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Voting equilibria and public funding of political parties

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Abstract
Direct public funding to political parties exists in most OECD countries and its allocation is executed on the basis of two principles: (i) proportional to the votes (or alternatively the number of seats), and (ii) equal distribution. We consider a situation in which there are two scenarios and two policies, where the optimal policy for each scenario is different. We study which policy is implemented when public political funding is introduced and voters are uncertain about the realized scenario. First, when the goal is to implement the optimal policy, we find that direct public funding to political parties is necessary if voters are more likely to be right than wrong about the scenario. Second, we characterize all equilibria based on voters' beliefs, the amount of money proportionally allocated, and the parties' preferences over the pairs scenario-policy and being in office.

1 Introduction

Financial resources are crucial for political parties, as they are essential for maintaining their organizational structure. In Spain, for instance, the lack of funding has threatened the continuity of parties such as Unión, Progreso y Democracia (UPyD) and Ciudadanos in the 2010 s.[1] This reliance on financial resources raises concerns that politicians might seek funding through various means and may feel pressured to return favors to their financial supporters. The 2019 Edelman Trust Barometer (Edel-

[1] In Spain, public funding for political parties is closely tied to electoral performance. After the 2016 general election, Unión, Progreso y Democracia did not secure any parliamentary seats and thus received no public funding. In November 2020, UPyD was removed from the political register due to unpaid debts and subsequently dissolved. Ciudadanos, which faced a significant decline in parliamentary seats in the November 2019 general election, ultimately did not participate in the 2023 general election.

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man 2019) underscores this issue, revealing that only one in five citizens believes the system operates in their favor, thus highlighting policy capture as a significant threat to societal welfare. Consequently, regulating political party funding is of paramount importance. Public funding emerges as a key instrument to reduce political parties' dependence on private donations and mitigate the risk of policy capture.

Most OECD countries provide public funding to those political parties that are represented in parliament. Funding is primarily determined by the percentage of votes obtained in the most recent general election and is mainly executed based on a combination of two principles: *strict proportionality* and *strict equality* (see Van Biezen et al. 2003; OECD 2016).[2] According to the principle of strict proportionality, public political funding is distributed in proportion to the votes obtained by each party in the national legislative elections and/or the number of seats obtained in parliament. As for the principle of strict equality, each party meeting the electoral threshold receives an equal sum of money.

This study aims to investigate how public funding influences the behavior of political parties, specifically by encouraging them to adapt their platforms to economic and social contingencies. Our key contribution is to demonstrate that public funding fosters a more effective political environment by mitigating both the impact of ideological constraints and the potential for parties to pander to voters when formulating their platforms.

In this paper, we present a simple model with two possible scenarios, A and B, and two feasible policies, 1 and 2. In each of these scenarios, there is one policy that is objectively considered to be optimal. In our model there are also two political parties and a pool of voters. Each party can be either ideological or pragmatic, where the preferred policy of the former is independent of the realized scenario, while the preferred policy of a pragmatic party is the optimal policy. Each voter can be either partisan or non-partisan, with the former always voting for her preferred party and the latter voting for the party proposing the optimal policy. Political parties care about money, the implemented policy, and being in office. We assume that political parties observe a perfectly informative signal and learn the realized scenario. However, voters may observe either this informative signal or an empty signal, in which case they retain an initial prior belief favoring scenario B. The political parties' voting game is such that each party announces a policy and voters vote for the party they prefer. In the absence of asymmetric information, a majority of voters would vote for the party proposing the optimal policy for each scenario. However, in equilibrium, the optimal policy may not be implemented because political parties and voters do not share the same information.

The inclusion of public funding based on the number of votes received by political parties has the potential to change the set of equilibria of the political parties' voting game. The central idea is that the effectiveness of public funding for political parties is contingent on the level of voter awareness. If voters hold correct beliefs about the scenario, then public funding can facilitate the implementation of the optimal policy. However, the amount of funding required also hinges on the number of non-partisan

[2] Table 3 in Appendix A shows how the calculation of the allocation of direct public funding to political parties varies across OECD countries.

voters and the rents for being in office. Starting from a context where political parties do not receive public funding, the equilibrium of the political parties' voting game is heavily dependent on the size of the benefits associated with holding office. When the rents for being in office are relatively small compared to the utility gained from implementing the preferred policy, an equilibrium always exists. In the case of pragmatic parties, the equilibrium consists of both parties announcing the optimal policy, which is referred to as the optimal *Downsian equilibrium*. In the case of ideological parties, each party announces its preferred policy, which is referred to as the *Madisonian equilibrium*.[3] Yet, when the rents for being in office significantly outweigh the utility derived from the preferred policy, the existence of an equilibrium may become challenging. Whether political parties are *policy-oriented* or *office-oriented*, the inclusion of public funding acts as a coordination mechanism between both parties. This is understood as the coincidence of their proposed policies. Such coordination can occur in either the optimal or the non-optimal Downsian equilibrium, depending on whether voters hold correct or incorrect beliefs about the scenario. Whenever political parties are policy-oriented, proportional funding imposes a disciplinary role on ideological parties when voters have accurate information about the scenario. This forces parties to develop their platforms based on prevailing economic and social conditions rather than strictly adhering to their ideological positions. Similarly, equal funding prevents the emergence of perverse incentives for pragmatic parties when voters have inaccurate information about the scenario, as it prevents these parties from detaching themselves from existing contingencies and crafting platforms solely to attract misguided voters. In contrast, when parties are office-oriented, proportional funding allows political parties —whether pragmatic or ideological— to formulate their platforms in accordance with what is optimal in the current economic-social context. This outcome is achieved when voters are well-informed; otherwise, optimal policies cannot be implemented by office-oriented parties because their primary goal is to gain power, which leads them to formulate policies that appeal to a misinformed electorate.

This paper contributes to the existing literature on how public funding affects the equilibria of the political parties' game. Ortuño-Ortín and Schultz (2005) consider the public funding system for political parties based on the allocation of funds according to their percentage of votes. They demonstrate that the degree of policy convergence increases as the proportion of public funds tied to the percentage of votes increases. Ortuño-Ortín and Schultz (2012) find that increasing the dependence of funding on the percentage of votes improves welfare. Troumpounis (2012) finds that parties exert greater effort when the direct public funding is allocated on the basis of the number of received votes rather than on the basis of the number of seats obtained in parliament. Our research also contributes to the literature on the impact of asymmetric information and political parties' motivations on the equilibria of the political parties' game. Gratton (2014) argues that if there is a small fraction of pragmatic candidates

[3] The terminology of *Downsian equilibrium* follows the insights of Downs (1957) into two-party competition and the prediction of party convergence to the policy position espoused by the median voter. The terminology of *Madisonian equilibrium* is in reference to the views of James Madison on the role of factionalism and rivalry between political parties (see Madison 1787). Madison recognizes these as essential factors for the proper functioning of government, thanks to the representation of diverse interests and the mitigation of the risk of oppression imposed by majorities.

who always tell the truth and the signal received by voters is informative, the optimal policy according to the realized scenario is implemented in equilibrium. According to McMurray (2022)'s findings, political parties propose polarized platforms in equilibrium when they possess the same information as voters. Prato and Wolton (2022) claim that policy errors are likely to occur even when the electorate is large, if candidates are primarily motivated by office and are sufficiently well-informed.

