

Composition of the European Parliament.

The FPS-Method

An intermediate formula between Cambridge Compromise and 0.5-DP
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General information

The actual EP composition comes from the negotiations carried out on 2007 for the 2009-2014 period; due to the fact that for the 2014-2019 period only a minor readjustment was made, which consisted in lowering 1 seat to 15 of the Member States.

After more than one decade, the total population of the EU has increased in several million inhabitants, although some Member States had their populations decreased. Some of the better represented countries have their population lowered and now they cannot lose seats for the 2019-2024 period, because it has been agreed not to lower any representation.

Degrressive proportionality imposes to raise the representation of some Member States because with the actual distribution and population data, the cost of a MEP is higher for France than it is for Germany, it is even more costly for Spain than for Germany, etc.

694 seats are needed to get DP with no state losing representation. We call the distribution of these 694 seats Basic Distribution, *BD*.

A formula that **complies** to all established requirements has been found.

Firstly, the population of each Member State is switched for an adjusted quota. The adjusted quota of many Member States is higher than its corresponding DB value, and for the rest of Member States it is very near to its corresponding DB value.

Secondly, the adjusted quotas have been rounded to whole numbers using Webster's Method forcing representation of each Member State to be equal or higher than its DB value and not higher than 96. The obtained allotment verifies all the established requirements for any EP size higher than 694 (Table 2, column 4 for $H=700$ and Table 3, column 3 for $H=710$).

The quota adjustment consists in assigning 3 seats to each Member State, and the rest of seats being distributed in this way: 40% of seats in proportion to the square root of the population of the Member States; 60% in proportion to population of the Member States.

The proposed formula is not as simpler as CamCom, as it distributes some of the seats in proportion to the square root of the population, but it adapts a lot better to the actual status quo and it is not complex as the square root of a number is a well-known concept.

Also, if in the future the populations do not change too much, for the 2024-2029 period, no state would lose more than one seat (Table 5, column 4).

Summary

In this paper we propose a new mathematical formula to distribute the seats of the EP, it is called the *FPS method*. The FPS method is easy to apply, objective, transparent, durable and fair (according the current requirements). The distribution obtained with FPS is always degressive proportional (DP).

The adoption of the FPS method allows to allocate the seats of the EP in the future, being able to bypass the no-state-lose-seats constraint. In this manner, the results of the formula without this constraint for the period 2024-2029 would be very similar to the 2019-2024 (if populations stay similar).

The current allotment totalizes 678 seats, then the assignment of several countries is increased to achieve degressive proportionality, and 694 seats have been allocated (basic distribution, BD). Therefore, to obtain the composition of EP (in both scenarios), we can apply the Webster's method to the FPS quota with a minimum of BD and a maximum of 96.

1. Introduction

The limitations to determine the composition of the EP established in the Treaty of Lisbon are well known: no Member State can receive less than 6 seats and no more than 96. A Member State more populated than another cannot have fewer representatives and the distribution has to be DP. The maximum size of EP is 751 seats.

The DP concept was initially adopted in the European Parliament, a proposal by MEPs A. Lamassoure and A. Severin, said that the population/seat ratio had to be decreasing when moving from a more populated country to a less populated one. Therefore, according to 2017 populations, if Germany has 96 seats, France must have 78, Italy 73, Spain 56, etc. The allotment verifying DP with no Member State losing seats is shown in the last column of Table 1. We will call this distribution *basic distribution, BD*.

The proposed Cambridge Compromise (or CamCom) developed in 2011 improved the DP concept by using the population to seats relationship *before rounding*. This modification, of the DP concept, was accepted.

The proposed CamCom formula which distribute EP seats among the 28 states is very simple, transparent and durable. But the EP did not accept it, mainly because 19 Member States would lose representation (some of them would lose 4 seats in 2014 compared to those in the previous period) and, on the other hand, it was very harsh to the countries that occupy the center of the Table sorted by population. A pragmatic solution was instead adopted for the period 2014-2019, in which no Member State gained representation and 15 Member States lost one seat each, with the EP going from having 766 seats to 751, which is the limit established in The Treaty of Lisbon.

