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Public debt and the political economy of reforms*

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Abstract

We consider a two-period model of redistributive politics in which two office-motivated politicians have the possibility *both* to raise debt and to implement a reform creating a net increase in the total taxable endowment. The costs of the reform are incurred in first period, whereas the benefits occur in the second period. Both benefits and costs can be perfectly redistributed across voters. Voters are perfectly forward-looking and ex-ante homogeneous. We show that the reform is always implemented only when sufficient debt can be raised. A limit on debt sufficiently more restrictive than the natural limit will prevent the implementation of the reform. Such a debt limit forces the reforming candidate to pursue an overly egalitarian strategy of redistribution making it possible for a non-reforming candidate to win a majority of voters.

Keywords: Political Competition; Public Debt; Reforms; Redistributive Politics; Electoral Rules.

JEL classification: C72; D72; D78; H6.

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1 Introduction

Why does the political process fail to deliver beneficial reforms? This puzzle has dominated the academic and policy sphere over the last decades.¹ A key to shed some lights on this puzzle is to understand under which circumstances electoral incentives can stand in the way of implementing such reforms. Our focus is to understand the determinants of reforms in an environment where the reform is given its best chance to go through the political process: We consider a reform that costs some resources today but generates more resources in the future, that is the reform increases the size of the redistributive pie. Politicians are interested in having as many resources as possible to target voters and they can perfectly redistribute resources across voters within each period. In principle, the electoral incentives of politicians are therefore in line with the implementation of the reform, as long as the total increase in resources translates into an increase in the amount of resources that can be targeted to current voters.

We show that public debt is the decisive factor determining whether electoral incentives indeed promote the implementation of reform or whether they discourage it. Public debt allows politicians to transform future reform benefits into resources that can be targeted to today's voters. Due to uncertainty about the outcome of future elections, voters evaluate resources left in the future as a public good benefiting all voters. In contrast, resources available today can be perfectly shifted across voters. Such targetable resources are more valuable for convincing a majority of voters than non-targetable benefits. Therefore, the electoral incentives of politicians are in line with the implementation of the reform, as long as debt allows to make enough of the increase in the pie targetable to voters. When public debt is restricted, the non-targetable nature of future reform benefits makes it difficult for a reformer to win against a non-reforming candidate. Without debt, a politician cannot commit to enough present-day redistribution to sustain the implementation of pie-increasing reforms in electoral competition.

More precisely, we study the implementation of a reform in an environment where two office-motivated politicians run for election. There are two periods and the same politicians run for election in each period. In the first period they can redistribute available resources in the electorate and also implement a reform that costs some resources today but generates more resources tomorrow. This reform therefore creates a net increase in the total taxable endowment and its benefits and costs can be perfectly shifted across voters in the period in which they occur. As argued above, one might expect that politicians that are interested in targeting electoral favors to a majority of voters should

¹See for instance Williamson (1994), Tommasi and Velasco (1996), Rodrik (1996), Persson and Tabellini (2000), and Drazen (2000).

be interested in implementing such pie-increasing reform.

We prove two main results. First, when there are no restrictions on public debt except for the natural debt limit then the pie-increasing reform is always implemented in the equilibrium of the electoral game. The same holds when the restriction on debt is not too stringent in the sense that the amount of debt that can be raised under reform is sufficiently higher than the amount of debt that can be raised without reform. This result confirms the conjecture that pie-increasing reforms should be implemented in political equilibrium when debt can be raised. Any non-reforming candidate will be at a disadvantage because she has less resources available out of which she can finance electoral favors.

Our second result shows that this result is overturned once the restriction on debt becomes too stringent. In particular, when the more in public debt that a reforming candidate can raise is too small, then she comes at a disadvantage to the non-reforming candidate. In particular, the strict debt limit makes the per-se perfectly targetable reform benefits acquire the character of a public good from the point of view of voters in the first electoral period. On the one hand, voters perfectly know the size of future reform benefits, but on the other hand, they cannot be certain about the outcome of the electoral game of redistribution in the future electoral period. This means that from their point of view, future reform benefits that cannot be transferred to the present have the character of providing a public good that promises higher utility for everyone, but whose benefits cannot be targeted to specific voters. A non-reforming candidate does not have to cover the costs of the reform. This gives him leeway in the first-period budget to make offers to a majority of voters that more than compensates them for not receiving the expected value of the reform benefits in the future. Basically, the stringent debt limit forces the reforming candidate to propose an overly egalitarian strategy of redistribution. That is, while she can recur to a bigger pool of available resources, the reformer is forced to spread this bigger pie too equally across voters. In contrast, the non-reforming candidate can better skew his smaller amount of resources and win a majority of voters against the reformer.

We proceed as follows. Section 2 discusses the related literature. Section 3 describes the formal framework. Section 4 solves for the Nash equilibrium in the last period. Our main results are presented in Section 5 where we solve for the equilibrium in the first period. Section 6 clarifies how alternative modeling choices would affect our results. In particular we extend our model to a three-period setup and we compare the policy outcomes of vote-share maximizing and winner-take-all systems. The last section contains concluding remarks. We relegate all proofs to the Appendix.

2 Related literature

Our work builds on the game-theoretic literature on the “divide-the-dollar”-game. Following Myerson (1993), this literature features models of political competition in which a policy proposal specifies how a cake of a given size should be distributed among voters.² Our model differs from these models in that policy proposals affect the size of the cake that is available for redistribution.³

Lizzeri and Persico (2001) extend the framework of Myerson (1993) by characterizing political equilibria under the assumption that politicians face a choice between a public good and pork-barrel redistribution. The tradeoff they identify between targetable and non-targetable policies is also present in our analysis: Even if we start with a reform that is purely targetable, restrictions on debt create a public good aspect of the reform for the first-period election.