The remainder of the paper is organized as follows. In Sect. 2 we set out the model. In Sect. 3 we characterize all equilibria of the political parties' voting game, both for the case of policy-oriented political parties and for the case of office-oriented political parties. In Sect. 4 we offer some final remarks. Appendix A shows how the calculation of the allocation of direct public funding to political parties varies across OECD countries. Appendix B contains detailed proofs of the results presented in Sect. 3.

2 The model

Let $N = \{L, R\}$ be the set of political parties. Each party $j \in N$ has to propose a policy $k \in K$ where $K = \{1, 2\}$ is the set of policies. Let $k_j \in K$ be the proposed policy by party j. Let $p \in K$ be the implemented policy that depends on the proposed policies k_L and k_R. When both political parties propose the same policy, such policy becomes implemented. In the case that parties propose different policies, the policy that is carried out will depend on the representation each party holds in the chamber. Such representation is often depicted by the number of seats owned by each party, which ultimately depends on the electoral support received in the election. Each of the policies will be the optimal one, depending on the economic context. The set of possible scenarios is $C = \{A, B\}$ with $c \in C$ being a scenario. A matching is a pair scenario and implemented policy. The optimal matchings are policy 1 in the case of scenario A, i.e., $(A, 1)$, and policy 2 in the case of scenario B, i.e., $(B, 2)$. Note that the set of possible matchings is $\{(A, 1), (A, 2), (B, 1), (B, 2)\}$.

Political parties have preferences over matchings, money, and being in office, denoted by (c, p), m_j, and $w \geq 0$ respectively. We assume that parties' preferences are represented by an additively separable utility function $u_j(c, p, m_j, w) = v_j(c, p) + m_j + w$ where $v_j(c, p) : C \times K \to \{0, 1\}$.

We first explain how parties' preferences depend on the matchings. Each party can be of two types: ideological and pragmatic, denoted by j^i and j^p respectively. An ideological party has a most preferred and a least preferred implemented policy, regardless of the realized scenario. We assume that for party L, $v_{L^i}(c, 1) = 1$ and $v_{L^i}(c, 2) = 0$, for any $c \in C$. For party R, $v_{R^i}(c, 2) = 1$ and $v_{R^i}(c, 1) = 0$, for any $c \in C$. For a pragmatic party, the most preferred matching is that in which the policy is the optimal one according to the realized scenario, that is, $v_{j^p}(A, 1) = v_{j^p}(B, 2) = 1$, while for the least preferred matchings, $v_{j^p}(A, 2) = v_{j^p}(B, 1) = 0$.

Parties in our model have preferences over policies and being in office. The extent to which one is more important than the other depends on the magnitude of w. If $w \in [0, 1]$, the policies are more important than being in office and we say that parties are *policy-oriented*. If, on the other hand, $w > 1$, being in office is more important than the policies and we say that parties are *office-oriented*.

We now focus on the money political parties get in the course of publicly funded elections. In line with the evidence, the public political funding consists of choosing: (i) the total amount of money to be allocated to the parties, $M > 0$; (ii) the amount of money to be allocated that does not depend on the obtained votes, $0 \leq M_0 \leq M$; and (iii) a linear public political funding scheme, $m_j = \frac{M_0}{2} + \alpha_j(M - M_0)$, with α_j representing the fraction of votes obtained by party $j \in N$.[4] Thus, a pair (M, M_0) defines a public funding scheme in the model.

Let H be the set of voters. Voters have preferences for political parties. The utility that a voter derives from a political party comes either from the identity of the party or its proposed policy. The set of voters consists of three disjoint sets, the L-partisan voters, the R-partisan voters, and the set of non-partisan voters. Partisan voters are those who support their party regardless of the proposed policy, while non-partisan voters support the party proposing the optimal policy. Without loss of generality, we assume that the group of non-partisan voters splits equally in the case that both parties propose the same policy. Let λ and ρ be the proportions of partisans of parties L and R, respectively, and $1 - \lambda - \rho$ be the proportion of non-partisan voters. We assume party L has an advantage, meaning that the proportion of L-partisan voters is greater than the proportion of R-partisan voters, that is, $\lambda > \rho > 0$.[5] We assume that $\lambda < \frac{1}{2}$ which means that the non-partisans are decisive when deciding the winner of the election.

We consider the following game between the two political parties. At $t = 0$, nature determines the type (either ideological or pragmatic) of each political party, decides the scenario (either A or B), and sends a perfectly informative signal about the scenario. The type of each political party is common knowledge to both parties but unknown to the voters. At $t = 1$, political parties observe the perfectly informative signal and thus learn the scenario. Voters have a prior belief μ such that $\mu > \frac{1}{2}$, where μ represents the probability they assign to scenario B. This prior belief reflects that voters assign a higher probability to scenario B than to scenario A. With probability $\hat{q}$, voters observe the perfectly informative signal, while with probability $1 - \hat{q}$, they observe an empty signal, and the initial prior applies.[6] Both μ and $\hat{q}$ are known to the political parties. At $t = 2$, both parties simultaneously propose their own policies. At $t = 3$, each voter votes for one party, and funds are allocated to the parties. We focus on calculating and analyzing the pure strategy Nash equilibria (PSNEs) in the political parties' game. For clarity, 'PSNE' is used to denote a single equilibrium, while 'PSNEs' refers to multiple equilibria. The game consists of 8 subgames, each defined by a specific combination of party types and scenarios. Each subgame is characterized by (L^l, R^r, c), where $l, r \in \{i, p\}$ denote the type of each party (ideological i or pragmatic p), and $c \in C$ represents the scenario (either A or B). In each subgame, each party must announce a

[4] In line with Troumpounis (2012)'s findings, in this paper we consider a public funding scheme based on funding per vote.

[5] Our qualitative results do not change in the case in which party R is the advantaged party.

[6] $\hat{q}$ can alternatively be interpreted as the proportion of non-partisan voters who are informed about the realized scenario, while $1 - \hat{q}$ represents the proportion of non-partisan voters who are not informed.

policy. Thus, the strategy s_j for party j is a bundle of 8 policies, one for each subgame, meaning $s_j \in K^8$.

Parties pay attention to the number of votes they receive, as this will determine the amount of money allocated to them. Therefore, we analyze how voters cast their votes. Parties know that partisan voters always vote for the party they support— that is, partisan supporters of party L always vote for party L, while partisan supporters of party R always vote for party R. In the case that both political parties propose the same policy $k \in K$, each party receives the votes from their respective supporters and half of the non-partisan voters.

3 Results

Our general objective in this paper is to study the pure strategy Nash equilibria of the game of the political parties depending on both public political funding and voters' beliefs. Two types of equilibria may arise: equilibria *à la Downs* (policy convergence between parties), and *à la Madison* (policy divergence between parties where party L proposes policy 1 while party R proposes policy 2). We will refer to an optimal (non-optimal) Downsian equilibrium as one in which both parties propose the optimal (non-optimal) policy according to the realized scenario. Our general result is that the proportional allocation of money acts as a coordination device for the parties, where the convergence on the optimal or the non-optimal policy depends on voters' beliefs.