In recent years we have worked hard to find a formula that can be satisfactory and consistent with all the limitations set out in the Lisbon Treaty. On 30th January 2017, some of the alternatives found at a workshop included in the third item of the AFCO Committee's agenda were presented.

In July 2017, participants in the workshop were asked to modify the proposals so that the allocation of the seats of the EP would check some additional requirements. Additional requirements were the size of the EP must be 700 or 710 seats and that no Member State could lose representation with respect to its current assignment. This second requirement makes it difficult to obtain a durable mathematical formula.

In spite of this, we have obtained a new formula to distribute the seats of the EP that is intermediate between CamCom and 0.5-DP and the obtained distribution verifies all current requirements (Lisbon's Treaty and no loss of seats).

This formula satisfies the conditions of objectivity, justice, durability and transparency. In addition, by applying the distribution obtained the requirements set out in the Treaty of Lisbon, with the DP modification before rounding (adopted in 2013) and the requirement that no Member State lose representation with respect to the 2014-2019 term, are reached. To obtain the corresponding allotment we applied the Webster's method with minimum and maximum requirements. The maximum requirement is 96 for each country and the minimum requirements are the basic distribution BD, ($BD = \text{current allotment} + DP$).

So the new formula represents a possibility to close this problem, which has now more than a decade of existence.

The contents of the rest of the paper are distributed as follows.

Section 2 shows a table with the composition of the EP in 2014-2019 term and the populations that will be used to determine the composition for 2019-2024. DP breaches of the current share are also indicated and the basic distribution is shown in the last column. Section 3 presents the new formula and its justification. Section 4 shows the composition of EP for two scenarios $H = 700$ and $H = 710$ (numerically and graphically). Finally, section 5 points out several considerations. In particular: how to modify the proposed formula if DP needs to be increased or decreased in the future; how to obtain the representation of a new Member State; and so on.

2. The current allotment

In Table 1 we show, in the first column, the 27 countries belonging to de EU after Brexit, and their respective populations in the second column. Next, in the third column we show the current allotment and in the fourth column the ratio between population and seats for each country. The last column shows the basic distribution, which is an allotment verifying DP and no loss of seats for any country.

We show in red, in fourth column, the cases of non degressivity, that is when a quotient is greater than the previous one.

Specifically, the non degressivity cases are:

- **France** → Germany
- **Spain** → Italy and Germany
- **Netherlands** → Romania
- **Sweden** → Portugal and Czech Republic
- **Austria** → Hungary
- **Denmark** → Bulgaria
- **Ireland** → Slovakia and Finland

On the other hand, Sweden has now more population than Hungary but has less seats. This is due to population changes from 2013 to 2017, because in 2013 Sweden had fewer inhabitants than Hungary.

Table 1. Current population and allotment of 678 seats. Basic distribution BD.

Country	P=Population	S=Current seats	Current DP= P/S	BD
Germany	82.064.489	96	854.838	96
France	66.661.621	74	900.833	78
Italy	61.302.519	73	839.761	73
Spain	46.438.422	54	859.971	56
Poland	37.967.209	51	744.455	51
Romania	19.759.968	32	617.499	32
Netherlands	17.235.349	26	662.898	28
Belgium	11.289.853	21	537.612	21
Greece	10.793.526	21	513.977	21
Czech Rep.	10.445.783	21	497.418	21
Portugal	10.341.330	21	492.444	21
Sweden	9.998.000	20	499.900	21
Hungary	9.830.485	21	468.118	21
Austria	8.711.500	18	483.972	19
Bulgaria	7.153.784	17	420.811	17
Denmark	5.700.917	13	438.970	14
Finland	5.465.408	13	420.416	14
Slovakia	5.407.910	13	415.993	14
Ireland	4.664.156	11	424.014	13
Croatia	4.190.669	11	380.970	12
Lithuania	2.888.558	11	262.596	11
Slovenia	2.064.188	8	258.024	8
Latvia	1.968.957	8	246.120	8
Estonia	1.315.944	6	219.324	6
Cyprus	848.319	6	141.387	6
Luxemb.	576.249	6	96.041	6
Malta	434.403	6	72.400	6
Total	445.519.516	678		694

3. New method: the FPS formula

- First we calculate the adjusted quotas.
- Second, using Webster's method, we round the adjusted quotas to integers with minimum requirements equal to the basic distribution and a maximum 96 seats.