The first extension of Myerson (1993)’s setup to a dynamic model was done by Lizzeri (1999). Lizzeri (1999) shows that in a two-period model of “divide-the-dollar” electoral competition, candidates will always raise the maximal debt, because it allows them to better target the pool of resources to voters. Our analysis builds on Lizzeri (1999) by studying the interaction between debt and reform in such a redistributive politics setup. This setup allows to distil the pure effect of electoral competition on policy outcomes, because it does not impose any exogenous heterogeneity on politicians or voters. Furthermore, it derives political turnover endogenously as the outcome of the electoral game. In contrast, the literature on strategic debt has derived the tendency of the political process to accumulate debt from partisan preferences combined with the exogenously imposed threat that a currently ruling government is replaced in the future. Alesina and Tabellini (1990) show that a currently ruling party that has different spending objectives than a potential future incumbent uses debt to bind its successor’s hands.⁴ Recently there has been a revival of the literature on the political economy of public debt. Battaglini and Coate (2008) introduce Barro (1979)’s tax smoothing setup of public debt into an infinite horizon model of legislative bargaining. Similar to Alesina and Tabellini (1990) they show that, when a district is not sure to remain in the governing coalition, the incentive

²Contributions to this literature include Laslier and Picard (2002), Roberson (2006), Sahuguet and Persico (2006), Carbonell-Nicolau and Ok (2007), Kovenock and Roberson (2009), Crutzen and Sahuguet (2009). See Kovenock and Roberson (2012) for a review.

³Recent paper that also endogenize the size of the redistributive pie are Bierbrauer and Boyer (2014) and Boyer and Konrad (2014), however these papers are static and do not study the interaction between debt and reforms.

⁴Other early papers in this line of research are Persson and Svensson (1989) and Tabellini and Alesina (1990).

of politicians to spend pork on their own district leads to the use of public debt even when this means accepting higher tax distortions in the future.⁵ Except for few papers to be discussed shortly, most of the literature on the political economy of public debt has neglected the interaction between public debt and growth-enhancing reforms. Specifically, debt might be necessary to incentivize politicians to pursue pie-increasing reforms. Building on the model of endogenous political turnover following Myerson (1993), we can establish this interaction with a minimal recurrence to exogenously imposed driving forces of political decisions.

By doing this, we also contribute to the large literature on political economy of reforms. In this paper we shut down the channels that the previous literature has identified as impediments to reform.⁶ Our objective is to show how growth-enhancing reforms and debt interact in a political economy setup, absent all the previously identified channels. The previous papers that have looked at this interaction work with the partisan preferences setup building on Alesina and Tabellini (1990). Beetsma and Debrun (2004, 2007) rely on the assumption of an exogenous probability of change in political power. They do not consider a feedback of the decisions on debt and reform on the electoral outcome. Ribeiro and Beetsma (2008) go a first step towards endogenizing political turnover. However, they still need to add a final period with exogenous probability of change in power. Furthermore, only one politician runs a reform platform and she cannot decide not to reform, while her opponent is exogenously set to run a no-reform platform. In contrast, in this paper all politicians compete using *both* the decision to reform and the public debt level in order to win an election. The probability of reform is thus derived from an optimizing decision of politicians competing for election. This allows us to answer the question when politicians have an incentive to go for a reform in the first place and how their electoral incentives to raise public debt interact with this decision to reform.⁷

⁵Further papers with different setups are Yared (2010) and Song et al. (2012). For a survey of these recent contributions see Battaglini (2011).

⁶In contrast to Fernandez and Rodrik (1991) and Cukierman and Tommasi (1998), our analysis does not link the benefits and costs of reform to specific voters. Furthermore, we have no uncertainty regarding appropriate timing of the reform as in Laban and Sturzenegger (1994b,a) and Mondino et al. (1996). Reforms do not fail because of insufficient technical knowledge by decision makers as in Caselli and Morelli (2004) and Mattozzi and Merlo (2007). We also exclude powerful vested interest that could block reform as in Olson (1982), Benhabib and Rustichini (1996) and Gehlbach and Malesky (2010). There is no conflict between different groups about who will bear the costs of reform as in Alesina and Drazen (1991), Drazen and Grilli (1993) and Hsieh (2000). Finally, the success of the reform does not depend on the competence of politicians as in Prato and Wolton (2014).

⁷Esslinger and Mueller (2015) is another recent paper investigating the interaction of public debt and future investments of the state. It introduces public debt into the model of state building by Besley and Persson (2009, 2010, 2011). Esslinger and Mueller (2015) show that the possibility to raise debt can incentivize investments in fiscal and in growth-enhancing infrastructure.

3 The model

The electorate. There are two periods and a continuum of voters of measure 1. Voters are risk-neutral, live for the two periods, and have a discount factor equal to 1. All voters are identical and in each period have 1 unit of money which is perfectly divisible.

Political process. In each period there is an election where voters choose between two candidates. The set of candidates is the same at both dates. One candidate is denoted by A , the other by B . Each candidate $i \in \{A, B\}$ is purely office-motivated. In the core of the analysis we assume that the politicians maximize their vote-shares, akin to a proportional system.⁸

Policies. Electoral competition takes the form of promises of taxes and transfers to each individual voter. These promises are associated to a level of debt in order to finance them (if needed), and the decision to pursue a reform. The candidates may use mixing and can choose random distributions from which the actual promises to voters are drawn. We denote the cumulative distribution functions of these random distributions as $F^i(\cdot)$, $i \in \{A, B\}$. Specifically, we follow Myerson (1993) and assume that the favors offered to different voters are *iid* random variables with probability distribution F . We appeal to the law of large numbers for large economies and interpret $F(x)$ not only as the probability that any one individual receives an offer weakly smaller than x , but also as the population share of voters who receive such an offer.

