Does Voter Distribution Matter in the Directional Model? A Refutation of the Original Claims

Abstract: *In this paper I demonstrate that the distribution of voters influences the theoretical predictions formulated through the instrumentality of the directional model of spatial analysis, thereby refuting the claims made by Macdonald, Listhaug and Rabinowitz (1991) who argue that the distribution of voters is only relevant for proximity-based models. Further, I show that the boundary of the region of responsibility is not always the ideologically dominant position, as Rabinowitz and Macdonald (1989) originally assert, this situation appearing only as a special case, determined by the fact that the area encompassed between the graph of the voter distribution function and the X -axis is numerically higher between the boundary of the region of responsibility and the point of origin then between the most extreme point of the ideological dimension and the boundary of the region of responsibility. Finally, I improve the full proportionality theorem by specifying the necessary conditions for each position described in the theorem to become ideologically optimal.*

Keywords: *directional model, distribution of voters, dominant position, full proportionality theorem, ideological dynamics, region of responsibility.*

Introduction

The purpose of this paper is to demonstrate that the distribution of voters[1] matters in any attempt to determine the optimal placement of political parties in the directional model of Rabinowitz and Macdonald[2]. Although in the original description of the model Rabinowitz and Macdonald assert that "any candidate whose intensity exceeds the radius of the region of acceptability will perform worse in any two-person election than a candidate who adopts the same directional stand and is located at the boundary of the region of acceptability"[3] and Macdonald, Listhaug and Rabinowitz further assert that the directional model can provide theoretical predictions without "assumptions [...] that constrain the strategies of parties or the distribution of voters"[4] in the present paper I intend to present the conditions under which these assertions are erroneous and the distribution of voters proves to be decisive in determining the ideological dynamics of political parties. To achieve this objective I will start from a simple example in which I show that these assertions are in fact contradicted by the results of the electoral competition after which I provide a generalized demonstration in support of this position.

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II. The Spatial Analysis of Electoral Competition

The Spatial Analysis of Electoral Competition is a theoretical framework which uses methodological tools specific to Public Choice Theory[5] and mathematical models in order to analyze the ideological dynamics of political candidates and parties, the structure of the party system and electoral competition in all the aspects involved. Two of the most important methodological principles used in this framework are: a) methodological individualism, a "principle, rule or program telling historians and social scientists how to define collective concepts, explain social phenomena and/or reduce macro to micro"[6] which postulates that "only individuals have aims and interests"[7] and b) instrumental rationality, a "conception of rationality"[8] which identifies utility maximization as the underlying basis of individual action.

Spatial Analysis traces its roots back to the works of Black[9] and Downs[10], the latter being responsible for the development of the first spatial model which analyzed electoral competition, starting from the economic models elaborated by Hotelling[11], Lerner and Singer[12] and Smithies[13] with the purpose of determining the optimal placement of economic agents in a competition involving duopoly. In his model Downs introduces a series of assumptions in order to infer universal and general statements regarding electoral behavior, at the cost of severely simplifying the real electoral process: a) voters and candidates are rational actors, with the term rational action meaning "that type of action which is efficiently planned to achieve the political and economic objectives consciously selected by actors"[14], b) the preferences of voters can be ordered from left to right in a similar manner for all voters[15], c) the preferences of each voter is unimodal and slides monotonously both to the left and to the right of V(x,y)[16], d) parties do not have perfect mobility as they are unable to "ideologically jump" over other competitors[17], e) parties compete on a single ideological dimension, i.e. economic interventionism[18], f) the ideological dimension is representable through a linear scale which goes from 0 to 100 starting from the left extremity[19], g) parties exhibit a vote-maximizing behavior[20], h) voters participate in the elections only if it is rational from a utility standpoint, meaning that the benefits of their actions outweigh the costs[21], i) the party positions are well defined, in the sense that each party can be identified through the set of policies which it advocates[22], j) the electoral system is plurality (first-past-the-post), the elections are held in a single circumscription and only one candidate is elected[23].

