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The Provision of Public Goods Under Alternative Electoral Incentives*

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Abstract

We discuss a fundamental trade-off in the political process that can lead to inefficient provision of public goods: politicians may not offer to provide socially desirable public goods because the bene ts of the public good cannot be targeted to voters as easily as pork barrel spending. We study how this inefficiency is affected by alternative ways of conducting elections. We rst compare a winner-take-all system with a proportional system. We then contrast two different ways of electing politicians to nationwide offices: one is majority rule, the other is the system used in U.S. presidential elections: the electoral college.

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1 Introduction

Democratic societies delegate to elected representatives the power to tax and to provide public goods. A common complaint made by citizens and by the press is that a large fraction of public spending is not devoted to genuinely useful public projects, but rather to redistribution and pork-barrel projects. At least part of this redistribution does not seem to be from the rich to the poor, rather it is thought to be a wasteful result of jockeying by candidates for political advantage. Thus, it would be desirable to reduce the money tied up in redistribution, and increase the fraction devoted to public goods.

It has long been known that the political process may lead to an inefficient provision of public goods. Conventional wisdom - presented in textbooks such as Stiglitz [?] - is that the inefficiency comes from the difference between the Samuelsonian optimum and the policy preferred by the median voter.[1] According to this view, the source of inefficiency is voter heterogeneity; democratic provision of public goods would be efficient in a society with identical voters.

This approach assumes exogenous restrictions on the policy space - such as linear taxes - and, as a consequence, ignores a fundamental distortion in majoritarian decision making: politicians have an incentive to tax minorities to target bene ts to a majority. Candidates thus face a trade-off. When public money are funneled to pork-barrel projects, less are available to nance public goods. The bene ts from the public good may be higher on average, but they cannot be targeted to groups of voters as easily as the bene ts from pork barrel projects or pure transfers. We call this a trade-off between efficiency and targetability. The goal of our analysis is to model this trade-off and to explore how alternative ways of electing politicians affect the provision of public goods and the distribution of resources across voters.

To highlight the basic idea, we initially focus on a model that is extremely simple. Two candidates compete for election, by making a (binding) electoral promise to each voter. Candidates only care about the outcome of the election. Voters are homoge-

[1] This idea can be traced back to Bowen [?].

neous: each voter will vote for the candidate promising her the most utility. Candidates are faced with only two possible choices: providing the public good or redistributing money. The public good gives every voter the same utility, and is the efficient choice: social welfare is higher when the public good is provided. Money, however, can be targeted to subsets of voters. Despite this simplicity, the solution is quite rich and a number of interesting issues emerge.

First we show that targetability commands a premium, and therefore the provision of public goods may be inefficient even in a world with identical voters. Then we study two dimensions of the political process. In our model candidates are motivated by some bene ts of holding office. The rst dimension we consider is a comparison of two extreme ways to divide the spoils of office between the two candidates. The rst system is a winner-take-all system, where all the spoils go to the winner. The second system is a proportional system: the spoils of office are split among the two candidates proportionally to their share of the vote. Although these systems seem quite different a priori, it is not obvious that they will generate differences in the incentives to provide public goods. For example, in a standard Downsian model with linear taxes the equilibrium would be the same under either system; both candidates would choose the ideal point of the median voter. Lindbeck and Weibull [?] showed that the two systems lead to the same (efficient) outcome in a world where candidates engage in pure redistribution. Analogously, we show that, absent the public good, our model yields the same prediction under both systems.

The reason the two systems differ in our model re ects a fundamental difference in the incentives they provide to candidates seeking public office. Let us consider the case where one candidate promises to provide the public good. Now, suppose that the opponent tries to defeat him by redistributing money to some majority of voters. The margin of victory of the redistributive plan against the public good declines as the public good becomes more valuable. This is because of the reduction in the number of voters to whom a candidate can promise bene ts that are worth more than the bene ts provided by the public good. When candidates maximize the share of the vote, the margin of victory is very important for it determines candidates' payoff. Hence, in the proportional system the option of redistributing becomes less attractive as the public good becomes more valuable. In contrast, in a winner-take-all system all that matters about a particular redistributive plan is whether it beats the public good: the margin of victory is irrelevant. Thus, in a winner-take-all system the attractiveness of a redistributive plan does not depend on how valuable the public good is, so long as redistribution defeats the public good. We find that the proportional system is more efficient when the public good is very valuable, and the winner-take-all system is more efficient when the public good is not very valuable. We also find that the inequality in the redistribution of resources increases with the value of the public good under both systems.

The second dimension of the political process that we consider involves two different ways of electing politicians to nationwide offices. The first way is to elect the candidate who obtains a majority of votes in a nation-wide electoral district. The second way is to elect the candidate who gets the majority of the votes in the majority of districts. We shall call the second system the *electoral college*. We show that the electoral college generates a more unequal distribution of resources and less efficient provision of global public goods. The reason for the difference is the following. If the electorate is made up of a single district, candidates only need to worry about "fending off" attacks by the other candidates on the majority of voters. In the electoral college system candidates need to worry about the other candidate going after 1/4 of the voters: 1/2 of the voters in 1/2 of the districts. This creates the need to concentrate promises on smaller groups of voters and means that the relative inflexibility in the targeting of the benefits from public goods must now lead to even worse inefficiency.

2 Related literature

A comprehensive survey of the literature is in Persson and Tabellini [?]. Most of the literature on the inefficiency of democracy focuses on decision making in legislatures.[2] For instance, Baron [?] models the legislative process via a sequential bargaining model. These models analyze speci c, very structured legislative processes; they do not address candidates competing in large elections, and they cannot compare electoral systems. In this vein is Chari *et al.* [?], where policy is determined through bargaining between a president and local representatives. This gives rise to a common pool problem whereby an excessive number of local public projects are nanced from general taxation (see also Weingast *et al.* [?]). Similarly, Persson, Roland, and Tabellini [?] compare congressional and parliamentary systems. In their model, the politician choosing the level of public good provision has the option of foregoing the public good and appropriate the money for his own district; once again, a common pool problem arises. Our setup differs from these models. In our model, policy is made by candidates not representing any speci c district: when proposing to increase transfers to a district, our candidates take into account the loss of another district. Thus, nationwide candidates mitigate the common pool problem by internalizing, in part, the costs of providing pork-barrel projects.