The possibility to enact a reform is present only in the first period. The cost of this reform is incurred in the first period and the benefit occurs in the second period. We make the following assumptions:

$$1 > e - c > 0, \tag{A1}$$

$$1 > c, \tag{A2}$$

where e is the per capita benefit from the reform and c is the per capita cost. Assumption (A1) states that reform is beneficial and that the net benefit of the reform is lower than the endowment of the economy. Assumption (A2) ensures that the first-period endowment is enough to finance the reform.

The government debt is financed by borrowing from abroad and there is no possibility of default. The size of the deficit in the first period is interpreted as the fraction of the average voter's period 2 resources that is pledged to the repayment of the debt.⁹

⁸We discuss how a change to a winner-take-all or majoritarian system where candidates maximize their winning probabilities would affect our results in Section 6.

⁹We also allow for the possibility of a surplus which will, however, never occur in equilibrium.

There is a natural limit on debt that corresponds to the total resources that can be mobilized to repay debt. Formally, the debt level δ belongs to $[-1, 1]$ in case no reform is undertaken. The lower bound represents the case where the maximal budget *surplus* of 1 is run and transferred from the first to the second period. The upper bound represents the case where the total amount of resources available in the second period is transferred to the first period. Since the reform increases the resources in the second period, when the reform is undertaken it raises the resources that can be brought to the present by debt. Hence, the upper bound of δ increases when the reform is undertaken so that δ belongs to $[-1, 1 + e]$.

Later on in the analysis, we also introduce the possibility that the amount of debt that can be incurred is (exogenously) restricted. Such a restriction can be interpreted as a constitutional debt limit. We denote by $\bar{\delta}$ the (first-period) debt limit. We assume that $\bar{\delta} \geq 1$.¹⁰

Formally, a first-period policy of candidate i consists of a quintuplet

$$p_1^i = (\beta^i, \delta_R^i, \delta_N^i, F_{1,R}^i, F_{1,N}^i),$$

where β^i is the probability of doing the reform, $\delta_R^i \in [-1, \min\{\bar{\delta}, 1 + e\}]$ and $\delta_N^i \in [-1, \min\{\bar{\delta}, 1\}]$ represent the deficit level when the reform is or is not enacted respectively,¹¹ and $F_{1,R}^i$ and $F_{1,N}^i$ are cumulative distribution functions for the case where the reform is or is not enacted, respectively. The subscript R (resp. N) indicates that the reform is (resp. not) undertaken.

A second-period policy p_2^i of candidate i consists only of the choice of the cumulative distribution function F_2^i .

Feasible policies. Policies are feasible if they satisfy the following budget constraints.

First-period budget constraint:

if the reform is not undertaken,

$$\int_{-1}^{+\infty} x dF_{1,N}^i(x) = \delta_N^i; \quad (1)$$

if the reform is undertaken,

$$\int_{-1}^{+\infty} x dF_{1,R}^i(x) = \delta_R^i - c; \quad (2)$$

¹⁰Allowing $\bar{\delta}$ to go below 1 increases the number of cases to consider without providing additional insights. In particular, the case $\bar{\delta} < 1$ exhibits the same properties as the case $\bar{\delta} = 1$.

¹¹As will show our analysis below, in equilibrium there is only going to be pure strategies concerning the deficit level.

Second-period budget constraint:

if the reform is not undertaken,

$$\int_{-1}^{+\infty} x dF_2^i(x) = -\delta_N^i; \quad (3)$$

if the reform is undertaken,

$$\int_{-1}^{+\infty} x dF_2^i(x) = e - \delta_R^i. \quad (4)$$

Thus in the first period the *additional* resources that can on average be given to each voter are the resources transferred from the future by debt, δ^i , minus the costs c that have to be paid in case of reform. In the second period the debt δ^i has to be repaid, but newly created resources e can on average be given to each voter in case of reform.¹²

Timing. The timing of the game is as follows:

Period 1:

Stage 1 Each candidate $i = \{A, B\}$ offers a policy p_1^i in order to win the election.

Stage 2 Each voter observes her draw (x_1^A, x_1^B) from each candidate's distribution plan, the reform proposals, the proposals for debt, and then votes. When voters are indifferent between the two candidates, they flip a coin to decide who to vote for.

At period 2 everybody observes the first-period deficit and if the reform was undertaken so that the strategies are conditioned on the first-period outcome; there are two stages:

Period 2:

Stage 1 Candidates choose distribution plans $F_2^i(\cdot)$, $i = A, B$.

Stage 2 Each voter observes his draw (x_2^A, x_2^B) from each candidate's distribution plan and then votes.

¹²Note that since the budget constraints are formulated in terms of *transfers*, we look at changes in the existing endowment of people. That is a transfer of -1 means that the person loses its full endowment. We treat the reform benefits e additionally created in the second period not as an additional per-capita endowment, but as a general increase in resources available for transfers (similar to the resources that are additionally available in the first period if debt is raised). This is why the lower bound of the second-period integrals is -1 : The whole per capita endowment of 1 is taken away and nothing from the additional pie is given to the worst-off individual. We could also work with e occurring as an additional person-specific endowment, in which case this lower bound would become $-(1 + e)$.

Vote-shares. We denote by $S_t^i(p_t^i, p_t^j)$ the share of the votes of candidate i in period $t \in \{1, 2\}$ if she chooses to play strategy p_t^i and the other candidate j chooses to play strategy p_t^j . Then, $S_t^j(p_t^j, p_t^i) = 1 - S_t^i(p_t^i, p_t^j)$.

A Nash equilibrium is characterized here by a pair of strategies p_t^i and p_t^j which are mutually optimal replies.

4 Last-period equilibrium

We start by presenting the second-period equilibrium distribution. We define by μ_2 the resources available in the second period for making transfer offers. Specifically, μ_2 corresponds to the right-hand side of the second period budget constraints (3) or (4). When debt is raised μ_2 can take a negative value, which means that on average resources that would otherwise be available for transfers have to be taken away from the voters. The lowest value of μ_2 occurs when the debt raised is so high that all future resources are necessary for debt repayment. The maximal amount of resources in the second period is reached if the elected first-period politician ran a full surplus and has undertaken the reform. Formally, $\mu_2 \in [-1, 1 + e - c]$.