According to Downs the ideological dynamics of parties[24] is inseparably linked to the distribution of voters: if the distribution is unimodal parties ideologically move toward the median voter, i.e. the voter which splits the distribution in two equal halves, if the distribution is bimodal and the modes approach the extremities of the dimension the ideological competition is centrifugal and if the distribution is multimodal parties move toward each of the modes of the distribution. Although Downs' model had a significant value mainly because of the originality of applying this kind of analytical tools to political theory, it has been subjected to substantial critiques which either refer to the oversimplification of reality or to the omission of certain variables (e.g. Stokes' critique on the unidimensionality of the model[25], Wittman's critique regarding the different potential party goals[26], Hinich and Ordeshook's critique regarding the failure to distinguish between vote-maximizing objectives and plurality-maximizing objectives[27], Palfrey's critique regarding the failure to take into account new entry potential[28], Osborne's critique regarding the cognitive limitation of

voters[29], etc.). In light of the considerable number of deficiencies present in the Downsian model, the field has experienced a series of alternative models which, similarly to Downs' position, start from the premises that the distance between the ideal position of the and the position of the candidate determine the utility function of voters[30], e.g. Davis, Hinich and Ordeshook[31] who consolidate and expand the results of the Downsian predictions for two-party systems, Hinich and Pollard[32], Enelow and Hinich[33], Greenberg and Weber[34], Poole and Rosenthal[35], Grofman[36], Erikson and Romero[37], etc.

III. The Directional Model

The directional model was proposed by Rabinowitz and Macdonald as a critique to classical spatial analysis, considered by the authors "seriously flawed"[38]. The main premises on which Rabinowitz and Macdonald build their enterprise is that the utility function of voters is not designed based on an estimation of the euclidean space distance, instead being the result of two factors: 1. direction, meaning that voters attach a positive utility only to candidates who are perceived to be placed on the same side of the ideological dimension and 2. intensity, meaning that voters like candidates which propose policies more intensely. Assuming that candidate intensity is relevant immediately derives from the way in which Rabinowitz and Macdonald conceptualize political space, as a "symbolic field"[39] and from the assumption that voters perceive policies in a diffuse manner[40]. Rabinowitz and Macdonald therefore argue that voting is influenced by the affects of individuals and in this sense an increased level of intensity in policy proposals ensures candidates a better electoral positioning. But the model is still incomplete. Because in this form the theoretical predictions generated by the model would favor radical extremism (as all parties would have incentives to propose aggressive policies) its authors incorporate a construct which they term "region of responsibility"[41], asserting that any candidate who crosses the region of responsibility is penalized by the electorate for adopting an "unreasonable" position[42]. Although the authors do no specify a penalty function in the original model Macdonald, Listhaug and Rabinowitz define an example of such a function as: $P = r(|p|-r)$, where P = penalty function, r = radius of the region of responsibility and p = position of the candidate, claiming however that it does not have a universal nature[43].

Knowing its assumptions as well as the structure of the penalty function we can describe the directional model from a mathematical standpoint in the following manner:

$$U(V,C) = V \cdot C - P = \sum_{i=1}^{n} v_i \cdot c_i - r(|c_i| - r)$$

where $U(V,C)$ = the utility of voter V when electing C, V = the total length of the vector of the voters position in an ideological space with n dimensions, C = the total length of the vector of the candidate position in an ideological space with n dimensions, P = penalty function, V_i = the position of a voter on an i-dimension, C_i = the position of a candidate on an i-dimension, r = radius of the region of responsibility.

The directional model was in its turn subjected to a series of criticisms, out of which Westholm's position is particular strong: the region of responsibility is a property of the entire electorate although individual preference and perception functions cannot be universalized[44], the lack of a universally specified penalty function[45], the degree of falsifiability of the theory is severely reduced by comparison with previous models[46], the empirical analysis of the model is based on interpersonal[47] comparisons rather than intrapersonal[48] comparisons[49].

In the contemporary literature the majority of papers which deal with the directional model are engaged in the proximity-directional debate, taking the form of comparative studies between sets of data analyzed through both theoretical perspectives, such as Platt, Poole and Rosenthal on the American Congress[50], Gilljam on Sweden[51], Pierce on France[52], Kramer and Rattinger on Germany[53], Blais et al on Canada[54], Karp and Banducci on New Zeeland[55], Cho and Endersby on the UK[56], Claasen in an experimental framework[57], Tiemann in the elections for the European Parliament[58], etc.