There is work comparing the effects of alternative electoral systems on the distribution of resources, in the absence of a public good. Myerson [?] studies redistributive politics under alternative electoral systems when there is competition among more than two candidates. In Brams and Davis [?] and Snyder [?], candidates redistribute resources across electoral districts. When the environment is asymmetric, the two systems - winner-take-all and proportional representation - yield different outcomes. All these models are purely about redistribution, hence they do not yield welfare implications.

[2] An exception is Coate and Morris [?], who focus on the fact that politicians have private information on the effects of government policy.

3 The model

Our setup does not restrict the set of feasible transfers in any way except to require that they satisfy a budget constraint. Myerson [?] introduced this model (without the public good) to study redistributive politics.

3.1 Economy and Agents

There are two candidates, 1 and 2. There is a continuum of consumers/voters; the set of voters is denoted by V which can be taken as the interval $[0, 1]$.[3] There are two goods, money and a public good. The public good can only be produced by using all the money in the economy.[4]

Each voter has an endowment of one unit of money. The public good yields a utility of G to each voter. Voters have no a priori preference for either candidate, and have linear utility over goods.[5]

Candidates make binding promises to each voter. A candidate can offer to provide the public good (to all voters); alternatively, he can offer different taxes and transfers to different voters. Because a candidate s promise is only relevant if he gets elected, each voter s optimal behavior is to vote for the candidate who promises her the greatest utility.

[3] This is a convenient assumption because it will allow us to invoke the law of large numbers on a number of occasions. This is meant to be an approximation for a game with a large (but nite) number of voters.

[4] This assumption is relaxed in section 6.

[5] This assumption is made solely to simplify the notation and presentation of the results; all the results hold for any increasing utility function. Thus, we will feel free to interpret the results for the case in which voters are risk averse.

3.2 Electoral Systems

In our model, candidates are motivated to run by the prospect of spoils of office. We discuss two alternative electoral systems, characterized by how these spoils are divided between candidates.

A *proportional system*, where the spoils are divided proportionally to the candidates share of the vote. Thus, candidates maximize the share of the vote.

A *winner-take-all system*, where all the spoils go to the winner. Thus, a candidate s payoff in the winner-take-all is 0 if his share of the vote is less than 1/2, 1 if it is greater than 1/2, and 1/2 if the share of the vote is exactly 1/2.

3.3 Game

A pure strategy for a candidate speci es whether he chooses to offer the public good or pure transfers (he cannot offer both, but see section 6 for a model where this is possible). In the event he chooses transfers, a pure strategy speci es a promise of a transfer to each voter. Formally, a pure strategy is a function $\Phi : V \to [-1, +\infty)$ that satis es the following condition: either $\Phi(v) = G - 1$ for all $v \in V$, or $\int_V \Phi(v)dv = 0$. This is a balanced budget condition. $\Phi(v) + 1$ represents the utility enjoyed by voter v.

There are two stages of the game:

Stage 1 Candidates choose offers to voters simultaneously and independently.

Stage 2 Each voter v gets offers $\Phi_1(v), \Phi_2(v)$ from candidates 1 and 2. After observing the offers, voter v votes for candidate i if $\Phi_i(v) > \Phi_h(v)$. If the voter gets the same offer from both candidates, she randomizes with equal probability.

A mixed strategy in this game could in principle be a very complicated object since the space of pure strategies is so large. However, it turns out that we only need to look at simple distributions. In this paper we discuss the case where the offers of transfers made by candidate i to voters are realizations of the same random variable with c.d.f. $F_i : \Re \to [0, 1]$. Of course, the fact that offers are realizations of the same random variable does not mean that each voter gets the same offer. Note also that at stage 2 each voter observes her realized promises, not random variables.

Because there are in nitely many voters, F_i will be the empirical distributions of offers in the electorate; $F_i(x)$ is the fraction of voters who receive promises below x from candidate i. By manipulating F_i, candidate i is able to target transfers to sections of the populations. In the following sections we therefore reduce the representation of a mixed strategy to the probability of offering the public good (denote this by α_i) and the distribution of transfers $F_i(\cdot)$ under candidate i s strategy if he chooses to offer transfers. The budget constraint then is $\int_{-1}^{\infty} x dF_i(x) = 0$. The lower support of integration is explained by the fact that voters cannot be taxed more than their endowment.

Let $S(F_i, F_h)$ denote the share of the vote of candidate h if he promises to transfer according to F_h and candidate i promises to transfer according to distribution F_i. The share of the vote of candidate h is equal to the probability that any random voter receives an offer from h which is higher than the offer she receives from i. Thus,

$$S(F_i, F_h) = \int_{-1}^{\infty} F_i(x) dF_h(x)$$

The game among candidates is constant sum and symmetric under either assumption on candidates objectives. Hence, in equilibrium both candidates must get 50 % of the votes in expectation.

4 Winner-take-all vs. Proportional System

If $G > 2$, then under either assumption on candidates objectives the unique equilibrium involves both candidates promising to provide the public good. To see this observe that if candidate i offers the public good, he ties in the event candidate h also offers the public good, and wins if candidate h offers transfers since, because of the budget constraint, candidate h cannot offer more than $G - 1 > 1$ to more than 50% of the voters. Conversely, if candidate i chooses to offer money he gets less than 50% of the votes in the event that the other candidate offers the public good.

Section 4.1 describes the benchmark case where $G < 1$, hence provision of the public good is dominated by a strategy of offering the same (zero) transfer to every voter.