Proposition 1 *In the unique equilibrium, if no resources are available both candidates' offer distributions are degenerate on $\mu_2 = -1$, otherwise they draw their offers from a uniform distribution on $[-1, 1 + 2\mu_2]$.*

This result follows Myerson (1993). We provide a sketch of the arguments for the proof of Proposition 1. We denote by δ^* the actual debt so that $\delta^* = \delta^i$ when candidate i is elected in period 1. The resources that are available in the second period for transfers are $\mu_2 = -\delta^*$ when no reform is undertaken and $\mu_2 = e - \delta^*$ when the reform is undertaken. Therefore, in the second period we are back to a static version of the “divide-the-dollar” game where the average resources available for making transfer offers are given by μ_2 . Myerson (1993) shows that the equilibrium offer distribution is uniform on $[-1, 1 + 2\mu_2]$.¹³ We show that this is an equilibrium. Suppose politician A plays the uniform distribution on $[-1, 1 + 2\mu_2]$. Then the vote share of politician B playing any budget balanced distribution is given by:

¹³Myerson (1993) shows that an equilibrium offer distribution starts at the lowest possible offer and that upper bound k of this distribution can then be calculated by using the budget constraint $\int_{-1}^k x dF_2^i(x) = \mu_2$ and the fact that both candidates must in equilibrium win $\frac{1}{2}$ of the votes:

$$\int_{-1}^k \frac{x+1}{k+1} dF_2^i(x) = \frac{1}{2} \Leftrightarrow \frac{\mu_2+1}{k+1} = \frac{1}{2} \Leftrightarrow k = 1 + 2\mu_2.$$

$$\begin{aligned}
S_2^B(p_2^B, p_2^A) &= \int_{-1}^{+\infty} F_2^A(x) dF_2^B(x) \\
&\leq \int_{-1}^{+\infty} \frac{x+1}{2+2\mu_2} dF_2^B(x) \\
&= \frac{\mu_2+1}{2+2\mu_2} = \frac{1}{2},
\end{aligned}$$

where the inequality in the second line is strict if candidate B makes any offer $x > 1 + 2\mu_2$ with positive probability.

Given a uniform distribution on $[-1, 1 + 2\mu_2]$, in period 2 each voter expects to get $\mu_2 = -\delta^*$ in the case of no-reform and $\mu_2 = e - \delta^*$ in the case of reform.

The second-period equilibrium analysis reveals that politicians have an incentive to skew the distribution of resources in order to gain the support of the winners of this redistribution as in Myerson (1993): Even if all voters are ex-ante homogenous some voters are treated very well and others are treated very badly. The same force is at play in our second-period equilibrium: The resources left after debt repayment are allocated in exactly the same way as in Myerson's analysis.

5 First-period equilibrium

It turns out that for the equilibrium characterization, it is easier to work with a modified deficit concept: We define $\bar{\rho} := \min\{\bar{\delta} - 1, e\}$ so that $\bar{\rho} > 0$ implies a maximal deficit of $\bar{\delta} = 1 + \bar{\rho}$. The amount $\bar{\rho}$ is the level of debt higher than the per-capita endowment of 1. By definition, it is possible to raise debt higher than the endowment only in case of reform. For the reform case, this measure captures how easily the reform benefits e can be drawn to the first period by debt. If $\bar{\rho} > 0$, then $e - \bar{\rho}$ is the amount of the reform benefits that cannot be drawn to the first period by debt and remains available in the second period for transfers. If $\bar{\rho} = 0$, then the maximal debt $\bar{\delta}$ equals the endowment of 1.¹⁴ In case of reform, the full benefits e then remain available in the future for transfers. Finally, define ρ^i as the actual amount of deficit above the endowment that is raised by candidate i . For the case of no reform $\rho^i \in [-2, \bar{\rho}]$, and for the case of reform $\rho^i \in [-2 + c, \bar{\rho}]$.¹⁵

¹⁴As already mentioned when introducing $\bar{\delta}$, we do not discuss $\bar{\rho} < 0$ here, since this does not add anything new to the analysis. In particular, all that counts for the incentives to implement the reform is by how much the reform candidate can raise more debt than the no-reform candidate. For $\bar{\rho} > 0$, $\bar{\rho}$ captures exactly this more in debt that a reformer can raise. The case $\bar{\rho} < 0$ is equivalent to $\bar{\rho} = 0$ in the sense that the reformer can raise the same debt as the non-reformer.

¹⁵The lower bound follows from the definition of $\bar{\rho}$ and the fact that the lowest possible value of $\bar{\delta}$ in case of reform is $-1 + c$. This corresponds to running a maximum surplus.

5.1 Natural limit or non-stringent limit on debt

Theorem 1 *Assume debt is restricted by $\bar{\delta} \geq 1 + c$, or equivalently $\bar{\rho} \geq c$. In the unique equilibrium, both candidates undertake the reform with probability 1 and announce the maximum budget deficit $\bar{\delta} = 1 + \bar{\rho}$. First-period offers to voters are drawn from a uniform distribution on $[-1, 3 + 2(\bar{\rho} - c)]$. That is both candidates draw first period offers from the following distribution:*

$$F_R^*(x) = \begin{cases} 0, & \text{if } x \leq -1, \\ \frac{x+1}{2+2(\bar{\rho}-c)}, & \text{if } -1 \leq x \leq 3 + 2(\bar{\rho} - c), \\ 1, & \text{if } x \geq 3 + 2(\bar{\rho} - c). \end{cases} \quad (5)$$

Second-period offers are degenerate on $-(1+e)$ if $\bar{\delta} \geq 1+e$, otherwise they are drawn from a uniform distribution on $[-1, -1 + 2(e - \bar{\rho})]$.