The adjusted quota, q_i corresponding to the Member State i , in the first step, are obtained by the sum of three real positive numbers $q_i = F + P + S$, (**Fix**, **Proportional** and proportional to **S**quare root). Exactly, the adjusted quota for the current data are:

$$q_i = 3 + 0.6 * (H - 3 * 27) * \frac{p_i}{\sum_{i=1}^{27} p_i} + 0.4 * (H - 3 * 27) * \frac{\sqrt{p_i}}{\sum_{i=1}^{27} \sqrt{p_i}} =$$

$$= 3 + 0.6 * (H - 3 * 27) * \frac{p_i}{445519516} + 0.4 * (H - 3 * 27) * \frac{\sqrt{p_i}}{90926.61}$$

Here, H is the Parliament size and p_i is the population of state i . The number 27 is the number of Member States, as currently. 27 must be changed to the correct number of States currently in EU.

That is, the adjusted quota q_i of the Member State i is obtained by three sums:

- A **Fixed** number of seats to each Member State. The fixed number is 3 in our proposal.
- A number of seats in **Proportion** to the population applied to the 60% of $(H-3*27)$ seats. That is: $0.6 * (H - 3 * 27) * \frac{p_i}{\sum_{i=1}^{27} p_i} = \frac{0.6*(H-3*27)}{445519516} * p_i$, in our proposal, because the sum of current population in the EU is 445 519 516.
- A number of seats in proportion to the **Square** root of population applied to the 40% of $(H-3*27)$ seats. That is, $0.4 * (H - 3 * 27) * \frac{\sqrt{p_i}}{\sum_{i=1}^{27} \sqrt{p_i}} = \frac{0.4*(H-3*27)}{90926.61} * \sqrt{p_i}$, because the sum of the square roots of population in the EU is 90 926.61.

Scientific justification of the FPS method.

The distribution of EP seats as a fixed part and a second part in proportion to population has been justified in CamCom.

The distribution of EP seats as a part in proportion to population and other part in proportion to square root of population has been justified (30 January, in Brussels) in 0.5-DP method, taking into account Jagiellonian Compromise.

It is therefore reasonable to consider the combination of these three sums.

The proposed formula is a particular case of the next bi-parametric family of method:

$$q_i = f + (1 - r) * (H - f * n) * \frac{p_i}{\sum_{i=1}^{27} p_i} + r * (H - f * n) * \frac{\sqrt{p_i}}{\sum_{i=1}^{27} \sqrt{p_i}}$$

Here, n is the number of Member States. So, numbers H and n are given in advance. However, the size H can be changed.

The other two parameters, f , which is the number of fixed seats for each Member State, and r the proportion of non-fixed seats that are distributed in proportion to the square root of the population, are those that can be varied to increase or decrease the DP.

Therefore, the two parameters are: $r \in [0,1]$ and $f \in [0, n/H]$.

After testing many values for f and r , in the two scenarios $H = 700$ and $H = 710$, we have observed that for the values $f = 3$ and $r = 0.4$ the quota adjustment is very reasonable in respect to all of limitations (Lisbon Treaty and for ensuring that no Member State loses representation).

On the other hand, if:

- $f = 5$ and $r = 0$ we have the CamCom method.
- $f = 0$ and $r = 0.5$ we have the 0.5-DP method.

So, the proposed method, with $f = 3$ and $r = 0.4$ can be considered as an **intermediate formula between CamCom and 0.5-DP**.

In the future, after 2024, when Member States can lose representation, we must apply Webster's method (or other method for rounding) with the only requirements: minimum 6 seats and maximum 96 seats. In that case, **the proposed formula is very simple, transparent, durable and fair** (according to the current political requirements).

4. The composition of EP for two scenarios

Next we show the distribution of seats obtained with the FPS-method when $H = 700$ and $H = 710$ using the population of Eurostat 2017 and standard rounding (Webster's method).