Let q be the probability with which voters believe they are in the scenario chosen by nature at $t = 0$ after having observed either the perfectly informative signal or an empty signal. Note that if the scenario is B, for any $\hat{q}$, the voter posterior always assigns a greater probability to scenario B; equivalently $q > \frac{1}{2}$ is always the case and voters are always right about the scenario. However, if the scenario is A, the voter posterior can now favor either scenario A or B, or view both scenarios as equally likely. We say that voters are right about the scenario if $q \geq \frac{1}{2}$, and we say that voters are wrong if $q < \frac{1}{2}$.[7] Thus, in the case that political parties propose different policies, with probability q the party proposing the optimal policy wins the election, while with probability $1-q$ the party proposing the non-optimal policy wins the election. Instead, when both political parties propose the same policy, the party with more supporters is the one that wins the election. Our analysis reveals that if the voters' posterior q is greater than $\frac{1}{2}$ (i.e., if voters assign a higher probability to the correct scenario than to the incorrect one), then the optimal Downsian equilibrium is achieved. Conversely, the non-optimal Downsian equilibrium occurs when q is less than $\frac{1}{2}$.

Note that the votes parties expect to get depend on the policies that both parties propose, which in turn determine which policy will be implemented, the money they receive, and which party will win the election. We assume that political parties have Von Neumann–Morgenstern utility functions, so when computing their expected utility we make explicit the proposed policies by both parties.

[7] For $c = A$, the probability assigned by voters to the correct scenario is $q = 1 - (1 - \hat{q})\mu$. For $c = B$, it is $q = \hat{q} + (1 - \hat{q})\mu$.

Table 1 Pragmatic party R

	$k_R = 1$	$k_R = 2$
$k_L = 1$	$1 + \frac{M_0}{2} + (\frac{1+\lambda-\rho}{2})(M - M_0) + w,$ $1 + \frac{M_0}{2} + (\frac{1+\rho-\lambda}{2})(M - M_0)$	$q + \frac{M_0}{2} + \Big(\lambda + q(1-\lambda-\rho)\Big)(M - M_0) + qw,$ $q + \frac{M_0}{2} + \Big((1-\lambda)(1-q) + q\rho\Big)(M - M_0) + (1-q)w$
$k_L = 2$	$q + \frac{M_0}{2} + \Big((1-\rho)(1-q) + q\lambda\Big)(M - M_0) + (1-q)w,$ $q + \frac{M_0}{2} + \Big(\rho + q(1-\lambda-\rho)\Big)(M - M_0) + qw$	$\frac{M_0}{2} + (\frac{1+\lambda-\rho}{2})(M - M_0) + w,$ $\frac{M_0}{2} + (\frac{1-\lambda+\rho}{2})(M - M_0)$

Table 2 Ideological party R

	$k_R = 1$	$k_R = 2$
$k_L = 1$	$1 + \frac{M_0}{2} + (\frac{1+\lambda-\rho}{2})(M - M_0) + w,$ $\frac{M_0}{2} + (\frac{1+\rho-\lambda}{2})(M - M_0)$	$q + \frac{M_0}{2} + \Big(\lambda + q(1-\lambda-\rho)\Big)(M - M_0) + qw,$ $(1-q) + \frac{M_0}{2} + \Big((1-\lambda)(1-q) + q\rho\Big)(M - M_0) + (1-q)w$
$k_L = 2$	$q + \frac{M_0}{2} + \Big((1-\rho)(1-q) + q\lambda\Big)(M - M_0) + (1-q)w,$ $(1-q) + \frac{M_0}{2} + \Big(\rho + q(1-\lambda-\rho)\Big)(M - M_0) + qw$	$\frac{M_0}{2} + (\frac{1+\lambda-\rho}{2})(M - M_0) + w,$ $1 + \frac{M_0}{2} + (\frac{1-\lambda+\rho}{2})(M - M_0)$

For any subgame where the scenario is $c = B$, the unique PSNE is the optimal Downsian equilibrium, regardless of the party types; that is, $(k_L, k_R) = (2, 2)$. Voters assign a higher probability to scenario B than to scenario A. For party R, proposing policy 2 is a dominant strategy. For party L, the best reply is also proposing policy 2. Since each party gets half of the non-partisan votes, the party winning the election would be the one with more partisan supporters.

For subgames where the scenario is $c = A$, Tables 1 and 2 present the expected utilities of both parties, depending on their proposed policies, when party R is pragmatic or ideological, respectively. Note that for party L, the expected utility remains the same regardless of whether it is pragmatic or ideological. Consequently, Table 1 refers to the subgames (L^i, R^p, A) and (L^p, R^p, A), while Table 2 refers to the subgames (L^i, R^i, A) and (L^p, R^i, A). In each cell of the tables, the first line shows the expected utility of the L party, and the second line shows the expected utility of the R party.

For the remainder of the paper, we focus on the subgames where $c = A$ and study the pure strategy Nash equilibria of the game of the political parties. To do this, we distinguish two situations: when the utility of being in office is less than or equal to the utility obtained from the most preferred matching ($w \leq 1$) and when it is strictly greater ($w > 1$).

3.1 Policy-oriented political parties

Let us assume that $w \in [0, 1]$. We distinguish the cases in which party R is pragmatic and in which it is ideological.

In Proposition 1, we analyze the case in which party L can be either ideological or pragmatic and party R is pragmatic. Specifically, we consider the subgames (L^i, R^p, A) and (L^p, R^p, A). Before stating Proposition 1 we introduce some notation. Let $f_1(q, \lambda, \rho, w) = \frac{(1+w)q}{(1-\lambda-\rho)(\frac{1}{2}-q)}$ and $f_2(q, \lambda, \rho, w) = \frac{(1-w)(1-q)}{(1-\lambda-\rho)(\frac{1}{2}-q)}$ which, by abuse of notation we will refer to as f_1 and f_2.

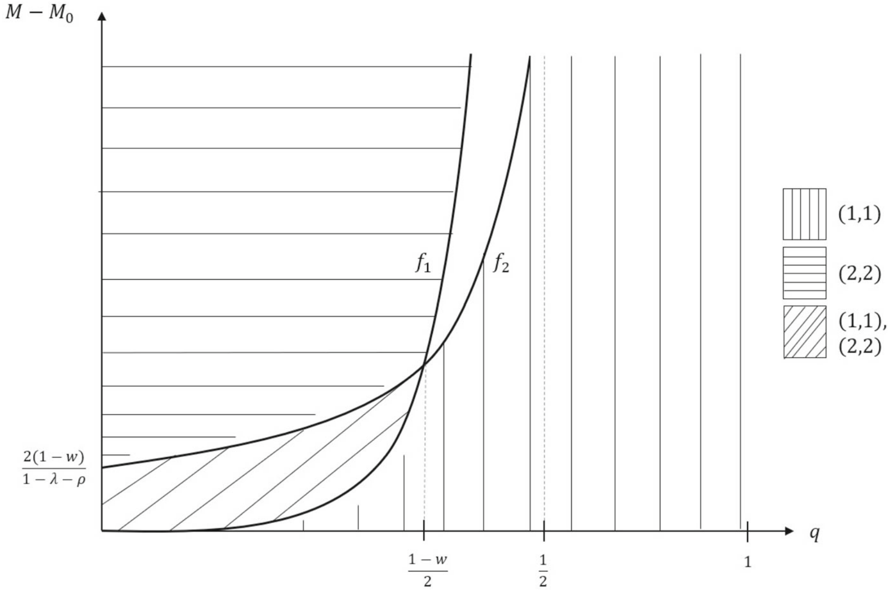

Fig. 1 Equilibrium areas for the case of pragmatic party R when $w \in (0, 1]$

Proposition 1 *Let $c = A$ and party R be pragmatic. We distinguish two cases:*

(i) *Let $q \geq \frac{1}{2}$. The optimal Downsian equilibrium is the unique PSNE.*
(ii) *Let $q < \frac{1}{2}$. We distinguish four subcases:*