Section 4.2 and 4.3 analyze the interesting parameter range, when $1 < G < 2$. In this case there is no equilibrium in pure strategies. To show this, suppose candidate i s strategy was Φ_1. If $\Phi_1(v) = G - 1 \; \forall v$, i.e. candidate 1 promises each voter the public good, then candidate 2 can choose to promise more than $G - 1$ to more than 50% of the voters and obtain more than 50% of the votes. This is impossible in equilibrium. Suppose then that candidate 1 chooses to offer money. Now candidate 2 could take a set of voters V_1 with small positive measure such that $\Phi_1(v) > -1$ for $v \in V_1$, tax all their endowment and use the money to nance offers of $\Phi_1(v) + \epsilon$ to all other voters. The set V_1 and the ϵ can be chosen so that candidate h wins with a share of the vote arbitrarily close to one hundred percent.

Section 4.2 describes the mixed strategy equilibrium of the game when the election is run under a winner-take-all system, i.e. when candidates care only about winning. Section 4.3 does the same when the rewards depend on the vote share, i.e. candidates maximize the share of the vote. We want to stress that there is a natural interpretation for these mixed strategies: choosing F should be thought of as choosing the Lorenz curve, i.e. the empirical distribution of transfers, in the population.

4.1 The Game of Pure Redistribution

Before discussing how the provision of public goods differs in the two systems it is useful to show that the equilibrium in the game of pure redistribution is the same under the two systems.

Proposition 1 *(Myerson). Suppose $G < 1$. Then the unique equilibrium under the winner-take-all and proportional systems involves both candidates drawing offers to all* *voters from a uniform distribution on* $[-1, 1]$. *Thus,*

$$F_i(x) = \begin{cases} 0 & \textit{for } x \leq -1 \\ \frac{x+1}{2} & \textit{for } -1 \leq x \leq 1 \quad \textit{for } i = 1, 2 \\ 1 & \textit{for } 1 \leq x \end{cases} \tag{1}$$

Proof: Let us show that this is an equilibrium. First, notice that the share of the vote from offering the public good is $F_i(G-1) < F_i(0) = 1/2$, so offering the public good yields less than 50% of the votes. Suppose now F_1 satis es equation 1, and candidate 2 offers money according to a distribution F. To satisfy the budget constraint it must be $\int_{-1}^{\infty} x dF(x) = 0$. We then have:

$$S(F_1, F) = \int_{-1}^{\infty} F_1(x) dF(x) \leq \int_{-1}^{\infty} \frac{x+1}{2} dF(x) = \frac{1}{2} = S(F_1, F_2)$$

The second-to-last equality holds because of the budget constraint. Therefore deviation cannot increase the share of the vote for candidate 2. For a proof of uniqueness see Myerson (1993) and Lizzeri (1997). ∎

Notice that in this game candidates will choose to tax and redistribute even when no public good is provided at equilibrium. This is in contrast with the standard, median voter, models of democratic provision of public goods. This contrast is due to the fact that in our model the redistributive tools of candidates are not restricted to linear taxes.

When voters are risk-neutral, the outcome of the political process is efficient: since $G < 1$ citizens value money more than they value the public good, and they do not mind the risk involved in the redistribution process.

4.2 A winner-take-all System

Theorem 2 *Suppose* $1 < G < 2$. *Under the winner-take-all system the unique equilibrium involves a constant probability of providing the public good;* $\alpha(G) = 1/2$ *for* $G \in (1, 2)$. *The equilibrium distribution of money for both candidates is the following:*

$$F^*(x) = \begin{cases} 0 & for\ x \leq -1 \\ \frac{1}{2}\left(\frac{x+1}{2-G}\right) & for\ -1 \leq x \leq 1-G \\ \frac{1}{2} & for\ 1-G \leq x \leq G-1 \\ \frac{1}{2}\left(1+\frac{x+1-G}{2-G}\right) & for\ G-1 \leq x \leq 1 \\ 1 & for\ 1 \leq x \end{cases} \tag{2}$$

When $G > 2$, the unique equilibrium is to offer the public good for sure: $\alpha(G) = 1\ \forall\ G\ \in\ (2, \infty)$.

Proof: **Case** $1 < G < 2$: We want to show that this is an equilibrium. First, the strategy F^* is feasible since the average sum spent is $\int_{-1}^{\infty} xdF^*(x) = 0$. Suppose candidate 2 follows the equilibrium strategy: then the share of the vote of a candidate 1 who redistributes according to F, and meets candidate 2 who promises transfers is:

$$S(F^*, F) = \int_{-1}^{\infty} F^*(x)dF(x). \tag{3}$$

When F is a best-response, it is never the case that the offers of candidate 1 fall outside candidate 2 s support: formally, $F(-1) = 0$ and $F(1) = 1$. The share of the vote accruing to candidate 1 (expression (3)) is

$$S(F^*, F) =$$
$$\frac{1}{2}\left[\int_{-1}^{1-G}\left(\frac{x+1}{2-G}\right)dF(x) + F(G-1) - F(1-G) + \int_{G-1}^{1}\left(1+\frac{x+1-G}{2-G}\right)dF(x)\right] =$$
$$\frac{1}{2}\left[\frac{M_1+M_2}{2-G} + \frac{1-G}{2-G}\left[F(G-1) - F(1-G)\right] + \left(1-\frac{G}{2-G}\right)(1-F(G-1)) + \frac{1}{2-G}\right]$$

where

$$M_1 := \int_{-1}^{1-G} xdF(x)$$

and

$$M_2 := \int_{G-1}^{1} xdF(x)$$

are the total transfers generated by promises in the interval $[-1, 1-G]$ and $[G-1, 1]$, respectively. It is obviously never a best response to promise anything in $(1-G, G-1)$ nor is it optimal to promise $G-1$ to any positive measure of voters: indeed, any strategy that promises $G-1$ to a mass m of voters is dominated by one that is identical, except that ε of the voters previously being offered $G-1$ are now offered $1-G$, and the remaining $m-\varepsilon$ are offered $G-1+\delta$. Thus, we can safely restrict to checking those deviations F for which $F(G-1)-F(1-G)=0$. The above expression then reads

$$S(F^{*},F)=\frac{1}{2}\left[\frac{M_1+M_2}{2-G}+2\left(\frac{G-1}{2-G}\right)F(G-1)+\left(1-\frac{G}{2-G}\right)+\frac{1}{2-G}\right] \qquad (4)$$

The problem of candidate 1 is to choose an F under the constraint that $M_1+M_2\leq 0$ (budget constraint). First, clearly the candidate will choose to make $M_1+M_2=0$. Second, whenever $F(G-1)<\frac{1}{2}$ we have $S(F^{*},F)<\frac{1}{2}$, so candidate 1 is sure to lose against redistribution (but to win against the public good); whenever $F(G-1)>\frac{1}{2}$, the candidate is sure to win against redistribution but is sure to lose against the public good. Finally, when $F(G-1)=\frac{1}{2}$ the candidate ties against the public good and against redistribution. Since $\alpha=1/2$, the candidate is indifferent between any F such that $M_1+M_2=0$.