Second column: the adjusted quota using FPS method without limitations. Third column: adjusted quotas according to the current limitations. Fourth column: the rounding with Webster's method. Last column: degressivity before rounding, that is, the ratio population/quota according to current limitations = P/Q .

SCENARIO 700 SEATS

The quotas are:

$$q_i = 3 + 0.6 * (700 - 3 * 27) * \frac{p_i}{445519516} + 0.4 * (700 - 3 * 27) * \frac{\sqrt{p_i}}{90926.61} =$$

$$= 3 + 8.33634 \times 10^{-7} p_i + 0.00272308 \sqrt{p_i}$$

Table 2. Scenario 700. Quota according to limitations, Seats distribution and DP.

Country	Adjusted Quota	Q=Quota according Current Limitations	Seats Webster	Degressivity Before Round=P/Q
Germany	96.0799	96.0000	96	854.838
France	80.8043	78.8216	79	845.728
Italy	75.4244	73.5736	74	833.214
Spain	60.2692	58.7903	59	789.899
Poland	51.4297	51.0000	51	744.455
Romania	31.5772	32.0000	32	617.499
Netherlands	28.6729	28.0000	28	615.548
Belgium	21.5612	21.0322	21	536.789
Greece	20.9441	21.0000	21	513.977
Czech Rep.	20.5089	21.0000	21	497.418
Portugal	20.3777	21.0000	21	492.444
Sweden	19.9449	21.0000	21	476.095
Hungary	19.7328	21.0000	21	468.118
Austria	18.2994	19.0000	19	458.500
Bulgaria	16.2469	17.0000	17	420.811
Denmark	14.2543	14.0000	14	407.208
Finland	13.9222	14.0000	14	390.386
Slovakia	13.8407	14.0000	14	386.279
Ireland	12.7691	13.0000	13	358.781
Croatia	12.0679	12.0000	12	349.222
Lithuania	10.0361	11.0000	11	262.596
Slovenia	8.6331	8.4213	8	245.115
Latvia	8.4624	8.2547	8	238.526
Estonia	7.2208	7.0436	7	186.828
Cyprus	6.2153	6.0627	6	139.924
Luxemb.	5.5475	6.0000	6	96.042
Malta	5.1569	6.0000	6	72.401
Total	700.0000	700.0000	700	

To obtain the allotment using the Webster's method we call \mathbf{q} the vector of adjusted quotas with FPS method (approximately the first column of Table 2), being $\mathbf{q} = (96.0799, 80.8043, 75.4244, \dots, 6.21525, 5.5475, 5.15689)$, and \mathbf{m} is the vector with the minimum seats for each Member State, BD being the last column in Table 1, that is, $\mathbf{m} = (96, 78, 73, 56, 51, \dots, 6, 6)$, then, to obtain the quota according to the current limitations, it necessary to find k such that:

$$\sum_{i=1}^{27} \text{median}(96, m_i, k * q_i) = 700$$

The median of three numbers, $x \leq y \leq z$, is y . In our case the value 0.9755 is an approximation of the exact value of k .

To obtain the Webster's allotment we must solve:

$$\sum_{i=1}^{27} \text{median}(96, m_i, [k * q_i]_W) = 700$$

The $[r]_W$ means the whole numbers nearer to r . There is an interval of values of k verifying the previous equation, for example, all $k \in [0.975, 0.983]$ are valid, and the corresponding allotment is shown in the fourth column. This is our proposal composition of the EP for the 2019-2024 term.

Finally, fifth column show the degressivity before rounding, that is the ratio between population and quota.

Remarks

- The rounding of the quotas according current limitations to the nearest whole number (fourth column) gives to each Member State at least the same number of representatives that the current allotment does. Also, the obtained distribution is DP as we can see in the last column. So, all requirements are verified for the next term.
- The adjusted quota for Germany is $q_1 = 96.079$ and for Malta is $q_{27} = 5.1569$. And the standard rounding, to the nearest whole number, gives to Malta only ONE seat less that the minimum of 6, and it gives to Germany 96 seats. Just another four Member States would obtain one less seat than the current allotment (Portugal, Hungary, Bulgaria and Lithuania).
- Thus, all limitations could be suppressed and no state would lose more than one seat!

