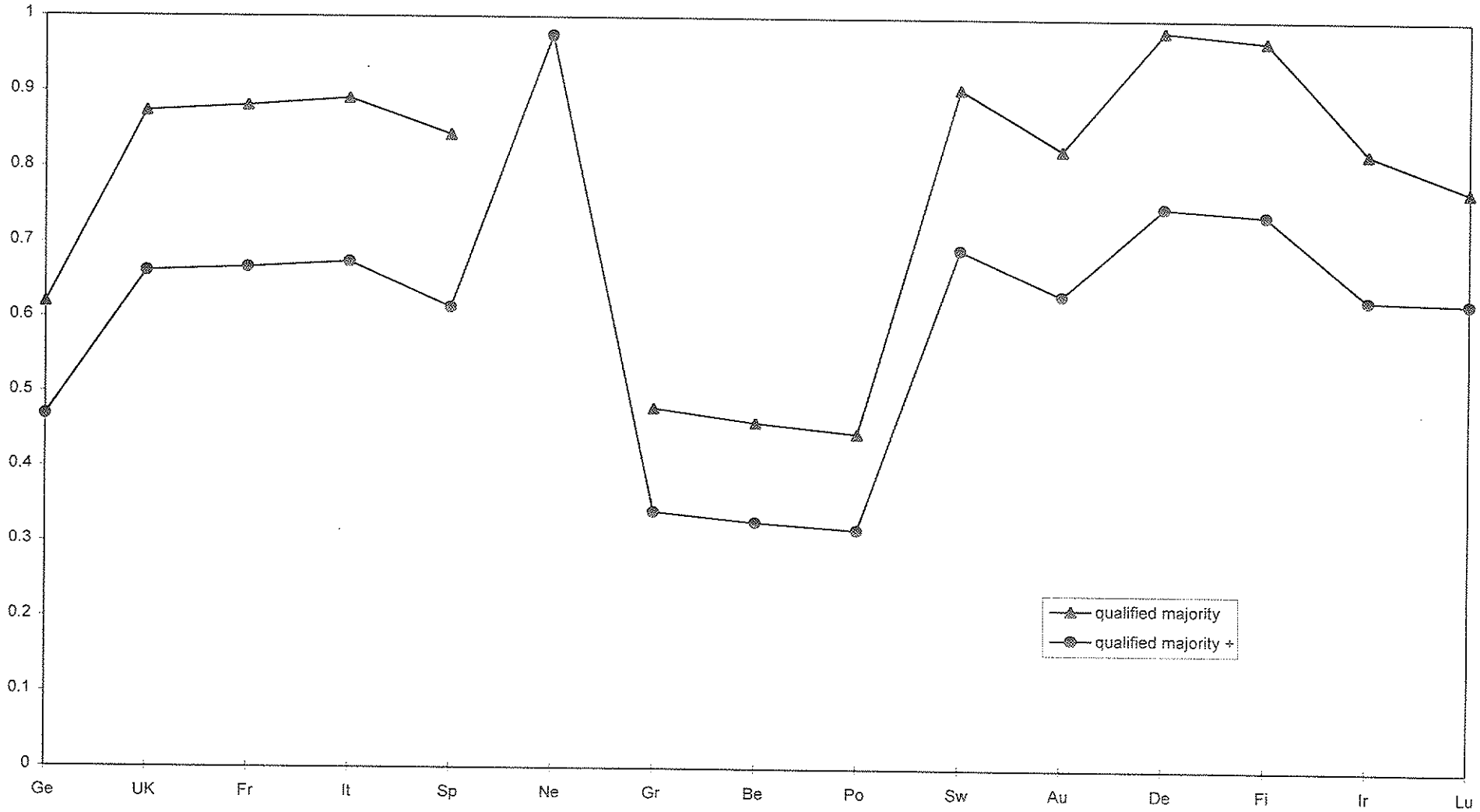


Figure 3. Weights that the current indices give to the "One Man, One Vote" principle for member states



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