(ii.i) *The optimal Downsian equilibrium is the unique PSNE if $M - M_0 < \min\{f_1, f_2\}$ or $q > \frac{1-w}{2}$ and $M - M_0 = f_2$;*
(ii.ii) *The non-optimal Downsian equilibrium is the unique PSNE if $M - M_0 > \max\{f_1, f_2\}$;*
(ii.iii) *Both the optimal and the non-optimal Downsian equilibria are the only PSNEs if $f_1 \leq M - M_0 \leq f_2$;*
(ii.iv) *There is no PSNE otherwise.*

All proofs can be found in Appendix B. Figure 1 shows four different areas according to the non-existence or existence of equilibria and the type of equilibrium that exists, as a function of values of q and $M - M_0$. In particular, $(k_L, k_R) = (1, 1)$ is the unique PSNE in the vertical striped area, which includes the pairs $(q, M - M_0)$ such that $\frac{1-w}{2} < q < \frac{1}{2}$ and $M - M_0 = f_2$. In the horizontal striped area, which includes the pairs $(q, M - M_0)$ such that $\frac{1-w}{2} < q < \frac{1}{2}$ and $M - M_0 = f_1$, the unique PSNE is $(k_L, k_R) = (2, 2)$. In the positive sloping striped area, which includes the pairs $(q, M - M_0)$ such that $q < \frac{1-w}{2}$ and $f_1 \leq M - M_0 \leq f_2$, both $(k_L, k_R) = (1, 1)$ and $(k_L, k_R) = (2, 2)$ are PSNEs. Finally, the unstriped area is one of non-existence of PSNE.

Proposition 1 shows that if a pure strategy Nash equilibrium exists, it will be of the Downsian type, either optimal or non-optimal. Note that if no money is allocated proportionally, then both parties proposing the optimal policy is the unique PSNE

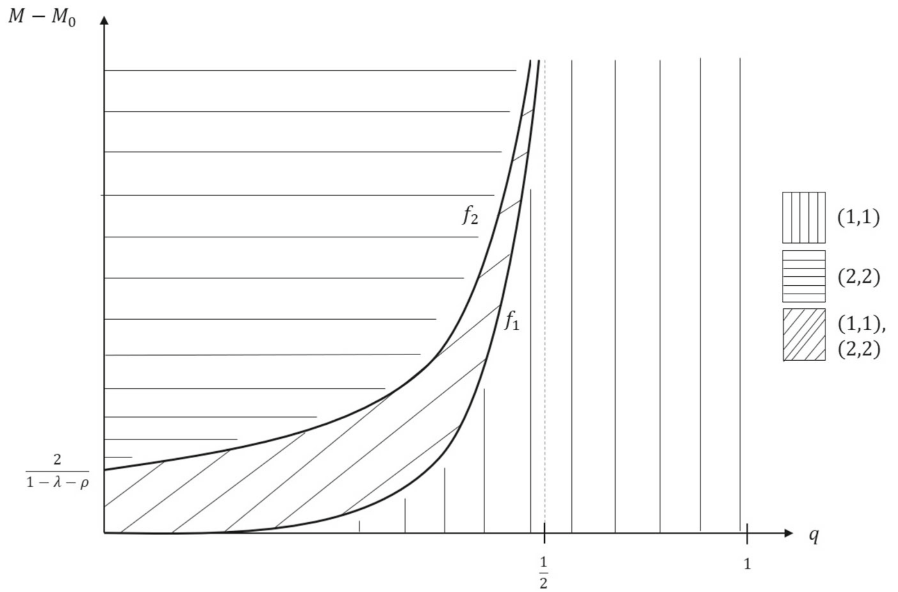

Fig. 2 Equilibrium areas for the case of pragmatic party R when $w = 0$

for any voters' posterior, that is, the optimal Downsian equilibrium. This is because both parties have aligned interests: they both have policy 1, the optimal policy, as their most preferred policy. The introduction of money, proportionally allocated, does not change the fact that both parties coordinate on policies for extreme values of q, although this coordination need no longer be around the optimal policy. Whether the equilibrium in which they coordinate is optimal or non-optimal depends on the values of q and $M - M_0$. For $q > \frac{1}{2}$, parties always coordinate in proposing the optimal policy. For q values less than half and sufficiently small, they may eventually fail to coordinate in proposing the optimal policy, and they both propose the non-optimal policy. Meanwhile, for values of q and $M - M_0$ in the unstriped area, coordination problems arise and there is no PSNE. The size of the area of no equilibrium is increasing in w. In particular, if there are no rents for being in office, this area does not exist and there is always an equilibrium (see Fig. 2).

In Proposition 2, we analyze the case in which party L can be either ideological or pragmatic and party R is ideological. Specifically, we consider the subgames (L^i, R^i, A) and (L^p, R^i, A). Before stating Proposition 2 we introduce some additional notation. Let $f_3(q, \lambda, \rho, w) = \frac{q(1+w)-w}{(1-\lambda-\rho)(\frac{1}{2}-q)}$ and $f_4(q, \lambda, \rho, w) = \frac{(1+w)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})}$ which, by abuse of notation we will refer to as f_3 and f_4.

Proposition 2 *Let $c = A$ and party R be ideological.*

(i) *The optimal Downsian equilibrium is the unique PSNE if $M - M_0 > f_4$;*
(ii) *The non-optimal Downsian equilibrium is the unique PSNE if $M - M_0 > f_3$;*
(iii) *The Madisonian equilibrium is the unique PSNE if $M - M_0 < \min\{f_3, f_4\}$;*

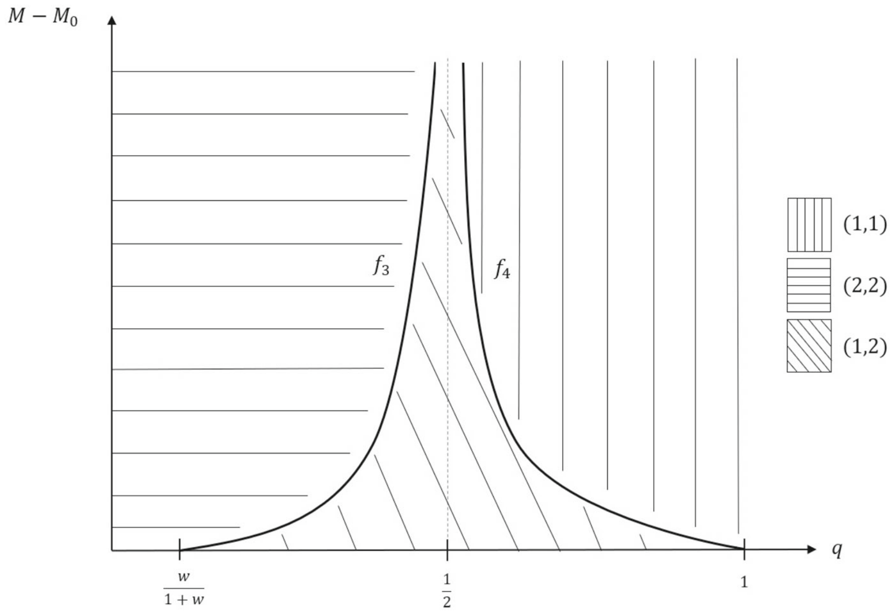

Fig. 3 Equilibrium areas for the case of ideological party R when $w \in [0, 1]$

(iv) *If* $M - M_0 = f_4$, *then the optimal Downsian and Madisonian are PSNEs, and if* $M - M_0 = f_3$ *then the non-optimal Downsian and Madisonian are PSNEs.*