SCENARIO 710 SEATS

In this case, the quotas are obtained as follow:

$$\begin{aligned} q_i &= 3 + 0.6 * (710 - 3 * 27) * \frac{p_i}{445519516} + 0.4 * (710 - 3 * 27) * \frac{\sqrt{p_i}}{90926.61} = \\ &= 3 + 8.47101 \times 10^{-7} p_i + 0.00276707 \sqrt{p_i} \end{aligned}$$

Table 3. Scenario 710. Quota according to limitations, Seats distribution and DP.

Country	Adjusted Quota	Q=Quota according Current Limitations	Seats Webster	Degressivity Before Round=P/Q
Germany	97.5836	96.0000	96	854.838
France	82.0613	81.3001	81	819.945
Italy	76.5944	75.8839	76	807.846
Spain	61.1944	60.6268	61	765.972
Poland	52.2120	51.7277	52	733.982
Romania	32.0389	32.0000	32	617.499
Netherlands	29.0877	28.8179	29	598.078
Belgium	21.8611	21.6583	22	521.271
Greece	21.2340	21.0370	21	513.073
Czech Rep.	20.7918	21.0000	21	497.418
Portugal	20.6585	21.0000	21	492.444
Sweden	20.2187	21.0000	21	476.095
Hungary	20.0032	21.0000	21	468.118
Austria	18.5466	19.0000	19	458.500
Bulgaria	16.4609	17.0000	17	420.811
Denmark	14.4361	14.3022	14	398.604
Finland	14.0987	14.0000	14	390.386
Slovakia	14.0158	14.0000	14	386.279
Ireland	12.9270	13.0000	13	358.781
Croatia	12.2144	12.1011	12	346.305
Lithuania	10.1497	11.0000	11	262.596
Slovenia	8.7241	8.6432	9	238.822
Latvia	8.5506	8.4713	8	232.427
Estonia	7.2890	7.2214	7	182.228
Cyprus	6.2672	6.2091	6	136.625
Luxemb.	5.5887	6.0000	6	96.042
Malta	5.1917	6.0000	6	72.401
Total	710.00	710.0000	710	

The quota according to the current limitations is obtained solving the equation:

$$\sum_{i=1}^{27} \text{median}(96, m_i, k * q_i) = 710$$

Then $k = 0.99072$.

To obtain the allotment we solve:

$$\sum_{i=1}^{27} \text{median}(96, m_i, [k * q_i]_w) = 710$$

Then all $k \in [0.989, 0.993]$ are valid. The obtained distribution is shown in the fourth column in Table 3 and the degressivity is shown in the last column.

Graphically

Fig. 1. Distribution curves of FPS-method. Red color for curve corresponding to $H = 700$, and blue color for $H = 710$. Black points show current allotment.