IV. Does voter distribution matter in the directional model?

According to Listhaug, Rabinowitz and Macdonald one of the main strong points of the directional model is that it can generate predictions regarding the ideological dynamics of parties without appealing to the distribution of voters. This can be deduced from the phrase "the theorem (n.a. regarding the optimal placement of parties in proportional systems) makes no assumptions about the nature of the penalty imposed on parties beyond the region of acceptability nor about the shape of the voter distribution"[59] and from the per a contrario interpretation of the statement that "proximity-based theory makes no definitive predictions about the location of parties unless assumptions are made that constrain the strategy of parties or the distribution of voters"[60]. Further, in their original construction Rabinowitz and Macdonald explicitly claim that no party which is placed on the boundary of the region of responsibility can be defeated by a party which is placed outside this region[61], the resulting conclusion being that this position is always the position toward parties converge. On the other hand, in the case study on Norway Macdonald, Listhaug and Rabinowitz assert that "in a fully proportional representation system[62] all parties should be located at or beyond the region of acceptability"[63]. Even so, the authors do not argue that in this case the ideological dynamic is influenced by voter distribution, the actual conditions in which a party should be placed outside the region of responsibility remaining unspecified. In the following pages I intend to demonstrate first of all that the optimal placement of parties can be successfully localized only if the distribution of voters is known, thereby refuting the claim that voter distribution is irrelevant and secondly to break the full proportionality theorem in the two hypothetical cases suggested by the authors, formulating the conditions in which parties should be located on the boundary of the region of responsibility and the conditions in which parties should be located outside the region, depending on the distribution of voters.

In order to easily understand the role played by the positioning of voters let us consider the following example in which for simplicity we have a single ideological dimension, two candidates which are competing: A and B and three voters: x, y and z. We consider that the ideological dimension is representable on a segment encompassed between {-5} and {5}, with 0 as a neutral point. A is placed on {-5}, B is placed on {-4}, x is placed on {-5} and y is placed on {-1}. With the above elements fixed, we will consider two different cases. In the first one z is placed on {-3} and in the second it is placed on {-5}. Also, for operational reasons we consider that the region of responsibility has a radius of 4, in a similar fashion to Macdonald, Listhaug and Rabinowitz's example[64]. In the case of voter x we have: $U(x,A)=x\cdot A-r(|A|-r)=-5\cdot(-5)-4(|-5|-4)=21$ (1) and $U(x,B)=x\cdot B=-5\cdot(-4)=20$ (2). From (1), (2) $\Rightarrow (x,A)>(x,B)$. In the case of voter y we have : $U(y,A)=y\cdot A-r(|A|-r)=-1\cdot(-5)-4(|-5|-4)=1$ (3) and $U(y,B)=y\cdot B=-1\cdot(-4)=4$ (4). From (3), (4)$\Rightarrow (y,B)>(y,A)$. In case 1 of voter z we

have: $U(z,A)=z\cdot A-r(|A|-r)=-3\cdot(-5)-4(|-5|-4)=11$ (5) and $U(y,B)=y\cdot B=-3\cdot(-4)=12$ (6).

From (5), (6) $\Rightarrow$ $(z,B)>(z,A)$. In case 2 of voter z we have: $U(z,A)=z\cdot A-r(|A|-r)=-5\cdot(-5)-4(|-5|-4)=$ (5¢) and $U(y,B)=y\cdot B=-5\cdot(-4)=20$ (6¢). From (5¢), (6¢) $\Rightarrow$ $(z,A)>(z,B)$.

According to the utility calculus of voters previously presented it is easy to observe that in both cases x prefers candidate A and y prefers candidate B. However, z's preferences are different between the two cases, depending on its positioning relative to the boundary of the region of responsibility. If he is placed within the region of responsibility z attaches to party A a utility of 11 units and B a utility of 12 units, thereby preferring B. However, if z exits the region of responsibility, situation reflected by the positioning on {-5}, z attaches a utility of 21 to A (even if he applies the penalty for extremism) and a utility of 20 to B, preferring A to B. The result is clearly influenced by the distribution of voters in this case, the positioning of z within the region of responsibility or outside of the region determining the aggregation of preferences for A or B respectively.