Figure 3 shows three different areas according to the type of equilibrium that exists, as a function of values of q and $M - M_0$. In particular, $(k_L, k_R) = (1, 1)$ is the unique PSNE in the vertical striped area, excluding the pairs $(q, M - M_0)$ such that $M - M_0 = f_4$. In the horizontal striped area, which excludes the pairs $(q, M - M_0)$ such that $M - M_0 = f_3$, the unique PSNE is $(k_L, k_R) = (2, 2)$. In the negative sloping striped area, where $M - M_0 < \min\{f_3, f_4\}$, the unique PSNE is $(k_L, k_R) = (1, 2)$. For the pairs $(q, M - M_0)$ such that $M - M_0 = f_4$ the PSNEs consist of $k_L = 1$ and $k_R \in \{1, 2\}$. Finally, for the pairs $(q, M - M_0)$ such that $M - M_0 = f_3$ the PSNEs consist of $k_R = 2$ and $k_L \in \{1, 2\}$.

Proposition 2 shows that a pure strategy Nash equilibrium always exists and it can be of two types, either Downsian or Madisonian. Note that if no money is allocated proportionally and there are no rents for being in office, then only the Madisonian equilibrium exists. This is because the interests of both parties are not aligned. The non-optimal Downsian equilibrium occurs when the rents of being in office are not zero and q is small enough (the size of this area depends on the magnitude of the rents of being in office). The introduction of money, proportionally allocated, brings two effects: the first is that the parameter region for which the Madisonian equilibrium exists is reduced; the second is that the Downsian equilibrium arises with either the optimal or the non-optimal feature, depending on the values of q and $M - M_0$. For q greater than half and sufficiently high, they coordinate in proposing the optimal policy. For q values less than half and sufficiently small they coordinate in proposing the non-optimal policy. Meanwhile, for values of q and $M - M_0$ in the negative sloping striped area, the Madisonian equilibrium is obtained.

3.2 Office-oriented political parties

Let us assume that $w > 1$. We distinguish the cases in which party R is pragmatic and in which it is ideological.

In Proposition 3, we analyze the case in which party L can be either ideological or pragmatic and party R is pragmatic (ideological). Specifically, we consider the subgames (L^i, R^p, A) and (L^p, R^p, A) $\Big((L^i, R^i, A)$ and $(L^p, R^i, A)\Big)$. Before stating Proposition 3 we add some notation and use the functions, f_1, f_2, f_3, and f_4, defined in the above section. Let $f_5(q, \lambda, \rho, w) = \frac{q(w-1)}{(1-\lambda-\rho)(\frac{1}{2}-q)}$ which, by abuse of notation we will refer to as f_5.

Proposition 3 *Let $c = A$ and party R be pragmatic (ideological).*

(i) *The optimal Downsian equilibrium is the unique PSNE if $M - M_0 > f_2 \quad (M - M_0 > f_4)$;*
(ii) *The non-optimal Downsian equilibrium is the unique PSNE if $M - M_0 \geq f_1 \quad (M - M_0 \geq f_5)$;*
(iii) *The Madisonian equilibrium is the unique PSNE if $f_3 \leq M - M_0 < f_2 \quad (f_3 \leq M - M_0 < f_4)$;*
(iv) *If $M - M_0 = f_2 \quad (M - M_0 = f_4)$, then the optimal Downsian and Madisonian are PSNEs;*
(v) *There is no PSNE otherwise.*

Figure 4 shows five different areas according to the non-existence or existence of pure strategy Nash equilibria and the type of equilibrium that exists, as a function of values of q and $M - M_0$. In particular, $(k_L, k_R) = (1, 1)$ is the unique PSNE in the vertical striped area, excluding the pairs $(q, M - M_0)$ such that $M - M_0 = f_2(f_4)$. In the horizontal striped area, which includes the pairs $(q, M - M_0)$ such that $M - M_0 = f_1(f_5)$, the unique PSNE is $(k_L, k_R) = (2, 2)$. In the negative sloping striped area, where $f_3 \leq M - M_0 < f_2(f_4)$, the unique PSNE is $(k_L, k_R) = (1, 2)$. For the pairs $(q, M - M_0)$ such that $M - M_0 = f_2(f_4)$ the PSNEs consist of $k_L = 1$ and $k_R \in \{1, 2\}$. Finally, the unstriped area is one of non-existence of PSNE.

Proposition 3 shows that if a pure strategy Nash equilibrium exists, it can be of two types, either Downsian or Madisonian. Note that if no money is allocated proportionally and the rents for being in office are arbitrarily large, then there is no PSNE. This is because the priority of both parties is to win the election, which leads to each party trying to differentiate itself from the other. The Madisonian equilibrium occurs when the rents of being in office are not so large and q is large enough (the size of this area depends on the magnitude of the rents of being in office). The introduction of money proportionally allocated makes both parties coordinate on policies for extreme values of q. Whether the equilibrium in which they coordinate is optimal or non-optimal depends on the values of q and $M - M_0$. For q greater than half and sufficiently high, they coordinate in proposing the optimal policy. For q values less than half and

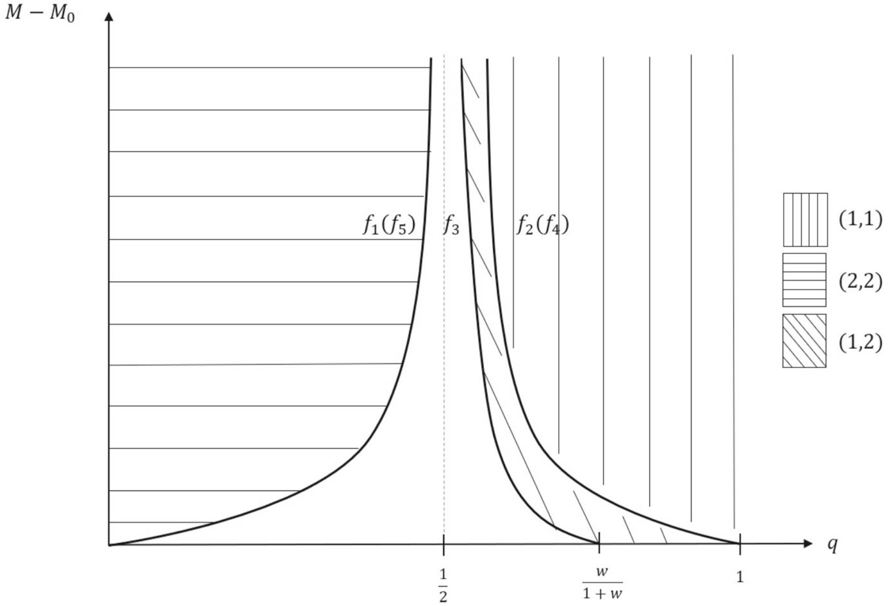

Fig. 4 Equilibrium areas for the case of pragmatic (ideological) party R when $w > 1$

sufficiently small they coordinate in proposing the non-optimal policy. Meanwhile, for values of q and $M - M_0$ in the negative sloping striped area, the Madisonian equilibrium is obtained.