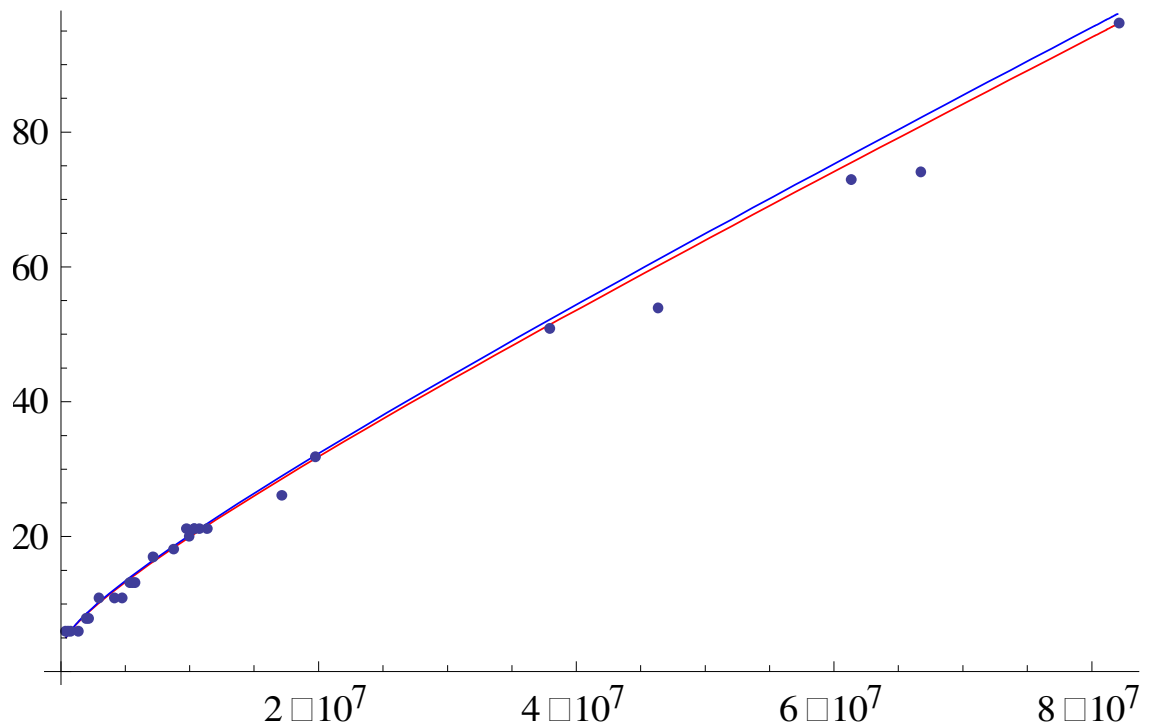


Fig. 2. Distribution curve of FPS (yellow line) and proposed EP composition, with 700 seats, 2019-2024 term (blue dots) are:

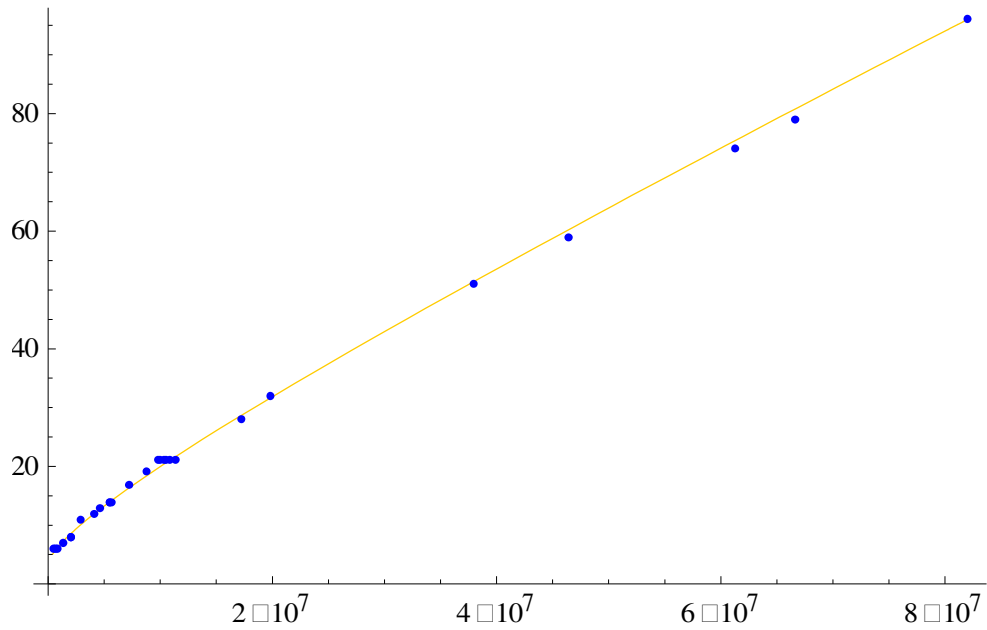
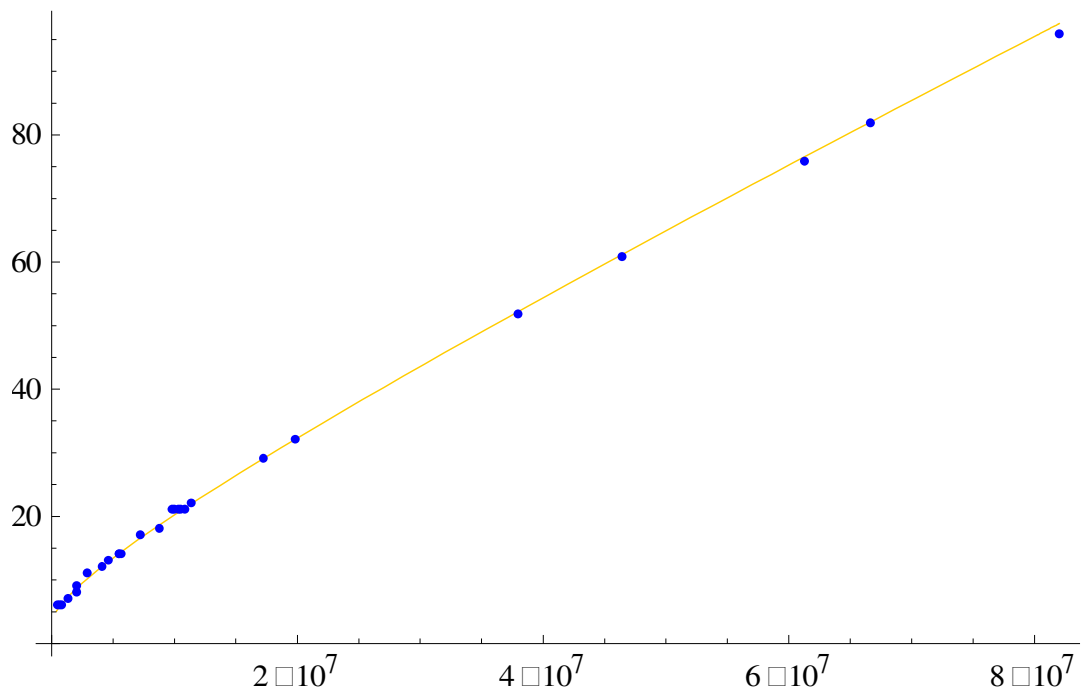