By definition, the reform is increasing the total size of the pie, so the reform benefits occurring in the second period surmount the first-period costs of the reform. However, resources that are left in the future cannot be targeted to voters in the first period. This is the reason why a no-reform candidate might have an advantage: If such a candidate has more resources available in the first period through saving on the costs of the reform, she can skew the distribution of these resources to win a majority. As we will see in Theorem 3, this strategy can work even though on average each single voter expects additional reform benefits in the future that surmount the per-capita costs of reform. However, if the reformer can raise sufficient debt so that enough future reform benefits can be transferred to the first period to compensate for the costs of the reform, then a reforming candidate has at least as many resources available for voter targeting in the first period. On top of that, a reformer can offer a higher expectation of future transfers. Hence, the reform is implemented with probability one when the debt limit is the natural or a non-stringent one. A non-stringent limit is defined by the requirement that the more in debt that a reforming candidate can raise is at least as high as the costs of the reform in the first period, i.e. $\bar{\rho} \geq c$.

The fact that both candidates raise the maximum deficit follows the same intuition as in Lizzeri (1999) and is linked to the argument just presented for the incentive to reform. Whatever amount of resources is left in the future is not targetable to first-period voters. A candidate that does not run the maximal deficit is therefore forced to offer an egalitarian distribution for the resources that she leaves in the future. This goes against the incentive to skew the distribution of resources in order to gain the electoral support of the voters that are treated favorably in the process of redistribution.

Indeed, as in the second-period equilibrium analyzed above, the shape of the distribution of favors reveals that politicians have this incentive of skewing the distribution of available resources : The total resources available from debt and first-period endowment minus the cost of the reform are allocated in exactly the same way as in Myerson's analysis.

5.2 Stringent debt limit

Efficiency trumps targetability.

Theorem 2 *Assume debt is restricted by $\bar{\delta} < 1 + c$, or equivalently $\bar{\rho} < c$, and also assume $e - \bar{\rho} \geq 2(c - \bar{\rho})$. In the unique equilibrium, both candidates undertake the reform with probability 1 and announce the maximum budget deficit $\bar{\delta} = 1 + \bar{\rho}$. Both candidates draw their first-period offers to voters from the distribution given by equation (5). Second-period offers are drawn from a uniform distribution on $[-1, -1 + 2(e - \bar{\rho})]$.*

In contrast to Theorem 1, the debt limit here no longer allows to draw enough future reform benefits to the first period to compensate for the reform's cost. Therefore, a no-reform candidate has more resources available in the first period for targeting voters. Specifically, the per-capita amount she has more available equals the difference between the costs and the part of the future benefits that can be transferred to the present, i.e $c - \bar{\rho}$. However, this higher budget today must be enough to make a majority better off than under reform, where everyone expects a boost in future transfers. The expected per-capita increase in future transfers is equal to $e - \bar{\rho}$, and corresponds to the part of future reform benefits that cannot be transferred to the present. Since the outcome of future redistribution is uncertain, these resources cannot be skewed to specific voters. Nevertheless, each voter expects $e - \bar{\rho}$ additional second-period transfers under reform. Therefore, $e - \bar{\rho}$ can be interpreted as the reform gain with public good character. The part $e - \bar{\rho}$ of the reform gains that has to be left in the future is just like a pure public good whose benefits cannot be targeted from the perspective of first-period voters.

The key to the intuition for the proof of Theorem 2 is to realize that when $e - \bar{\rho} \geq 2(c - \bar{\rho})$ the reform gain with public good character, $e - \bar{\rho}$, is too high compared to the amount of additional targetable resources under no-reform, $c - \bar{\rho}$, so that the no-reform candidate cannot win a majority of voters.¹⁶ The above condition can also be reformulated as $e - c \geq c - \bar{\rho}$. This offers an alternative interpretation. The efficiency gain of reform, $e - c$, is big enough to trump the loss in targetable resources, $c - \bar{\rho}$, that occurs in case of reform. Therefore, reform is still implemented with probability 1.

¹⁶The factor 2 on the right hand side of this inequality is explained by the fact in order to win a majority through targeting, a candidate can redistribute from $\frac{1}{2}$ of the voters to benefit the other half.

This also implies that both candidates in the first period compete by offering only one distribution.¹⁷ The incentives to skew this distribution in order to gain the support of the winners of redistribution has not changed. Hence, the shape of this distribution is the same as the one in Theorem 1.

Targetability trumps efficiency.

Theorem 3 *Assume debt is restricted by $\bar{\delta} < 1 + c$, or equivalently $\bar{\rho} < c$, and also assume $e - \bar{\rho} < 2(c - \bar{\rho})$. In the unique equilibrium, both candidates reform with probability $\beta = \frac{1}{2}(2 - H)$, where H is defined by*

$$H := 2(c - \bar{\rho}) - (e - \bar{\rho}). \quad (6)$$

(I) *When candidates do not reform, they raise the maximal deficit of 1 and draw first period offers from the following distribution:*

$$F_N^*(x) = \begin{cases} 0, & \text{if } x \leq -1, \\ \frac{1}{2} \left(\frac{x+1}{H} \right), & \text{if } -1 \leq x \leq -1 + H, \\ \frac{1}{2}, & \text{if } -1 + H \leq x \leq 3 - H, \\ \frac{1}{2} \left(1 + \frac{x-3+H}{H} \right), & \text{if } 3 - H \leq x \leq 3, \\ 1, & \text{if } x \geq 3. \end{cases} \quad (7)$$

Second period offers are degenerate on -1.

