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Application of Hamilton's and divisor methods to degressively proportional allocation functions

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Abstract

The most recognizable historically approved methods of proportional division of mandates in collegiate bodies refer to an ideal assumption where each vote is associated with identical number of representatives. Proportional methods of distribution such as Hamilton's and divisor methods of Jefferson, Adams or Webster cannot be directly applied to the allocation of seats between the Member States in the European Parliament because of the wide variation in their population. A desire to ensure appropriate representation have triggered legal acceptance of degressive proportionality rule contained in the Lisbon Treaty. The new principle, however, does not allow determining an unambiguous solution. The article presents the allocations which can be obtained reaching the classical methods of proportional division, taking into account degressively proportional allocation functions.

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1. Introduction

The principle of proportional representation as a general rule od allocation of seats in the electoral law is tied with the necessity to determine a method of converting real proportions to the integers. The number of developed solutions, however, shows that there is no ideal one. Each of the proposed methods of rounding the exact proportions has certain drawbacks, known in literature as a proneness to certain paradoxes. The situation is even more complex

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in the case of apportionment of mandates in the European Parliament. Lack of a clear indication defining the allocation degressiveness additionally complicates seeking the proper solution – there are many possible to be used.

The aim of the article is to show the applicability of the methods used for the proportional division to degressively proportional allocations. Basing on the known families of allocation functions the real apportionments are calculated and then, using classical methods, apportionments with integer values are determined. This approach allows to obtain weakly degressively proportional allocations in the sense of the Cambridge Compromise. Moreover, a method enabling to specify the measure of the equitable spread of degressive proportionality weight over all countries is indicated and on its basis an accordingly optimal allocation is selected.

2. Proportional methods of apportionment

The apportionment problem concerns determining a division of a given integer number of seats $H \geq 0$ proportionally among a set of *n* states according to their populations p_i, $i = 1,2,...,n$. The problem arises when the values of number of citizens of the state i divided by the total population $P = p_1 + p_2 + ... + p_n$ are not integer. One need to find then a vector $a = (a_1, a_2, ..., a_n)$ of nonnegative integers such that $\sum_{i=1}^{n} a_i = H$ (Balinski & Young, 1980).

The most well-known classical methods giving a solution of determining sought vector **a** are methods of Hamilton, Jefferson, Adams, Webster, Dean and Hill. First of them, also known as the method of largest reminder, was proposed by the U.S. Secretary of the Treasury Alexander Hamilton in 1792. The procedure of finding the apportionment is as follows. For a given vector of populations of the states $p = (p_1, p_2, ..., p_n)$ compute a vector of quotas $q = (q_1, q_2, ..., q_n)$, where $q_i = p_i H / P$. Next, order the fractional reminders $d_i = q_i - [q_i]$, where $[t]$ denotes rounding downwards, in descending sequence $d_{i_1} \geq d_{i_2} \geq ... \geq d_{i_n}$. Assign each state i $[q_i]$ seats and the remaining $m = H - \sum_{i=1}^{n} [q_i]$ ones to states $d_{i_1}, d_{i_2}, ..., d_{i_m}$ (Balinski & Young, 1977).

Jefferson's method, proposed by Thomas Jefferson, Secretary of State, was an alternative for Hamilton's solution, who was his main opponent in the U.S. government. According to this procedure one should find a divisor *d* such that $\sum_{i=1}^{n} [p_i / d] = H$. For any vector *p* and total number of seats *H* there always exists such a divisor. Furthermore, there usually is an interval of divisors returning the same allocation (Young, 1994).

Adams' and Webster's methods are simple modifications of Jefferson's method. Author of the first one proposed that values p_i / d should be rounded upwards – one, therefore, needs to find a divisor *d* such that $\sum_{i=1}^{n} [p_i / d] = H$ (where $[t]$ denotes the smallest integer equal ore more than *t*). In Webster's solution fractions are rounded to the nearest integer, that is $[p_i / d + 1/2]$. As in method of Jefferson there always exists a divisor giving sought allocation (Young, 1994).

The other two divisor methods of Dean and Hill differ only in the way of rounding as well. Hill's procedure orders to assign state $i [p_i / d]$ seats if the value p_i / d is less than the geometric mean of the two nearest integers and $[p_i / d]$ otherwise. In Deans' solution rounding is based on comparison to the harmonic mean (Young, 1994).

3. Degressively proportional allocation of seats

Some cases, however, preclude the proportional representation of citizens. Such situation occurs in the European Parliament due to large diversity of populations of the Member States.

Therefore seats in the European Parliament are allocated in accordance with the "Degressive Proportionality Principle". It was introduced in art. 1 point 15 of the Lisbon Treaty: "*The European Parliament shall be composed of representatives of the Union's citizens. They shall not exceed seven hundred and fifty in number, plus the President. Representation of citizens shall be degressively proportional, with a minimum threshold of six members per Member State. No Member State shall be allocated more than ninety-six seats.*" (Lisbon Treaty, 2007) and firstly interpreted

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