Case $G>2$: straightforward, since redistributing resources cannot give utility greater than G to more than 50% of the voters.

Uniqueness: see Appendix **??**. ∎

4.3 A Proportional System

We now discuss the system where candidates maximize the share of the vote.

Theorem 3 *Suppose* $1<G<2$. *Under the proportional system the unique equilibrium involves the following probability* β *of providing the public good;* $\beta(G)=G-1$ *for* $G\in(1,2)$. *The equilibrium distribution of money for both candidates is the same as in theorem 2.*

When $G>2$, *the unique equilibrium is to offer the public good for sure:* $\beta(G)=1\;\forall\, G\in(2,\infty)$.

Proof: **Case** $1 < G < 2$: Equation (4) makes clear that F^* would be part of a mixed strategy equilibrium if candidates were maximizing the share of the vote. To see this, assume that candidate 1 were maximizing the expected share of the vote, and let β be the probability of producing the public good at the equilibrium. When playing against F^*, candidate 1 only needs to worry about $F(G-1)$: the rate at which his share of the vote increases as $F(G-1)$ increases is $\frac{G-1}{2-G}$. When playing against the public good, candidate 1 s share of the vote is $1-F(G-1)$. We need the expected share of the vote,

$$(1-\beta)\left(\frac{G-1}{2-G}\right)F(G-1)+\beta\left(1-F(G-1)\right)+const$$

to be independent of $F(G-1)$, which happens for

$$\left(\frac{G-1}{2-G}\right)=\frac{\beta}{1-\beta}.$$

Solving for β concludes the proof.

Case $G > 2$: identical to Theorem 2.

Uniqueness: see Appendix **??**. ∎

4.4 Discussion and Comparison

The distribution of money across voters is the same in both systems and is illustrated in the gure. The degree of inequality in the candidates platforms increases as the public good becomes more valuable (G grows). This is because for a candidate to be indifferent between providing the public good and distributing money, the other candidate has to offer more than $G-1$ to 50% of the voters.

The probability of provision of the pubic good in the winner-take-all model is independent of G for $1 < G < 2$. When candidates maximize the share of the vote the equilibrium probability of providing the public good $\beta(G)$ is not constant in G : β goes from 0 to 1 as G increases from 1 to 2. This distinction is a consequence of the different incentives that candidates face under the two systems. In the proportional system a

Figure 1:

candidate cares about the margin of victory whereas in the winner-take-all system the candidate only cares about getting more than 50% of the votes.

We shall now give a more detailed intuition for the logic of Theorems 2 and 3. Suppose candidate 2 follows the equilibrium strategy and candidate 1 contemplates a deviation. There are two relevant events: (1) candidate 2 is offering the public good, (2) candidate 2 is redistributing money according to equation 2. If candidate 1 only worried about event (1) or event (2) in isolation we know that he would have a pro table deviation. If he only thinks about event (1) he can choose to go after the public good , which, as we saw above, involves offering more than $G-1$ to more than 50% of the voters. If he only worried about event (2) he can choose to go after the money. This is because the distribution in equation 2 is an inefficient way to redistribute money in the absence of the public good. Observe that there are no voters who are offered money in the interval $[1-G, G-1]$. Thus, offering $G-1$ to a voter is wasteful: candidate 2 could offer him $1-G$ and get the vote with the same probability but save money that can be employed to buy the votes of someone else.

The reason it does not pay for candidate 1 to deviate is that it is impossible to go simultaneously after the public good and after money. The deviation that pays against the public good hurts against money and the deviation that pays against money hurts against the public good. The equilibrium probability that the public good is provided balances these forces to make candidate 1 indifferent between going after money and going after the public good hence willing to play the equilibrium strategy. This probability must be different in the two systems because the payoff from deviation is different. In the winner-take-all system, going after money and going after the public good yield the same outcome: victory in event (1) and loss in event (2) or viceversa. Thus, the two events must be equally likely explaining the fact that $\alpha(G) = 1/2$. In the proportional system, the payoff of both options changes with G since the candidate cares about the potential margin of victory upon deviation. The gain from going after money is large when G is large and small when G is small. The margin of victory in going after money increases with G. Thus, the probability of providing the public good must change with G, rising from 0 to 1 as G goes from 1 to 2.

This discussion suggests that the details of our model are not essential for the results. What matters is that, when confronted with an opponent who promises the public good, the attractiveness of the option of redistributing resources is different in the two systems.

4.5 Efficiency and Constitutional Design

We are now in a position to compare electoral systems. We take the point of view of a voter who evaluates the two systems before receiving an electoral promise. Such a voter compares the two systems according to the probability distribution on outcomes that they induce. When $G < 1$ and $G > 2$ the equilibrium is the same under the two systems, so we can concentrate on the case where $1 < G < 2$.

The Samuelsonian condition requires that the public good be provided if and only if $G > 1$. Since each candidate is equally likely to get elected, the probability of provision of the public good is $1/2$ in the winner-take-all system and $G - 1$ in the proportional system: when $G < 3/2$ the probability of provision is higher in the winner-take-all system, when $G > 3/2$ it is higher in the proportional system. Thus, when $G > (<)\, 3/2$

the proportional (winner-take-all) system is more efficient.