(II) *When candidates reform, they raise the maximal deficit of $1 + \bar{\rho}$ and draw first period offers from the following distribution:*

$$F_R^*(x) = \begin{cases} 0, & \text{if } x \leq -1, \\ \frac{x+1}{4-2(c-\bar{\rho})}, & \text{if } -1 \leq x \leq 3 - 2(c - \bar{\rho}), \\ 1, & \text{if } x \geq 3 - 2(c - \bar{\rho}). \end{cases} \quad (8)$$

Second period offers are drawn from a uniform distribution on $[-1, -1 + 2(e - \bar{\rho})]$.

As soon as $e - \bar{\rho} < 2(c - \bar{\rho})$, the reform gain with public good character is not enough to compensate for the fact that a no-reform candidate has more resources available in the first period for targeting. The above condition can be rewritten as $H := 2(c - \bar{\rho}) - (e - \bar{\rho}) > 0$.

¹⁷In contrast, the next Theorem will show that when reform does not occur with probability 1, then candidates must choose the no-reform distribution taking into account the shape of the distribution under reform.

We therefore interpret H as the targeting advantage of *not* doing the reform. If $H = 0$, then the more in targetable resources is just canceled out by the reform gain with public good character and Theorem 2 holds. If $H > 0$, the more in targetable resources is enough to outweigh the efficiency gains from reform and the reform cannot be offered with probability 1 in equilibrium. Note, however, that even with a targeting advantage of no-reform, the reform will still be played with positive probability in equilibrium as long as it is efficient ($e - c > 0$). The reason is that by still playing the reform strategy with some probability, a candidate can use the pie-increase of the reform to force her opponent to concentrate half of her offers on relatively ‘expensive’ voters. This will give the reforming candidate an advantage if her opponent were to play a pure no-reform strategy. As can be seen from Theorem 3, the distribution offered in case of no-reform, $F_N^*(x)$, has a disconnected support with an upper (‘expensive’) part and a lower part. Since candidates maximize the share of vote so that the margin by which they win matters, the gains from deviating from this no-reform distribution depend on the value of H . Specifically, a candidate could deviate from the equilibrium no-reform distribution by shifting money from the upper part of the support of this distribution to the lower part in order to win votes when the other candidate also does not reform. The vote share gained from this deviation increases when H decreases. Since this deviation is detrimental against reform, in order to deter this deviation the probability of meeting reform has to be high enough. Therefore, when H decreases, the probability of reform should go up.

The fact that the reform is implemented with a probability less than one shows that the political process fails to deliver an efficient pie-increasing reform. In particular, the probability with which the reform occurs decreases with an increase in the targeting advantage of no-reform, i.e. higher H . Notice that this targeting advantage becomes smaller when more debt can be raised. Hence, debt goes hand to hand with the reform.

A lower targeting advantage of no-reform makes redistribution under no-reform more extreme. That is, the mass of high transfer offers and the mass of low transfer offers becomes concentrated more on the highest possible and lowest possible offers. This is because, for a non-reformer the profitable strategy against the reform is to offer to a majority of the voters transfers that exceed the offers they get under reform. If the targeting advantage of no-reform is small, then the highest possible offers under reform are bigger and the non-reformer must offer even higher offers to beat these offers. It then follows from the budget constraint that the remaining voters receive correspondingly lower transfers from the non-reformer. This intuition is similar to the static analysis of Lizzeri and Persico (2001) where a public good or transfers can be offered.

6 Alternative modeling choices

6.1 Electoral systems, debt, and reforms

In the core of the analysis we consider vote-share maximizing politicians. We now study the political outcomes in a winner-take-all system where politicians maximize winning probabilities.

First of all, the last-period equilibrium is the same under both winner-take-all and vote-share maximizing systems. This follows again from the analysis of Myerson (1993). Similarly, our results remains valid when there is only the natural limit or a non-stringent limit on debt, and when efficiency trumps targetability. Hence, the political equilibrium identified in Theorem 1 and Theorem 2 holds both under winner-take-all and proportional systems. Intuitively, since both politicians always raise the maximal feasible debt and the reform is offered with probability 1, there is no discontinuity between vote-share and winning probability maximization.

We now turn to the case where targetability trumps efficiency where the two objectives lead to different political equilibria.

Theorem 4 *Assume debt is restricted by $\bar{\delta} < 1 + c$, or equivalently $\bar{\rho} < c$, and also assume $c - \bar{\rho} > \frac{2+(c-\bar{\rho})}{3}$ which implies $e - \bar{\rho} < 2(c - \bar{\rho})$. Under the winner-take-all system in the unique equilibrium, both candidates reform with probability $\beta = \frac{1}{2}$. The deficit levels and distribution plans are the same as in Theorem 3.*

The condition needed in Theorem 4 for characterizing the equilibrium under the winner-take-all system is stricter than in Theorem 3 under vote-share maximization.¹⁸

Under the winner-take-all system, the probability of reform is independent of the exact value of the targeting advantage of no-reform, H . The difference between the two electoral systems comes from the different incentives they imply for politicians. Under the winner-take-all system, the goal is just to win a majority of votes, but the margin by which this is achieved is of no consequence. In contrast, under the proportional system, candidates maximize the share of vote and the margin by which they win becomes important. This implies that the value of deviating from the equilibrium strategy depends on the exact value of H under the proportional system, while it is independent of it under the winner-take-all system. This result again follows the intuition in Lizzeri and Persico (2001).

¹⁸A similar issue also arises in Lizzeri and Persico (1998) when characterizing the equilibrium for the winner-take-all system under the assumption that the provision of the public good does not use up all resources of the economy.

6.2 Three-period model

In a multi-period setup one might wonder if a less stringent debt limit incentivizes short-term reforms at the expense of reforms in the future. To check the robustness of our results to this hypothesis, we add a third period to our setup. In the following we shortly discuss this extension. A more detailed analysis is relegated to Appendix B.