4 Final remarks

Our results highlight the relevance of the design of political party public funding regulation. In the context of policy-oriented parties, our findings reveal that allocating money between parties proportionally to the percentage of votes poses a threat to societies where voters hold incorrect beliefs. Since voters' information about the optimal policy is not accurate, parties prefer to propose the non-optimal policy in order to attract more votes, which will ultimately mean more money for the party. Thus, the strict proportionality principle poses a disruptive role for pragmatic political parties insofar as it promotes the risk of pandering, thus compromising the achievement of the optimal policy in equilibrium.

However, in societies where voters hold correct beliefs, allocating public funding between parties proportionally to the percentage of votes contributes to the implementation of the optimal policy in equilibrium. Particularly noteworthy is the disciplinary role that the strict proportionality principle poses for ideological parties. The inclusion of public funding based on the number of votes would lead an ideological party whose preferred policy is not the optimal one according to the realized scenario to propose the optimal policy in order to attract votes from well-informed voters.

Our analysis offers an interesting policy implication. When voters hold incorrect beliefs, parties should not be allowed to compete for votes. Instead, applying the strict equality principle exclusively would prevent the emergence of perverse incentives to political parties. However, when voters hold correct beliefs, parties should be allowed to compete for votes. Since in practice it is difficult to anticipate the nature of the political parties that may emerge in societies, legislators will be obliged to impose both a lower- and an upper-bound to the amount of money to be distributed proportionally to the received number of votes when the goal is the implementation of the optimal policy.

When we shift our focus from policy-oriented to office-oriented parties, a striking fact emerges: office-oriented parties, faced with poorly informed voters, lack incentives to formulate optimal policies. This finding underscores the need to design public funding mechanisms that can encourage all political parties to develop optimal policies. Crucially, with office-oriented parties, such a design is only effective if citizens are well-informed about the economic and social contingencies they face. Therefore, the effective functioning of modern democracies, regardless of the nature of the political parties involved, necessarily hinges on ensuring robust institutions that provide citizens with accurate and comprehensive information.

Finally, we are aware that in this paper we have not covered all possible public political funding schemes but have focused only on the simple case of linear public funding. Providing insights to the study of non-linear public political funding is a worthy consideration for a future research project.

Appendix A

Table 3.

Table 3 Allocation calculation of direct public funding to political parties in OECD countries. Source: OECD (2016)

	Equal	Proportional to votes received	Proportional to seats received	Flat rate by votes received	Share of expenses reimbursed	Other
Australia				✓		
Austria	✓	✓		✓		
Belgium	✓	✓				
Canada				✓	✓	
Chile				✓		
Czech Republic	✓	✓	✓	✓	✓	
Denmark				✓		
Estonia	✓	✓	✓			
Finland			✓			
France		✓	✓			
Germany		✓				✓
Greece	✓	✓				
Hungary	✓	✓				
Iceland	✓	✓				
Ireland		✓				
Israel	✓			✓		
Italy		✓				✓

Table 3 continued

	Equal	Proportional to votes received	Proportional to seats received	Flat rate by votes received	Share of expenses reimbursed	Other
Japan		✓	✓			
Korea		✓	✓		✓	
Luxembourg	✓	✓				
Mexico	✓	✓				
Netherlands	✓		✓			
New Zealand		✓	✓			
Norway		✓				
Poland		✓				
Portugal	✓	✓				
Slovak Republic		✓	✓			
Slovenia	✓	✓				
Spain		✓	✓			
Sweden	✓	✓	✓			
Turkey		✓				
United Kingdom		✓	✓			✓
United States	✓	✓				
OECD 33	15	25	12	7	3	3

Appendix B

Before proving Propositions 1, 2, and 3 we define the best reply of each party, which selects the set of policies that maximizes the utility of a party depending on the proposed policy of the other party, w, q, λ, and ρ. For short, given λ and ρ, we denote it by $BR_j(k_{-j}, w, q)$.

Proof of Proposition 1. Let $c = A$, $w \in [0, 1]$, and party R be pragmatic. Table 1 displays the expected utilities of both parties in this case. We now compute the best replies of each party for each proposed policy of the other party. Equation 1 shows the best reply of party L when party R proposes policy 1.

$$BR_L(1, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{1-q(1-w)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1,2\} & \text{if } M - M_0 = \frac{1-q(1-w)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{1}$$

Equation 2 shows the best reply of party L when party R proposes policy 2.

$$BR_L(2, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{q-w(1-q)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1,2\} & \text{if } M - M_0 = \frac{q-w(1-q)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{2}$$

Equation 3 shows the best reply of party R when party L proposes policy 1.

$$BR_{R^p}(1, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{(1-w)(1-q)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1,2\} & \text{if } M - M_0 = \frac{(1-w)(1-q)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{3}$$

Equation 4 shows the best reply of party R when party L proposes policy 2.

$$BR_{R^p}(2, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{(1+w)q}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1,2\} & \text{if } M - M_0 = \frac{(1+w)q}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{4}$$

Figure 5 depicts the best replies of each party for each proposed policy of the other party. For a clearer graph, in the figure we use $BR_j(k_{-j})$ instead of $BR_j(k_{-j}, w, q)$.

We distinguish several cases:

(i) Let $q \geq \frac{1}{2}$. From Eqs. (1) to (4), proposing policy 1 is a dominant strategy for both parties. Then, we have that the unique PSNE is both parties proposing policy 1.

(ii) Let $q < \frac{1}{2}$. By definition, $f_1(q, \lambda, \rho, w) = \frac{(1+w)q}{(1-\lambda-\rho)(\frac{1}{2}-q)}$ and $f_2(q, \lambda, \rho, w) = \frac{(1-w)(1-q)}{(1-\lambda-\rho)(\frac{1}{2}-q)}$. We distinguish four subcases:

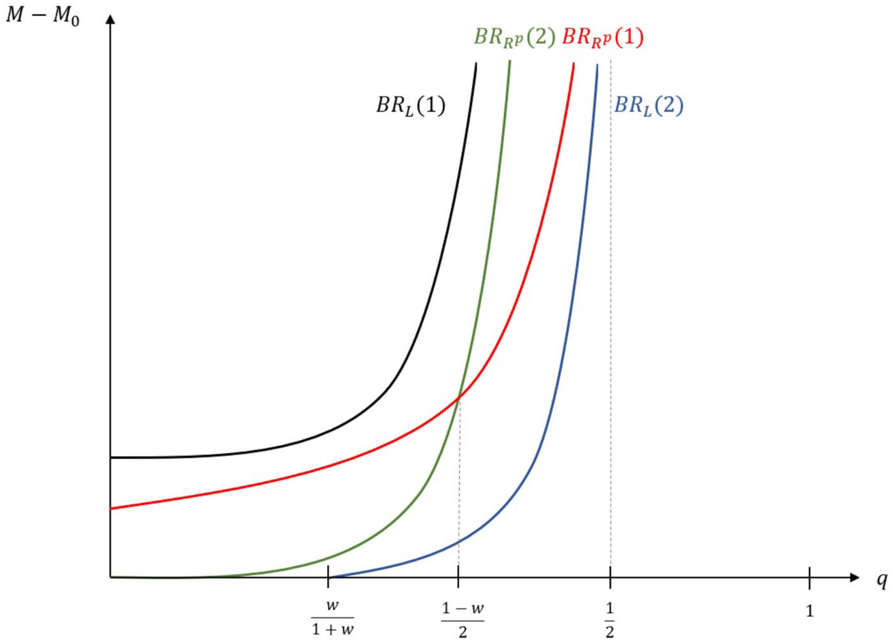

Fig. 5 Parties' best replies for the case of pragmatic party R when $w \in [0, 1]$