The result can be generalized by calculating the utility determined by the election of candidates for each voter on a direction of the ideological dimension. We consider, similarly to the previous example a single ideological dimension[65], representable on a segment encompassed between {-5} and {5} with 0 as a neutral point. Let f be the function of voter distribution $f:[-5,0)\to ¡$, with the classical description $f(x)=ax^2+bx+c$. Without a loss of generality let us consider that the radius of the region of responsibility has the same value as in the previous example, i.e. $r=\{-4\}$ and the two parties are placed on the extremity of the ideological dimension and the boundary of the region of responsibility: $A=\{-5\}$, $B=\{-4\}$[66]. Also, because unlike the previous example we do not have only 3 positions which correspond to the voters but n positions which correspond to n voters, we have: $g:[-5,0)\to ¡$, $g_A(x)=x\cdot A-r(|A|-r)=-5x-4$, $g_B(x)=x\cdot B=-4x$. For all voters which are placed between the ideological extremity and the boundary of the region of responsibility we have $g:[-5,-4)\to ¡$, $g_A(-5)=-5\cdot(-5)-4=21$,

$g_B(-5)=-4\cdot(-5)=20$, $g_A(-4)=-5\cdot(-4)-4=16$ si $g_B(-4)=-4\cdot(-4)=16\Rightarrow$

$\Rightarrow g_A(-5)>g_B(-5)$ and $g_A(-4)=g_B(-4)$ (1). But $g_A(x_{n+1})-g_A(x_n)=-5x_{n+1}-4+5x_n+4=$

$=-5(x_{n+1}-x_n)<0$ and $g_B(x_{n+1})-g_B(x_n)=-4x_{n+1}+4x_n=-4(x_{n+1}-x_n)<0\Rightarrow(\forall)x_{n+1}>x_n:$

$:g_A(x)]$ and $g_B(x)]$ (2). From (1), (2) $\Rightarrow g_A(x)>g_B(x)$ for $(\forall)\ x\in[-5,-4)$.

For all voters which are placed between the boundary of the region of responsibility and the neutral point the case is: $g:(-4,0)\to ¡$, $g_A(-5)=-5\cdot(-4)-4=16$,

$g_B(-5)=-4\cdot(-4)=16$, $g_A(-4)=-5\cdot(0)-4=-4$ si $g_B(-4)=-4\cdot(0)=0\Rightarrow$

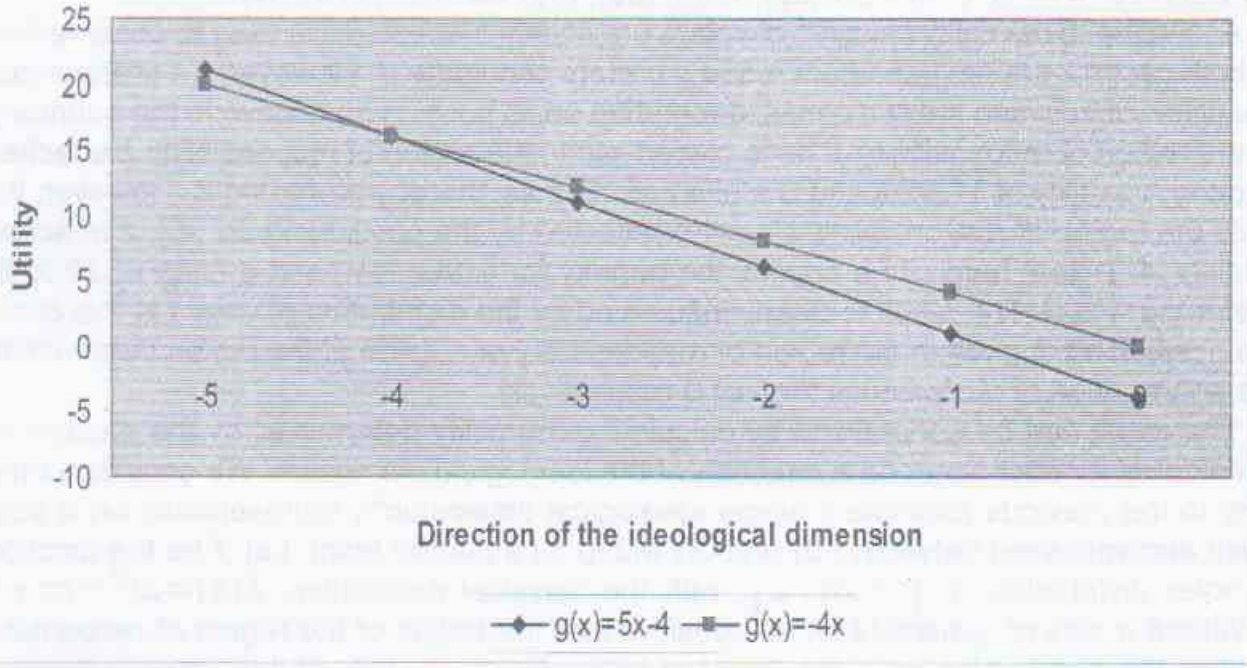
$\Rightarrow g_A(-4)>g_B(-4)$ si $g_A(0)=g_B(0)$ (3). But, similarly to the first case, $g_A(x_{n+1})-g_A(x_n)=$