We add one additional period to our model setup, with an election at the beginning of that period. There is now the possibility of a pie-increasing reform both in the first and second period. For simplicity, both reforms have cost c , which is incurred in the period in which the reform is enacted, and benefit e , which occurs one period after the reform is done. We also assume that (A1) and (A2) hold. The possibility to raise debt exists in the first and second period, while outstanding debt has to be repaid by the last period.

The last two periods are similar to our two-period model with the additional feature that outstanding debt from a previous period has to be repaid over these two periods. We start by analyzing the equilibrium in these last two periods. First, notice that any candidate i will always raise the maximal possible debt in the second period. Said differently, as much as possible of the outstanding debt from the first period will be repaid in the third period and only the then remaining outstanding debt will be repaid in the second period. The intuition behind this result is based on the analysis in Lizzeri (1999). Postponing repayment of outstanding to a later period corresponds to raising the maximal possible debt in the current period. Lizzeri (1999) has shown that such behavior gives a targeting advantage in the electoral setup considered here. All resources left in the future cannot be targeted to voters due to electoral uncertainty between the current and the future period. This puts a candidate that leaves more resources than necessary in the future at a disadvantage.

Given this preliminary result, we are able to derive the following proposition.

Proposition 2 *In the unique equilibrium, if there are no debt limits except for the natural ones, then both candidates reform with probability 1 both in the first and second period.*

This establishes that a less stringent *first-period* debt limit will not hamper the second-period reform. That is, in our setup there is no trade-off between incentivizing the short term reform at the expense of endangering the future reform. The crucial point is that the second-period reform is again pie-increasing and creates a net gain, $e - c$. With only the natural debt limit, this net gain can *additionally* be drawn to the first period by debt if the second-period reform is enacted. Therefore, enacting the second-period reform makes the targeting pie in first period bigger than without this reform. But since repayment needs to be ensured, the debt market will not allow a debt level that uses up resources that are necessary for covering the costs of the second-period reform. Said

differently, the debt repayment capacity increases under second-period reform. But to make use of this higher debt capacity in terms of creating more targetable resources in the first period, it needs to be ensured that the foundation for this higher capacity remains intact. Therefore, debt will only be so high that the costs of the second-period reform can still be covered.

Once the exogenous debt limits become more and more restrictive than the natural debt limits, we again get the result that this creates a targeting advantage for the non-reformer, because the reformer is hampered in her ability to make her bigger pie targetable to current voters. Therefore, reform will no longer occur with certainty, as summarized in the following proposition.

Proposition 3 *In the unique equilibrium, the more restrictive the exogenous debt limits, the less likely both the first-period and second-period reform occur.*

The intuition for the first part of the proposition follows the general intuition we have already established in the two-period case. As for the second part, the three-period model highlights a mechanism that only occurs in a multi-period model. Specifically, high inherited debt combined with the incentive to repay outstanding debt as late as possible works in favor of the 2nd-period reformer. Specifically, the combination of these two factors automatically transfers almost the whole reform benefits to the second-to-last period. For an inherited first-period debt of $\delta_1^* \geq 1 + e$, actually the whole benefit is transferred. To see this most clearly take the case where $\delta_1^* = 1 + e$. Note that the non-reformer has to repay e already in second-to-last period, whereas the reformer can postpone this repayment to the last period. This means that the reformer has $e - c$ additional resources available for targeting in the second-period and this gives him an electoral advantage that will beat any candidate choosing not to reform.

The opposite occurs if inherited first-period debt δ_1^* is low. Note that this occurs when the exogenous first-period debt limit $\bar{\delta}_1$ is more restrictive. For this case, the inherited first-period debt does not do much in transferring reform benefits to the second-to-last period. Hence, the exogenous second-period debt restriction $\bar{\delta}_2$ becomes again important in determining if enough reform benefits can be transferred to the present period. Specifically, if $\bar{\delta}_2$ is too stringent, there is again a targeting advantage of the non-reformer, as described in Theorems 3 and 4 of our original model.

7 Concluding remarks

The core of the analysis in this paper looks at a two-period model of redistributive politics in which politicians can implement a pie-increasing reform and raise debt.

A main insight is that debt and pie-increasing reforms go hand in hand: Equilibrium policies lead to the implementation of the reform when debt is restricted only by the natural debt limit, or when the debt limit allows the reformer to draw enough of the future reform benefits to the present. Specifically, through incurring the first-period costs of the reform, the reformer has less resources available in the first period that she can target to voters compared to a non-reformer. By allowing enough debt this disadvantage in targetability remains small enough, so that the efficiency gain of the reform can overcome the targetability issue. Our analysis then shows that once debt becomes more restricted we cannot expect the political process to lead to the implementation of the reform anymore. Intuitively, a too restrictive debt limit implies that a reforming candidate is forced to redistribute her bigger pie in a too egalitarian way, while a non-reformer has complete leeway to perfectly target her smaller redistributive pie. Even if the reform is not always implemented, it is still the case that debt and pie-increasing reform go hand in hand: The likelihood of the reform being offered by competing candidates increases as debt becomes less restricted.

Appendix

A Proof of Theorems

A.1 Proof of Theorem 1

The proof consists of three steps: in Step I, we show that in any equilibrium, both candidates must reform with probability 1. In Step II, we show that in any equilibrium, both candidates must raise the maximal deficit. In Step III, we characterize the equilibrium distributions.

Step I: First we show that in any equilibrium, both candidates must reform with positive probability. Consider the case where candidate A does not reform, raises any deficit $\delta^A \leq 1$, or equivalently $\rho^A \leq 0$, and plays any associated distribution. We show that if candidate B follows the equilibrium strategy where he is doing the reform, he defeats candidate A with probability 1.