If voters are risk-averse, they care not only about the probability of public good provision, but also about the distribution of transfers at equilibrium. However, notice that while the probability of providing the public good may differ in the two systems, the distribution of transfers is the same; furthermore, whenever the outcome of the two systems differ, the bet associated to the public good has higher mean, and lower spread, than the bet associated with transfers. Hence, risk-averse voters are unanimous in their preference for the system that yields higher provision of the public good, just as case of risk-neutrality.

5 The Inefficiency of the Electoral College

In some electoral systems, candidates to national level offices, like president, are selected on the basis of the majority of votes in a nationwide district. This is the system that was discussed in sections 4.2 and 4.3. In other systems, like the United States for presidential elections, the selection is made on the basis of a majority of votes in a majority of districts. Here we argue that the electoral college system is even more inefficient than the systems described in the previous sections in generating incentives for candidates to effectively provide public goods.

The electoral college system is characterized by a winner-take-all rule both at the district level and at the national level. To win, a candidate must obtain more than 50% of the votes in more than 50% of the districts. A district will be denoted by d. For simplicity, we assume a continuum of measure 1 of districts. All districts are identical both in size and in the bene ts they receive from the public good. A strategy must now specify, in the case that redistribution is chosen, the aggregate transfer to each district as well as the distribution inside the district.

The electoral college system is more inefficient than a nationwide winner-take-all system. This increase in the inefficiency is due to the fact that a candidate who offers to provide the public good must now worry about his opponent going after the majority of voters *in the majority of districts*. If $G < 4$, a candidate can offer more than $G-1$ to more than 50% of the voters in more than 50% of the states and zero to the rest. Such a strategy leads to sure victory against a candidate who chooses to offer the public good with probability one. Thus, if $G < 4$ there is no equilibrium where the public good is provided with probability 1.

Theorem 4 *Suppose elections are conducted under an electoral college system. Let μ_i^d be the average transfer offered by candidate i to voters in district d.*

(i) Suppose $G < 1$. In equilibrium candidates never promise to provide the public good, and both candidates make offers to voters according to the following process: each candidate draws μ_i^d from a uniform distribution on $[-1, 1]$. In district d candidate i makes offers to voters according do a uniform distribution on $[-1, 2\mu_i^d - 1]$.

(ii) Suppose $1 < G < 4$. The equilibrium probability of providing the public good is less than or equal to 1/2.

(iii) For $G > 4$, the public good is provided for sure at equilibrium.

Proof: **Part (i)** Take a district where candidate i has dedicated μ_i^d resources and candidate h has dedicated μ_h^d resources. If $\mu_i^d > \mu_h^d$ then, by following the equilibrium strategy, candidate i gets strictly more than 50% of the votes in district i and wins the district. This means that the candidate with more resources in the district gets all the electoral college votes in the district. If $\mu_i^d < \mu_h^d$, party h wins the district, and if $\mu_i^d = \mu_h^d$ then the two candidates split the district equally. Moreover, given μ_i^d, μ_h^d and given the fact that candidate i is distributing the resources uniformly, candidate h cannot do any better than choose a uniform. With any other distribution he would still lose if $\mu_i^d > \mu_h^d$, win if $\mu_i^d < \mu_h^d$ and tie if $\mu_i^d = \mu_h^d$. The fact that candidate h does not know μ_i^d when choosing the optimal distribution of resources in district d does not change the optimality of the uniform distribution.

Let us now consider how candidates distributed resource across districts. By preceding argument, districts behave exactly like voters: if a candidate dedicates more resources to the district he gets the district. Thus, choosing μ_i^d from a uniform distribution on $[-1, 1]$ is part of an equilibrium.

Part (ii) Suppose that candidate 1 was offering to provide the public good with probability greater than 1/2. Since $G < 4$, candidate 2 could offer more than G to more than 50% of the voters in more than 50% of the districts: this leads to an expected payoff strictly greater than 1/2, which is impossible at equilibrium.

Part (iii) Since $G > 4$, when your opponent follows the equilibrium strategy there is no way to use transfers and offer more than G to more than 1/4 of the voters, and that is the minimum share of the vote needed to reach an expected payoff of 1/2. So, offering money is dominated by offering the public good. ∎

In the previous result, we have not proved that an equilibrium exists when $1 < G < 2$. In any nite game that approximates our game, an equilibrium will exist and will exhibit the same qualitative features presented in Theorem 4.

Discussion

The logic of this Theorem 4 (i) is a hierarchical version of the logic of Theorem 1. The forces that generate a uniform distribution in a nationwide election also push toward a uniform distribution in each state. However, it cannot be an equilibrium that all districts get the same resources, for otherwise each district would get one dollar per voter. If this were the case a candidate could deviate by targeting higher offers to a majority of the districts. Thus, there must be an ex post difference in the amount of resources that each candidate offers to voters in different districts. It is then straightforward to apply the same logic to the distribution of resources across districts. This yields a uniform distribution on $[-1, 1]$.

When $G < 1$, there is a big difference between the equilibrium in a nationwide district election discussed in proposition 1 and the outcome described in Theorem 4. This re ects the incentives to go after 25% of the voters in the electoral college system as opposed to going after the majority in a nationwide district. The aggregate distribution of resources is much more unequal in the electoral college system. Recall that in proposition 1 we saw that in a nationwide district voters consumption is distributed uniformly on [0.2]. In the electoral college some voters get to consume as much as 4 while a lot more voters consume less than 1. More formally, the outcome of Theorem 4 is dominated by the nationwide district outcome in the sense of second degree stochastic dominance;[6] thus, whenever voters are risk-averse they will prefer a system with a nationwide district.

The contrast between Theorems 2 and 4 is also remarkable. When $G > 1$, the electoral college system delivers a probability of providing the public good which is not higher than in the nationwide district when $1 < G < 2$, and is strictly lower when $2 < G < 4$.

6 Extension: A Targetable Public Good

All of the previous analysis has proceeded under the assumption that producing the public good requires investing all the resources and that all voters value the public good in the same manner. Thus the bene ts from the public good cannot be targeted at all. We have found this assumption a useful way to introduce our results. However, clever politicians can always nd ways to provide public goods in a way that targets resources to groups of voters. For instance, although the bene ts from national defense are not easily targetable, candidates can use the location of military bases and the award of procurement contracts for weapon systems to create rents for groups of voters. We now extend the analysis to show that our previous results are robust to the introduction of a public good whose production does not need all the resources, one whose bene ts can be targeted to voters, and one whose bene ts are valued in different ways by different voters. We will see that these extensions are closely related.