$-5x_{n+1}-4+5x_n+4=-5(x_{n+1}-x_n)<0$ and $g_B(x_{n+1})-g_B(x_n)=-4x_{n+1}+4x_n=$

$=-4(x_{n-1}-x_n)<0\Rightarrow(\forall)x_{n+1}>x_n:g_A(x)]$ and $g_B(x)]$ (4). From (3), (4) $\Rightarrow$ $g_A(x)<g_B(x)$ for $(\forall)\ x\in[-4,0)$.

The mathematical apparatus is implemented in Figure 1. Here you can easily observe that the voters placed between [-5, -4) obtain a higher utility value when they choose a more extreme candidate and the voters placed between (-4, 0) obtain a higher utility value from the election of a candidate who lies within the region of responsibility as he is not penalized for radicalism. In the case when a voter is placed exactly on the border of the region of responsibility, under the assumptions of this form of the directional model the voter has a relation of indifference between alternatives.

Figure 1. Utility of the voters placed on the same direction of the ideological dimension as the candidates

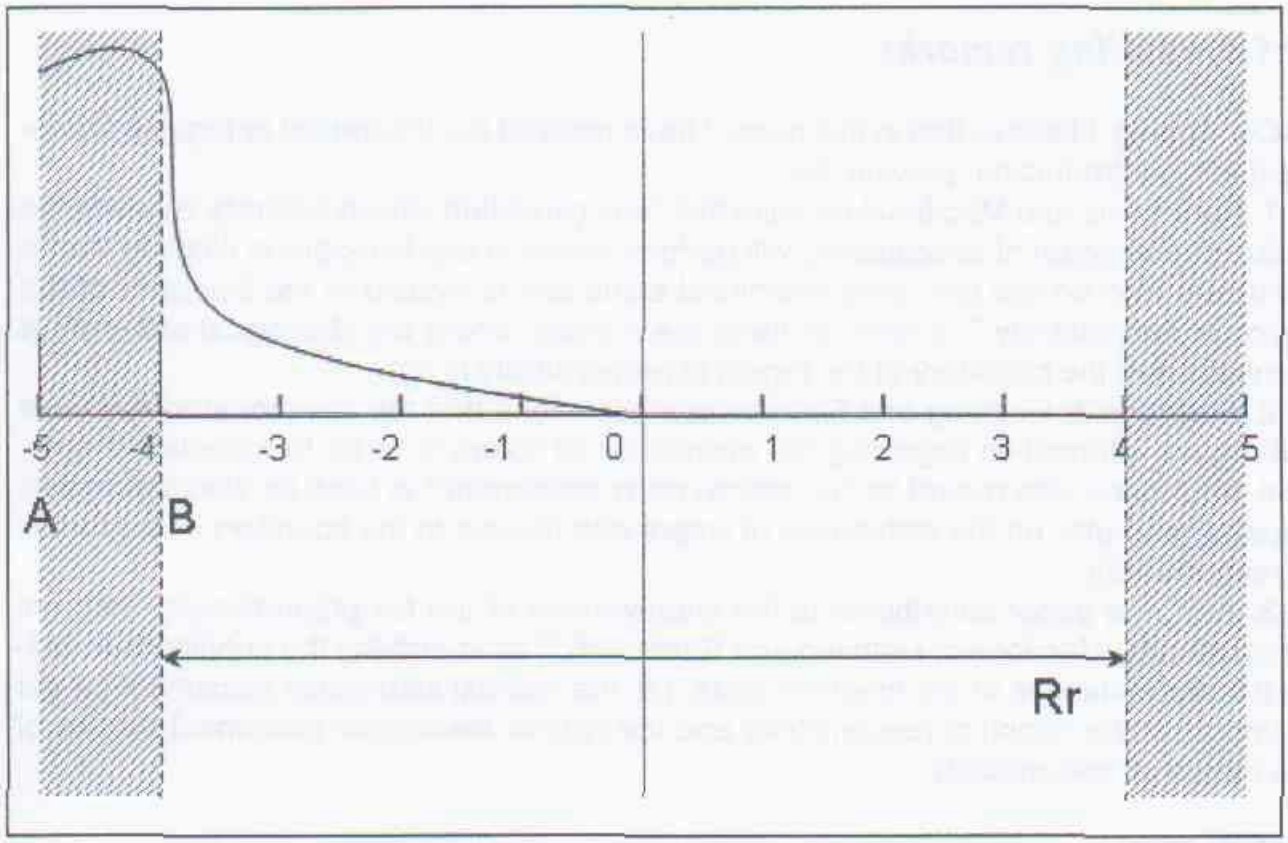


Source: Author

Thus, as I prove in the previous paragraphs by appealing to the linearity and monotony of the utility function as well as the values taken by the function in the minimum and maximum points of the interval each voter placed within the region of responsibility will vote for the party which is placed on the border of the region of responsibility and each voter placed outside the region will vote for the most extreme candidate of the ideological continuum, even if they apply the penalty function for radicalism[67].

As there are two positions which have the potential to become dominant[68] on each direction of the ideological dimension the problem which arises is to identify the conditions in which each position actually becomes dominant. In this sense, knowing the configuration of the distribution of voters is crucial because if the density of voters is larger between the boundary of the region of responsibility and the ideological extremity, the latter becomes the dominant position instead of the boundary of the region of responsibility. An example of such a situation, i.e. a predominantly extremist electorate is depicted in Figure 2[69], which is designed specifically to be a visual aid to the reader in understanding the conditions in which Rabinowitz and Macdonald's original claim that the boundary of the region is always a dominant position are false.

Figure 2. Density of voters in an extremist electoral pool



Source: Author

Because the distribution of voters is encompassed between the graph of the distribution function and the x-axis, therefore it is geometrically irregular, it can only be determined by calculating the area between the endpoints of the interval, that is the extremity of the ideological dimension and the boundary of the region of responsibility and the boundary of the region and the neutral point.

Thus we have three possible cases:

$$a)\ (x,a) > (x,r) \Leftrightarrow \int_{-a}^{-r} f(x) - \int_{-r}^{0} f(x) > 0$$

$$b)\ (x,a) < (x,r) \Leftrightarrow \int_{-a}^{-r} f(x) - \int_{-r}^{0} f(x) < 0$$

$$c)\ (x,a) = (x,r) \Leftrightarrow \int_{-a}^{-r} f(x) - \int_{-r}^{0} f(x) = 0$$

Where: $f(x)$ = voter distribution function, a = the extremity of the ideological dimension and r = the boundary of the region of responsibility.

In common language, the boundary of the region of responsibility is a dominant position only as a special case of the directional model, in the hypothesis in which the difference between the definite integral from the ideological extremity to the boundary of the region and the definite integral from the boundary of the region to the neutral point is negative. By contrast, the extremity of the dimension represents the ideologically domi-

nant position if the above mentioned difference is positive. If the difference is 0 than both positions are dominant.

V. Concluding remarks

Concluding, I believe that in this paper I have realized the theoretical enterprise formulated in the introduction, proving that:

1. Rabinowitz and Macdonald's claim that "any candidate whose intensity exceeds the radius of the region of acceptability will perform worse in any two-person election than a candidate who adopts the same directional stand and is located at the boundary of the region of acceptability"[70] is false as there are n cases where the ideological extremity is dominant and the boundary of the region of responsibility is not.

2. Macdonald, Listhaug and Rabinowitz's assertions that the directional model does not require information regarding the distribution of voters in order to formulate theoretical predictions with regard to the optimal party placement[71] is false as electoral results depend, inter alia, on the distribution of voters with respect to the boundary of the region of responsibility.

3. Also, the paper contributes to the improvement of the full proportionality theorem formulated by Macdonald, Listhaug and Rabinowitz[72] by specifying the conditions in which the two instances of the theorem occur, i.e. the optimal ideological placement on the boundary of the region of responsibility and the optimal ideological placement outside of the region of responsibility.

References

1 The "distribution of voters" refers to the configuration in which each member of an electoral pool is placed on an ideological dimension. It is representable as the graph of a function which reflects on the x-axis the ideological placements and on the y-axis the number of voters which correspond to each position.

2 Rabinowitz and Macdonald, 1989.

3 Ibid, p.108.

4 Macdonald, Listhaug and Rabinowitz, 1991, p.1113.

5 Public Choice Theory is the economic study of decisional processes which are not directly connected to the economic market. For a monograph see Mueller (2003).