Fig. 3. Distribution curve FPS (yellow line) and proposed EP composition with $H = 710$ seats for the 2019-2024 term (blue dots) are:



The last point corresponds to Germany and is below the curve because the maximum limit is 96 and the adjusted quota for Germany is 97.5836.

5. Final considerations

5.1 Simulation for 2024-2029 term, being $H = 700$

Table 4. FPS Method with Lisbon Requirements and EP size 700 seats

Country	Quota FPS-700	Quota Lisbon	Seats Webster	Degressivity
Germany	96.0799	95.8993	96	855.736
France	80.8043	80.6525	81	826.529
Italy	75.4244	75.2826	75	814.299
Spain	60.2692	60.1559	60	771.968
Poland	51.4297	51.3330	51	739.626
Romania	31.5772	31.5179	32	626.944
Netherlands	28.6729	28.6190	29	602.234
Belgium	21.5612	21.5207	22	524.604
Greece	20.9441	20.9047	21	516.321
Czech Rep.	20.5089	20.4704	20	510.287
Portugal	20.3777	20.3394	20	508.438
Sweden	19.9449	19.9074	20	502.225
Hungary	19.7328	19.6958	20	499.116
Austria	18.2994	18.2650	18	476.950
Bulgaria	16.2469	16.2164	16	441.145
Denmark	14.2543	14.2275	14	400.697
Finland	13.9222	13.8960	14	393.308
Slovakia	13.8407	13.8149	14	391.455
Ireland	12.7691	12.7451	13	365.957
Croatia	12.0679	12.0452	12	347.912
Lithuania	10.0361	10.0172	10	288.360
Slovenia	8.6331	8.6169	9	239.551
Latvia	8.4624	8.4465	8	233.109
Estonia	7.2208	7.2072	7	182.587
Cyprus	6.2153	6.2036	6	136.746
Luxemb.	5.5475	6.0000	6	96.042
Malta	5.1569	6.0000	6	72.401
Total	700.0000	700.0000	700	

In Table 4 we suppose no changes in population for the composition of 2024-2029 term and the requirement of *no state lose seats* is removed. Only Lisbon requirements would stay.