[6] A random variable A dominates a random variable B is the sense of second order stochastic dominance iff

$$B \sim A + \varepsilon, \text{ with } E(\varepsilon|A) = 0.$$

That is, B is equal, in distribution, to A plus a noise term.

In this section, the model is unchanged except that production of the public good requires only a fraction $I \in (0,1)$ of the total resources in the economy. Thus, providing the public good requires raising I in taxes and gives every voter a utility of at least IG. In contrast to the case described in the previous section, now a candidate who chooses to provide the public good must further specify taxes and transfers since $1-I$ resources in the economy are not pledged to the provision of the public good. This model allows for the possibility that the bene ts from the public good can be targeted but preserves the realistic feature of the previous model that these bene ts cannot be targeted as fully as pure transfers.

In this world, a mixed strategy involves a probability α of providing the public good and two distribution functions: The rst, denoted by F_M and represents how a candidate distributes transfers if he chooses not to provide the public good. The second, F_G represents the way the candidate distributes *utility* to voters when he decides to provide the public good.

The budget constraints are the following:

$$\int_{-1}^{\infty} x dF_M(x) = 0, \quad \int_{-1}^{\infty} x dF_G(x) = I(G-1) \tag{5}$$

and F_G must satisfy the constraint $F_G(x) = 0$ for $x \leq IG - 1$. This constraint says that when a candidate provides the public good the lowest utility any voter can get is $IG - 1$. Let $H = IG + 2(1-I)$. In equilibrium we have:

$$F_G^*(x) = \begin{cases} 0 & \text{for } x \leq IG - 1 \\ \frac{x+1-IG}{2(1-I)} & \text{for } IG - 1 \leq x \leq H - 1 \\ 1 & \text{for } H - 1 \leq x \end{cases} \tag{6}$$

$$F_M^*(x) = \begin{cases} 0 & \text{for } x \leq -1 \\ \frac{1}{2}\left(\frac{x+1}{2-H}\right) & \text{for } -1 \leq x \leq 1 - H \\ \frac{1}{2} & \text{for } 1 - H \leq x \leq H - 1 \\ \frac{1}{2}\left(1 + \frac{x+1-H}{2-H}\right) & \text{for } H - 1 \leq x \leq 1 \\ 1 & \text{for } 1 \leq x \end{cases} \tag{7}$$

Theorem 5 *Assume* $I > \frac{1}{3-G}$. *In the winner-take-all system, the probability of providing the public good is* $\alpha(G) = 1/2\ \forall G \in (1,2)$. *In the proportional system, the probability of providing the public good is* $\beta(G) = H - 1$ *for* $G \in (1,2)$.

Under both systems, we have:

(i) In the event that a candidate offers the public good, candidates distribute utility to voters according to F_G^* *de ned in equation 6.*

(ii) In the event that a candidate does not provide the public good, the distribution is F_M^* *de ned in equation 7.*

Proof: See Appendix **??**. ∎

Discussion

The distribution of transfers de ned in equation 6 is the same as in Theorems 2 and 3 with H replacing G. Thus, the presence of a divisible public good pushes candidates to make their offers more unequal.

The model of this section can easily be adapted to cover the case where voters have heterogeneous valuations for the public good. The case of voter heterogeneity is analogous to the case of a public good whose bene ts can be targeted since both cases generate a situation where different voters get different bene ts from the public good. It is easy to show that, in the proportional system, the probability of provision of the public good increases with the extent of voter heterogeneity; a more heterogeneous population leads to higher provision of the public good.

7 Conclusion

We have presented a political-economic model where the provision of a public good is determined by the electoral incentives of office-seeking candidates. When candidates have the option of redistributing resources instead of using them to provide the public good, the public good will be underprovided relative to the Pareto-optimum. This happens because, while bene ts from the public good may be higher on average, they cannot be targeted to groups of voters as easily as the bene ts from pork barrel projects or pure transfers.

In this setup, we have compared different electoral systems: the electoral college system is always less efficient than a system with a nationwide district. The winner-take-all system is less efficient than a proportional system when the public good is very desirable, and is more efficient when the public good is not very desirable. In both the winner-take-all and in the proportional system, the redistributional platforms that candidates propose become less egalitarian as the public good becomes more desirable.

This model addresses an important feature of political competition, the trade-off between efficiency and targetability. Some of our assumptions are quite strong but serve to simplify the model and make this trade-off emerge very cleanly. The basic force that drives our results is extremely robust, and our model captures several insights which will be common to more elaborate setups. First, the public good will be underprovided in a political equilibrium. Second, different electoral systems give different incentives to politicians to promise to provide the public good. In particular, in a winner-take-all system the inefficiency is less sensitive to the desirability of the public good than in a proportional system; and electoral systems that are subdivided hierarchically into districts provide greater scope for redistribution than nationwide elections.

Of the many simpli cations that make this model easy to analyze, a few are worth elaborating on. First, the assumption that electoral promises are binding is an extreme; in reality a politician cannot perfectly commit to honor his promises. However, all we really need for the model to work is that, given a promise from each candidate, a voter will vote for the candidate who promises her the most. Second, an unrealistic feature of our analysis is that with positive probability some voters are taxed all their endowment, they are fully expropriated. This is a consequence of the assumption that candidates know voters endowments and taxes are non distortionary. If either of these assumptions is relaxed, all voters would retain control of a positive amount of resources. We feel that the most interesting directions for future research involve further explorations of the political process. It would be interesting to try to remove the restriction to two candidates. This would be particularly important for a comparison of proportional representation with rst past the post systems, since these two systems seem to be associated with different numbers of candidates. We have shown that there are differences between the political systems *even* when they have the same number of candidates (two).