(ii.i) Consider any pair $(q, M - M_0)$ such that $q < \frac{1}{2}$ and $M - M_0 < \min\{f_1, f_2\}$. From Eqs. (3) and (4) proposing policy 1 is a dominant strategy for party R. Also, from Eq. (1) proposing policy 1 is a strict best reply for party L when party R proposes policy 1. Therefore, both parties proposing policy 1 is the unique PSNE.
Consider now any pair $(q, M - M_0)$ such that $q > \frac{1-w}{2}$ and $M - M_0 = f_2$. From Eq. (3) party R is indifferent between both policies when party L proposes policy 1. Also from Eq. (4) party R strictly prefers policy 1 when party L proposes policy 2. From Eq. (1) party L strictly prefers policy 1 when party R proposes policy 1, and from Eq. (2) party L strictly prefers policy 2 when party R proposes policy 2. Then, we have that the unique PSNE is both parties proposing policy 1.
(ii.ii) Consider any pair $(q, M - M_0)$ such that $q < \frac{1}{2}$ and $M - M_0 > \max\{f_1, f_2\}$. From Eqs. (3) and (4) proposing policy 2 is a dominant strategy for party R. Also, from Eq. (2) proposing policy 2 is a strict best reply for party L when party R proposes policy 2. Therefore, both parties proposing policy 2 is the unique PSNE. Consider now any pair $(q, M - M_0)$ such that $q > \frac{1-w}{2}$ and $M - M_0 = f_1$. From Eq. (4) party R is indifferent between both policies when party L proposes policy 2. Also from Eq. (3) party R strictly prefers policy 2 when party L proposes policy 1. From Eq. (1) party L strictly prefers policy 1 when party R proposes policy 1, and from Eq. (2) party L strictly prefers policy 2 when party R proposes policy 2. Then, we have that the unique PSNE is both parties proposing policy 2.

(ii.iii) Consider now any pair $(q, M-M_0)$ such that $f_1 \leq M-M_0 \leq f_2$. From Eq. (3) party R weakly prefers policy 1 to policy 2 when party L proposes policy 1. Also from Eq. (4) party R strictly prefers policy 2 when party L proposes policy 2. From Eq. (1) party L strictly prefers policy 1 when party R proposes policy 1, and from Eq. (2) party L strictly prefers policy 2 when party R proposes policy 2. Then, we have that both parties proposing either policy 1 or policy 2 are PSNEs.

(ii.iv) Consider now any pair $(q, M-M_0)$ such that $f_1 \leq M-M_0 \leq f_2$. From Eq. (3) party R strictly prefers policy 1 to policy 2 when party L proposes policy 1. Also from Eq. (4) party R strictly prefers policy 1 when party L proposes policy 2. From Eq. (1) party L strictly prefers policy 1 when party R proposes policy 1, and from Eq. (2) party L strictly prefers policy 2 when party R proposes policy 2. Then, we have that there is no PSNE.

■

Proof of Proposition 2. Let $c = A$, $w \in [0, 1]$, and party R be ideological. Table 2 displays the expected utilities of both parties in this case. We now compute the best replies of each party for each proposed policy by the other party. Equations 1 and 2 in the proof of Proposition 1, show the best replies of party L when party R proposes policy 1 and policy 2, respectively.

Equation 5 shows the best reply of party R when party L proposes policy 1.

$$BR_{R^i}(1, w, q) = \begin{cases} 1 & \text{if } M - M_0 > \frac{(1+w)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ \{1, 2\} & \text{if } M - M_0 = \frac{(1+w)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ 2 & \text{otherwise} \end{cases} \tag{5}$$

Equation 6 shows the best reply of party R when party L proposes policy 2.

$$BR_{R^i}(2, w, q) = \begin{cases} 1 & \text{if } M - M_0 > \frac{(1-w)q}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ \{1, 2\} & \text{if } M - M_0 = \frac{(1-w)q}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ 2 & \text{otherwise} \end{cases} \tag{6}$$

Figure 6 depicts the best replies of each party for each proposed policy by the other party. For a clearer graph, in the figure we use $BR_j(k_{-j})$ instead of $BR_j(k_{-j}, w, q)$.

We distinguish several cases:

(i) Let $M - M_0 > f_4$. From Eqs. (1) and (2) proposing policy 1 is a dominant strategy for party L. Also, from Eq. (5) proposing policy 1 is a strict best reply for party R when party L proposes policy 1. Therefore, both parties proposing policy 1 is the unique PSNE.

(ii) Let $M - M_0 > f_4$. From Eqs. (5) and (6) proposing policy 2 is a dominant strategy for party R. Also, from Eq. (2) proposing policy 2 is a strict best reply for party L when party R proposes policy 2. Therefore, both parties proposing policy 2 is the unique PSNE.

(iii) Let $M - M_0 < \min\{f_3, f_4\}$. From Eqs. (1) and (2) proposing policy 1 is a dominant strategy for party L. Also, from Eqs. (5) and (6) proposing policy 2 is

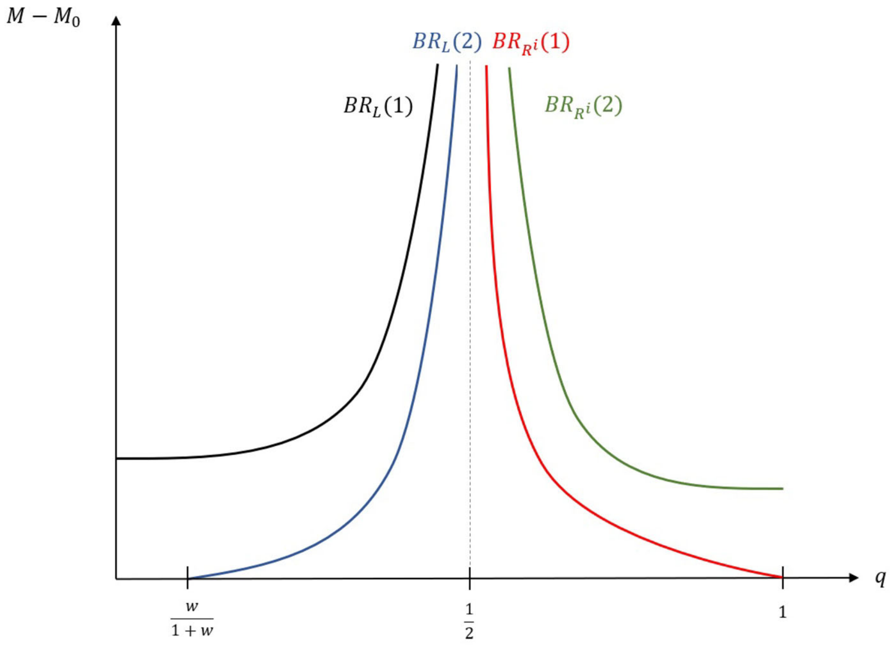

Fig. 6 Parties' best replies for the case of ideological party R when $w \in [0, 1]$

a dominant strategy for party R. Therefore, party L proposing policy 1 and party R proposing policy 2 is the unique PSNE.