6 Udehn, 2002, p.497.

7 Agassi, 1960, p.244.

8 Sugden, 1991, p.753.

9 Black, 1958.

10 Downs, 1957.

11 Hotelling, 1929.

12 Lerner and Singer, 1937.

13 Smithies, 1941.

14 Downs, 1957, p.55.

15 Ibid, p.164.

16 Ibid, pp.164-165.

17 Ibid, p.172.

18 Ibid, p.165.
19 Ibid, p.64.
20 Ibid, p.67. This assumption has an ambiguous nature as Downs does not appear to clearly distinguish between vote-maximizing and plurality-maximizing, which is later made by Davis, Hinich and Ordeshook (1970).
21 Miroiu, 2006, p.248.
22 Ibid, p.247
23 Ibid, p.248.
24 But the party system also.
25 Stokes, 1963.
26 Wittman, 1973.
27 Hinich and Ordeshook, 1970.
28 Palfrey, 1984.
29 Osborne, 1995.
30 Premises due to which these models are generically termed "proximity models" as they are representable in the euclidean space (Lewis and King, 1999, p.22).
31 Davis, Hinich and Ordeshook. 1970.
32 Hinich and Pollard, 1982.
33 Enelow and Hinich, 1982.
34 Greenberg and Weber, 1985.
35 Poole and Rosenthal, 1985.
36 Grofman, 1985.
37 Erikson and Romero, 1990.
38 Rabinowitz and Macdonald, 1989, p.93.
39 Ibid, p.94
40 Rabinowitz, 1978, p.793.
41 Macdonald, Rabinowitz and Listhaug, 2001, p.484; This construct was initially termed "region of acceptability" (Rabinowitz and Macdonald, 1989, p.108). However, in this paper I will use the term "region of responsibility" in general, the exception being represented by the cases where I directly quote papers from the period which precedes the 2001 redefinition of the term, as it adequately reflects the perceived irresponsibility of candidates.
42 Rabinowitz and Macdonald, 1989, p.108.
43 This penalty function will be also used in the present paper considering that the assertions regarding the irrelevance of the voter distribution function come from the same paper, i.e. Macdonald, Listhaug and Rabinowitz (1991).
44 Westholm, 1997, p.872.
45 Ibid, p.867.
46 Ibid, p.867.
47 Interpersonal comparisons are comparisons between the utilities of voters in voting a single party.
48 Intrapersonal comparisons are comparisons between the utility attached to every party by the voter.
49 Westholm, 1997, p.868.
50 Platt, Poole and Rosenthal., 1992
51 Gilljam, 1992.
52 Pierce, 1997.

53 Kramer and Rattinger, 1997.
54 Blais, Nadeau, Gidengil and Nevitte, 2001.
55 Karp and Banducci, 2002.
56 Cho and Endersby, 2003.
57 Claasen, 2007.
58 Tiemman, 2011.
59 Macdonald, Listhaug and Rabinowitz, 1991, p.1113.
60 Ibid, p.1113.
61 Rabinowitz and Macdonald, 1989, p.108.
62 By full proportional system the authors describe a system in which the electoral threshold is 0 or very close to 0. (Macdonald, Listhaug and Rabinowitz, 1991, p.1127)
63 Macdonald, Listhaug and Rabinowitz, 1991, p.1113; The authors term this proposition the "full proportionality theorem" (Macdonald, Listhaug and Rabinowitz, 1991, p.1127).
64 Macdonald, Listhaug and Rabinowitz, 1991, p.1112.
65 I consider only one ideological dimension to simplify the demonstration but the results do not differ for a multidimensional political field, the only modification being that vectors are used instead of points to describe the position of voters and candidates.
66 If the generalization is valid for these two points it is automatically valid for any other subset on [-5,0] with the boundary of the region of responsibility on {-4} as the function is linear.
67 As Westholm observes (1997, p.872), this position is difficult to defend as an extremist voter would have no incentive to apply a penalty to an extremist candidate.
68 The dominant position is defined as the position in which "the candidate is guaranteed at least a tie in the election and a positive plurality if his opposition selects some position other than the dominant one" (Davis, Hinich and Ordeshook, 1970, pp.426-427)
69 In order to simplify Figure 1 I have only introduced a single direction of the ideological dimension, i.e. the left direction.
70 Rabinowitz and Macdonald, 1989, p.108.
71 Macdonald, Listhaug and Rabinowitz, 1991, p.1113.
72 Ibid, p.1127.

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