A Appendix

A.1 Proof of Theorem 5

Proof: **Step 1: Optimality of** F_M^* the share of the vote accruing to candidate 1 offering money according to F_M, who meets a candidate 2 offering money according to F_M^*, is by the same reasoning as in theorem 2

$$\begin{aligned} S(F_M^*, F_M) &= \\ & \frac{1}{2}\left[\frac{M_{LM}+M_{HM}}{2-H} + \frac{1-H}{2-H}\left[F_M(H-1) - F_M(1-H)\right] + \right. \\ & \left. \left(1-\frac{H}{2-H}\right)(1-F_M(H-1)) + \frac{1}{2-H}\right] \end{aligned}$$

where

$$M_{LM} := \int_{-1}^{1-H} x dF_M(x)$$

and

$$M_{HM} := \int_{H-1}^{1} x dF_M(x)$$

are the total transfer to the lowest and highest interval, respectively. The problem of the candidate is to choose an F_M under the constraint that $M_{LM}+M_{HM}+\int_{1-H}^{H-1} x dF_M(x) = 0$. It is useful to compare with expression 4 in the proof of theorem 2: As in that case, we can immediately argue that a best response will not involve offers in the interval $(1-H, IG-1]$. However, ruling out the possibility of positive offers in the interval $(IG-1, H-1)$ requires more work.

We will rst discuss the proportional case. Suppose F_M is a best response to the equilibrium strategy, and let $M_{MM} := \int_{IG-1}^{H-1} x dF_M(x)$ denote the money spent (or raised) with offers in the interval $(IG-1, H-1)$. By way of contradiction, whenever $\max\{M_{LM}, M_{HM}\} > 0$ we construct a deviation $\widetilde{F_M}$ such that $\widetilde{F_M}(IG-1) = F_M(IG-1)$ and $\widetilde{F_M}(H-1) = F_M(H-1)$, but $\widetilde{M}_{MM} > M_{MM}$: we are able to show that the expected share of the vote using $\widetilde{F_M}$ is greater than when using F_M. This will imply that whenever $\max\{M_{LM}, M_{HM}\} > 0$ it must be that at equilibrium $F_M(IG-1) = F_M(H-1-)$.

In the case where one meets money, increasing M_{MM} to $\widetilde{M}_{MM}$ is purely wasteful: switching to $\widetilde{F_M}$ produces a change in share of the vote of $\frac{1}{2}\frac{M_{MM}-\widetilde{M}_{MM}}{2-H}$. When meeting a public good, the share of the vote is

$$\begin{aligned} S(F_G^*, F_M) &= 1 - F_M(H-1) + \int_{IG-1}^{H-1} \frac{x+1-IG}{2(1-I)} dF_M(x) = \\ & \frac{M_{MM}}{2(1-I)} + \frac{1-IG}{2(1-I)} \left[F_M(H-1) - F_M(IG-1)\right] + 1 - F_M(H-1) \end{aligned}$$

thus switching to $\widetilde{F_M}$ increases the share of the vote by $\frac{M_{MM}-\widetilde{M}_{MM}}{2(1-I)}$. It will pay to increase M_{MM} to $\widetilde{M}_{MM}$ if and only if

$$\frac{1}{2}\frac{(1-\beta)}{2-H} < \frac{\beta}{2(1-I)} \tag{8}$$

In equilibrium, $\beta = H-1$. Substituting this β we can rewrite the previous inequality as follows:

$$1 - I < 1 - I(2-G)$$

which holds for $G > 1$.

In the case of the winner-take-all game, we need to check whether inequality (**??**) holds for $\beta = 1/2$, which is true if and only if $\frac{1}{3-G} < I$. This inequality holds if the share of money left after investing in the public good is sufficiently low.

The above discussion guarantees that whenever $\max\{M_{LM}, M_{HM}\} > 0$, the best response F_M to the equilibrium strategy satis es $F_M(H-1-) - F_M(IG-1) = 0$. It is still possible that putting some mass on $H-1$ is an optimal strategy, but such a strategy can be approximated by a strategy without mass points at $H-1$, for which $F_M(H-1) - F_M(IG-1) = 0$. It will therefore be enough to check for deviations of this latter form. For these deviations, the payoff is identical to the one of equation (4) provided $H-1$ is substituted for $G-1$, and so the computations of Theorems 2 and 3 go through.

Step 2: Optimality of F_G^*: A player who chooses to provide the public good must optimally allocate the remaining $-I$ fraction of transfers, taking into account that he is already providing everyone with utility $IG-1$. It will be simpler to model this choice as one of a distribution F_G with $F_G(IG-1)=0$ and $M_{MG}+M_{HG}\leq -I$, where

$$M_{MG} := \int_{IG-1}^{H-1} (x-IG)\, dF_G(x) \text{ and } M_{HG} := \int_{H-1}^{1} (x-IG)\, dF_G(x)$$

When meeting the public good, the share of the vote is

$$\begin{aligned}
&1-F_G(H-1)+\int_{IG-1}^{H-1} \frac{x+1-IG}{2(1-I)} dF_G(x) = \\
&1-F_G(H-1)+\frac{M_{MG}}{2(1-I)}+\frac{1-IG}{2(1-I)} F_G(H-1).
\end{aligned}$$

When meeting money, the share of the vote is

$$\begin{aligned}
&\frac{1}{2}+\frac{1}{2}\int_{H-1}^{1} 1+\frac{x+1-H}{2-H} dF_G(x) = \\
&\frac{1}{2}\left[1+\int_{H-1}^{1} 1+\frac{x+1-IG+IG-H}{2-H} dF_G(x)\right] = \\
&\frac{1}{2}\left[1+\int_{H-1}^{1} 1+\frac{1+IG-H}{2-H} dF_G(x)+\frac{M_{HG}}{2-H}\right] = \\
&\frac{1}{2}\left[1+\left(1+\frac{1+IG-H}{2-H}\right)(1-F_G(H-1))+\frac{-I-M_{MG}^*}{2-H}\right]
\end{aligned}$$