(iv) Let $M - M_0 = f_4$. From Eqs. (1) and (2) proposing policy 1 is a dominant strategy for party L. Also, from Eq. (5) party R is indifferent between both policies. Therefore, party L proposing policy 1 and party R proposing either policy 1 or 2 are PSNEs. Analogously, if $M - M_0 = f_3$ party R proposing policy 2 and party L proposing either policy 1 or 2 are PSNEs.

■

Proof of Proposition 3. Let $c = A$ and $w > 1$. We divide this proof into two parts depending on whether party R is pragmatic or ideological:

Part I. Pragmatic party R.

Table 1 displays the expected utilities of both parties in this case. We now compute the best replies of each party for each proposed policy by the other party. Equation 7 shows the best reply of party L when party R proposes policy 1.

$$BR_L(1, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{1-q(1-w)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1, 2\} & \text{if } M - M_0 = \frac{1-q(1-w)}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{7}$$

Equation 8 shows the best reply of party L when party R proposes policy 2.

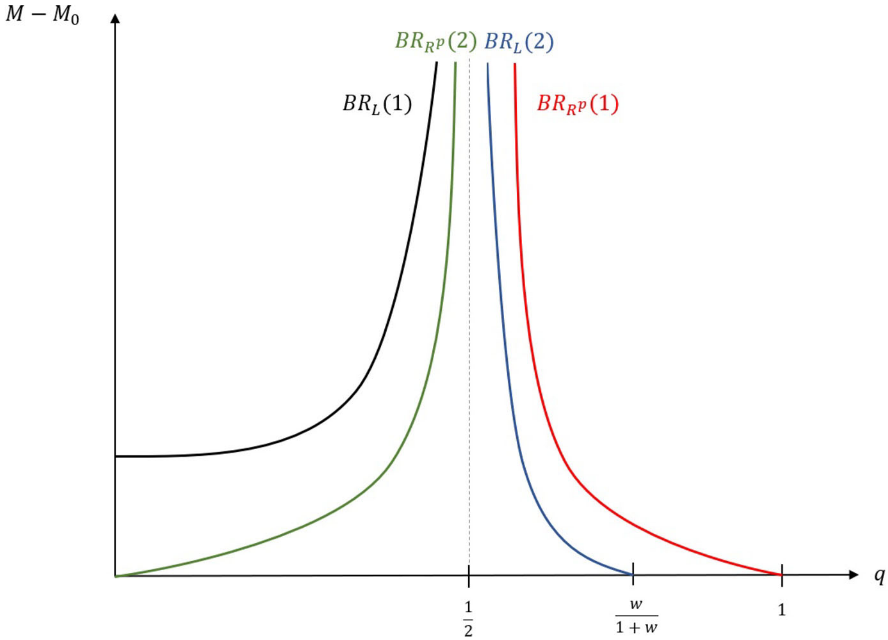

Fig. 7 Parties' best replies for the case of pragmatic party R when $w > 1$

$$BR_L(2, w, q) = \begin{cases} 1 & \text{if } M - M_0 > \frac{q-w(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ \{1, 2\} & \text{if } M - M_0 = \frac{q-w(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ 2 & \text{otherwise} \end{cases} \tag{8}$$

Equation 9 shows the best reply of party R when party L proposes policy 1.

$$BR_{R^p}(1, w, q) = \begin{cases} 1 & \text{if } M - M_0 > \frac{(w-1)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ \{1, 2\} & \text{if } M - M_0 = \frac{(w-1)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ 2 & \text{otherwise} \end{cases} \tag{9}$$

Equation 10 shows the best reply of party R when party L proposes policy 2.

$$BR_{R^p}(2, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{(1+w)q}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1, 2\} & \text{if } M - M_0 = \frac{(1+w)q}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{10}$$

Figure 7 depicts the best replies of each party for each proposed policy by the other party. For a clearer graph, in the figure we use $BR_j(k_{-j})$ instead of $BR_j(k_{-j}, w, q)$. We distinguish several cases:

(i) Let $M - M_0 > f_2$. From Eqs. (7) and (8) proposing policy 1 is a dominant strategy for party L. Also, from Eq. (9) proposing policy 1 is a strict best reply for party R when party L proposes policy 1. Therefore, both parties proposing policy 1 is the unique PSNE.

(ii) Let $M - M_0 \geq f_1$. From Eq. (9) party R strictly prefers policy 2 when party L proposes policy 1. Also, from Eq. (10) party R weakly prefers policy 2 when party L proposes policy 2. From Eq. (8) proposing policy 2 is a strict best reply for party L when party R proposes policy 2. From Eq. (7) proposing policy 1 is a strict best reply for party L when party R proposes policy 1. Therefore, both parties proposing policy 2 is the unique PSNE.

(iii) Let $f_3 \leq M - M_0 < f_2$. From Eq. (7) party L strictly prefers policy 1 when party R proposes policy 1. Also, from Eq. (8) party L weakly prefers policy 1 when party R proposes policy 2. From Eq. (10) proposing policy 1 is a strict best reply for party R when party L proposes policy 2. From Eq. (9) proposing policy 2 is a strict best reply for party R when party L proposes policy 1. Therefore, both parties proposing policy 2 is the unique PSNE.

(iv) Let $M - M_0 = f_2$. From Eqs. (7) and (8) proposing policy 1 is a dominant strategy for party L. Also, from Eq. (9) party R is indifferent between both policies. Therefore, party L proposing policy 1 and party R proposing either policy 1 or 2 are PSNEs.

(v) Consider now any pair $(q, M - M_0)$ such that $M - M_0 < \min\{f_1, f_3\}$. From Eq. (9) party R strictly prefers policy 2 to policy 1 when party L proposes policy 1. Also from Eq. (10) party R strictly prefers policy 1 when party L proposes policy 2. From Eq. (7) party L strictly prefers policy 1 when party R proposes policy 1 and from Eq. (8) party L strictly prefers policy 2 when party R proposes policy 2. Then, we have that there is no PSNE.

<u>*Part II.*</u> Ideological party R.

Table 2 displays the expected utilities of both parties in this case. We now compute the best replies of each party for each proposed policy by the other party. Equations 7 and 8 in Part I above, show the best replies of party L when party R proposes policy 1 and policy 2, respectively.

Equation 11 shows the best reply of party R when party L proposes policy 1.

$$BR_{R^i}(1, w, q) = \begin{cases} 1 & \text{if } M - M_0 > \frac{(1+w)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ \{1, 2\} & \text{if } M - M_0 = \frac{(1+w)(1-q)}{(1-\lambda-\rho)(q-\frac{1}{2})} \\ 2 & \text{otherwise} \end{cases} \tag{11}$$

Equation 12 shows the best reply of party R when party L proposes policy 2.

$$BR_{R^i}(2, w, q) = \begin{cases} 1 & \text{if } M - M_0 < \frac{(w-1)q}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ \{1, 2\} & \text{if } M - M_0 = \frac{(w-1)q}{(1-\lambda-\rho)(\frac{1}{2}-q)} \\ 2 & \text{otherwise} \end{cases} \tag{12}$$

The results in Part II are obtained using the same reasoning as in Part I. ■

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Data Availability No data was used for the research described in this article.

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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