Remark. No state losing more than one seats. In comparisons with 2014-2019 term, only four Member States lose one seat: Czech Republic, Portugal, Hungary and Lithuania (red number in Table 4). This is a behavior very different with respect to CamCom.

5.2 Enlargements of the EU in the 2019-2024 term

If the scenario has been set to $H=700$, the adjusted quota for a new Member State having p inhabitants is

$$q = 3 + 8.33634 \times 10^{-7}p + 0.00272308 \sqrt{p}$$

The obtained value of q must be multiplied by 0.975 and rounded to the nearest whole number. The assignment for the new Member State is the maximum between the corresponding to the Member State of EU-27 having just less population and the whole number obtained. Table 5 shows some examples.

Table 5. Possible enlargements of the EU-27 from scenario $H = 700$

Country	population	Adjusted quota, Aq	$0.975Aq$	Seats
Serbia	7.103.000	16.1787	15.7742	Max[16, 17] = 17
Bosnia Herz.	3.750.000	11.3993	11.1144	Max[11, 11] = 11
Albania	2.887.000	10.0335	9.7827	Max[10, 8] = 10
Macedonia	2.071.000	8.6452	8.4291	Max[8, 8] = 8
Montenegro	620.000	5.6610	5.5195	Max[6, 6] = 6

The rounding of 15.7742 is 16 for Serbia, but the population of Serbia is greater than Bulgaria and the assignment of Serbia is 17.

5.3 Changing formula in future

In order to increase DP we can increase f or r or both (in the bi-parametric formula). Increasing f is more favorable for less populated states. Increasing r it is more favorable for low and intermediate populated states.

Therefore, in the future the MEPs can easily adapt the formula for distributing the EP seats, if they would like to. They also know how they can increase or decrease degressivity to adapt the allotment.

5.4 Compositions for other sizes of the EP

The next table (Table 6) shows the compositions of EP according to FPS method for scenarios 701 to 709, for the 27 current Member States.

Table 6. FPS Composition of EP for scenarios $H = 701$ to $H = 709$

Country	H=701	H=702	H=703	H=704	H=705	H=706	H=707	H=708	H=709
Germany	96	96	96	96	96	96	96	96	96
France	80	80	80	80	80	81	81	81	81
Italy	74	74	74	75	75	75	75	76	76
Spain	59	59	60	60	60	60	60	60	60
Poland	51	51	51	51	51	51	51	51	52
Romania	32	32	32	32	32	32	32	32	32
Netherlands	28	28	28	28	29	29	29	29	29
Belgium	21	21	21	21	21	21	22	22	22
Greece	21	21	21	21	21	21	21	21	21
Czech Rep.	21	21	21	21	21	21	21	21	21
Portugal	21	21	21	21	21	21	21	21	21
Sweden	21	21	21	21	21	21	21	21	21
Hungary	21	21	21	21	21	21	21	21	21
Austria	19	19	19	19	19	19	19	19	19
Bulgaria	17	17	17	17	17	17	17	17	17
Denmark	14	14	14	14	14	14	14	14	14
Finland	14	14	14	14	14	14	14	14	14
Slovakia	14	14	14	14	14	14	14	14	14
Ireland	13	13	13	13	13	13	13	13	13
Croatia	12	12	12	12	12	12	12	12	12
Lithuania	11	11	11	11	11	11	11	11	11
Slovenia	8	9	9	9	9	9	9	9	9
Latvia	8	8	8	8	8	8	8	8	8
Estonia	7	7	7	7	7	7	7	7	7
Cyprus	6	6	6	6	6	6	6	6	6
Luxemb.	6	6	6	6	6	6	6	6	6
Malta	6	6	6	6	6	6	6	6	6
Total	701	702	703	704	705	706	707	708	709

When changing from a column to the next column the new seat allocated is show in blue (France, Slovenia, Spain, Italy, Netherlands, ...).

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