We can therefore consider a deviation $\widetilde{F}_G$ with $\widetilde{F}_G(H-1)=F_G(H-1)$ and $\widetilde{F}_G(IG-1)=F_G(IG-1)$ much as we did in the previous case, and nd that the same computations hold, so that whenever $M_{HG}>0$ it pays to shift money from the interval $(H-1,1)$ to the interval $(IG-1,H-1)$. Notice now that whenever we have a mass point for $\widetilde{F}_G$ at $IG-1$, we can approximate this with a molli cation for which there are no mass points at $IG-1$, so that we are justi ed in looking for deviations $\widetilde{F}_G$ such that $\widetilde{F}_G(IG-1)=0$. This, together with the above consideration on shifting money, shows that at equilibrium it has to be $F_G(x)=0\ \forall x\in[IG-1,H-1)$ so long as $M_{HG}>0$. But, the budget constraint hits much before that point: hence, at equilibrium it must be that $M_{HG}=0$. Then usual reasonings show that any distribution of $M_{MG}=-I$ on the interval $[IG-1,H-1]$ is an equilibrium, including F_G^*. ∎

A.2 Uniqueness

We shall now prove that the equilibria described in theorems 2 and 3 are unique in the class of equilibria characterized by a probability of providing the public good α_i and a transfer distribution F_i. Let α_i^* and F_i^* denote an equilibrium strategy. Here $1 < G < 2$.

Lemma 6 *For any feasible distribution $F_i(\cdot)$ that is different from a uniform distribution on $[-1, 1]$ there exists a feasible distribution F_j such that $S(F_i, F_j) > 1/2$.*

Proof: See Lizzeri [**?**]. ∎

Lemma 7 *In both the winner take all and proportional system $0 < \alpha_i^* < 1$ for $i = 1, 2$.*

Proof: The fact that $\alpha_i^* < 1$ was already shown in section 3.3. Suppose that $\alpha_i^* = 0$. There are two subcases: Case 1) Suppose that $F_i^*(\cdot)$ is uniform. Then candidate j can offer the public good and obtain a share of the vote that is equal to $G/2 > 1/2$. Thus candidate j gets a payoff above 1/2. Case (2): Suppose that $F_i^*(\cdot)$ is different from a uniform distribution on $[-1, 1]$. Then, by lemma **??**, candidate j can win with probability bigger than 1/2. ∎

Let W_i^* be the upper bound of the support of F_i^*.

Lemma 8 *In both the winner take all and proportional system For all i, (i) $W_i^* = 1$ and (ii) $F_i^*(G) = 1/2$.*

Proof: Suppose W_i^* is strictly below 1. Then candidate j can win more than 50% of the votes by offering slightly more than W_i^* to more than 50% of the voters. Suppose that $W_i^* > 1$, then candidate j can gain more than 50% of the votes against transfers by choosing the distribution in the statement of theorem 2.

Part (ii) is a consequence of the fact that the public good must exactly tie against transfers for $0 < \alpha_i^* < 1$ to be part of an equilibrium. ∎

Lemma 9 *In both the winner take all and proportional system* F_i^* *is strictly increasing and continuous on* $[G-1,1]$.

The proof an analogous result in Lizzeri (1997) works here.

Lemma 10 *In both the winner take all and proportional system* F_i^* *satis es equation 2 on* $(G-1,1)$.

Proof: Let $G-1<x<y<1$. By the previous lemma there is a positive mass of offers close to all these numbers. Candidate j could choose the following strategy: offer money according to F_i^* except when F_i^* is close to x. To a fraction $\eta=(x-G)/(y-G)$ of the voters who were supposed to get offers close to x he offers y instead and to $(1-\eta)$ of these voters he offers $G-1$ instead. This deviation satis es the budget constraint. Since $x,y>G-1$ it does not change the probability of winning against the public good. This deviation should not increase candidate j s share of the vote. Since F_i^* is continuous this requires that, $F_i^*(x)\geq\eta F_i^*(y)+(1-\eta)F_i^*(G)=\eta F_i^*(y)+(1-\eta)1/2$. We also obtain the reverse inequality since candidate j could shift to close to x voters such that η of them were supposed to get y and $1-\eta$ of them were supposed to get close to $G-1$. Substituting η we obtain

$$F_i^*(x)=\frac{(x-G)F_i^*(y)}{(y-G)}+\frac{(y-x)}{2(y-G)}$$

Which can be rewritten as:

$$\frac{F_i^*(x)}{x-G}=\frac{F_i^*(y)}{(y-G)}+\frac{(y-x)}{2(y-G)(x-G)} \tag{9}$$

The distribution in the statement of theorem 2 satis es equation 2. If F_i^* is not the distribution described in theorem 2, it is always possible to nd x,y such that $G-1<x<y<1$ and equation 2 is violated. ∎

Lemma 11 *In both the winner take all and proportional system* F_i^* *satis es equation 2 on* $[-1,1-G]$.

Proof: It is possible to use the proof in Lizzeri (1997) to show that F_i^* must be uniform on $[-1, b]$ for some $b \leq G - 1$. Now, recall that F_i^* is also uniform on $[G - 1, 1]$ by Lemma **??**, and that $F_i^* (G) = 1/2$ by Lemma **??**: the budget constraint then requires that $b = 1 - G$. ∎

Corollary 12 *In both the winner take all and proportional system F_i^* is the distribution described in equation 2.*

Lemma 13 *In equilibrium the probability of providing the public good is 1/2 in the winner-take-all system and $G - 1$ in the proportional system.*

Proof: Consider rst the winner-take-all system. It is obvious that $\alpha_i^* \leq 1/2$. Suppose that $0 < \alpha_i^* < 1/2$. Candidate i can win with probability one against transfers by moving money from $[G-1, 1]$ to $[-1, 1-G]$ since candidate i offers money in $[1-G, G-1]$ with probability zero. This leads to a payoff higher than 1/2 for candidate j which is a contradiction.

Consider now the proportional system. The statement is a consequence of the proof of theorem 3. ∎

This lemmata allows us to conclude that equilibrium is unique.

Proposition 14 *Equilibrium is unique both in the proportional and winner take all system and is described in theorems 2 and 3.*

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