The strategy of candidate B consists in doing the reform, running the maximal deficit, and drawing first period offers to voters from a uniform distribution on $[-1, 3 + 2(\bar{\rho} - c)]$, and second period offers are degenerate on $-(1 + e)$ if $\bar{\delta} \geq 1 + e$, otherwise they are drawn from a uniform distribution $[-1, -1 + 2(e - \bar{\rho})]$. Note that for $\bar{\delta} \geq 1 + e$, we have $\bar{\rho} = e$.

A voter votes for the candidate that gives him the highest total expected offer. Assume

candidate i offers x^i to the voter in the first period and proposes a deficit of ρ^i . The resulting total expected offer to the voter is the first period offer, x^i , plus the amount of transfers, μ_2^i , the voter expects in the second period if candidate i is elected. Given a deficit proposal of ρ^i , $\mu_2^i = -(1 + \rho^i)$ in case of no-reform, and $\mu_2^i = e - (1 + \rho^i)$ in case of reform. Since the outcome of the future redistribution is uncertain, today *each voter* expects μ_2^i for the second period if candidate i is elected. Therefore, if μ_1^i is defined as the mean of the first-period offer distribution $F^i(\cdot)$, candidate i is effectively adding a degenerate distribution at μ_2^i to $F^i(\cdot)$ to obtain a distribution with mean $\mu_1^i + \mu_2^i$. Therefore, define $\hat{F}^i(\cdot)$ as the distribution plan obtained by adding $F^i(\cdot)$ to the distribution degenerate at μ_2^i . $\hat{F}^i(\cdot)$ gives the distribution over total expected offers. A voter will vote for candidate A if A gives a higher total expected offer than B . Candidate A 's share of vote is equal to the probability that any random voter receives a total expected offer from candidate B which is lower than the offer he receives from A :

$$S^A = \int_{-2-\rho^A}^{+\infty} \hat{F}^B(x) d\hat{F}^A(x).$$

The ex ante total expected offers that voters get from candidate B are drawn from the following distribution:

$$\hat{F}^B(x) = \begin{cases} 0, & \text{if } x \leq -2 + (e - \bar{\rho}), \\ \frac{x+2-(e-\bar{\rho})}{2+2(1+\bar{\rho}-c)}, & \text{if } -2 + (e - \bar{\rho}) \leq x \leq 2(1 + \bar{\rho} - c) + (e - \bar{\rho}), \\ 1, & \text{if } x \geq 2(1 + \bar{\rho} - c) + (e - \bar{\rho}). \end{cases}$$

Since candidate A does not reform, her budget constraint becomes $\int_{-2-\rho^A}^{+\infty} x d\hat{F}_1(x) = 0$.

Suppose $-2 - \rho^A \geq -2 + (e - \bar{\rho})$, then

$$\begin{aligned} S^A &= \int_{-2-\rho^A}^{+\infty} \hat{F}^B(x) d\hat{F}^A(x) \\ &\leq \frac{2 - (e - \bar{\rho})}{2 + 2(1 + \bar{\rho} - c)} < \frac{1}{2}, \end{aligned}$$

since $e > c$ by assumption (A1).

Suppose $-2 - \rho^A < -2 + (e - \bar{\rho})$, then

$$\begin{aligned}
S^A &= \int_{-2-\rho^A}^{+\infty} \hat{F}^B(x) d\hat{F}^A(x) \\
&\leq \int_{-2+(e-\bar{\rho})}^{+\infty} \frac{x+2-(e-\bar{\rho})}{2+2(1+\bar{\rho}-c)} d\hat{F}^A(x) \\
&= \frac{1}{2+2(1+\bar{\rho}-c)} \left[2-(e-\bar{\rho}) - \int_{-2-\rho^A}^{-2+(e-\bar{\rho})} x+2-(e-\bar{\rho}) d\hat{F}^A(x) \right],
\end{aligned}$$

where $-\int_{-2-\rho^A}^{-2+(e-\bar{\rho})} x+2-(e-\bar{\rho}) d\hat{F}^A(x)$ is a positive term that is maximized for $\rho^A = 0$ and by offering -2 to half of voters, the other half of voters getting strictly more than $-2+(e-\bar{\rho})$ so that $\hat{F}^A(-2+(e-\bar{\rho})) = \frac{1}{2}$. Hence,

$$\begin{aligned}
S^A &\leq \frac{1}{2+2(1+\bar{\rho}-c)} \left[2-(e-\bar{\rho}) - \int_{-2-\rho^A}^{-2+(e-\bar{\rho})} x+2-(e-\bar{\rho}) d\hat{F}^A(x) \right] \\
&\leq \frac{1}{2+2(1+\bar{\rho}-c)} \left[2-(e-\bar{\rho}) + \frac{1}{2}[e-\bar{\rho}] \right] < \frac{1}{2},
\end{aligned}$$

since $\bar{\rho} \geq c$. Therefore, a candidate that plays reform with zero probability can be beaten for sure. In any equilibrium strategy, reform must therefore be played with positive probability.

We now show that the reform must be played with probability 1 in any equilibrium. Assume therefore that candidate A reforms with positive probability $\beta^A < 1$, and for this case of reform raises any deficit $\delta_R^A \leq 1+e$, or equivalently $\rho_R^A \leq e$, and plays any associated distribution. Similarly he does not reform with probability $1-\beta^A$, and for this case of no-reform raises any deficit $\delta_N^A \leq 1$, or equivalently $\rho_N^A \leq 0$, and plays any associated distribution. Candidate B follows the same strategy as above. Then by the above analysis candidate B wins for sure if A does not reform. Furthermore, it can be shown that the vote share of candidate B is equal to $\frac{1}{2}$ if A reforms and plays any deficit $\delta_R^A \leq 1+e$ and any possible distribution. Therefore, candidate B 's total probability of winning is $(1-\beta) + \beta \cdot \frac{1}{2} > \frac{1}{2}$. This cannot happen in equilibrium, where both candidates should win with equal probability. Hence, in any equilibrium both candidates must reform with probability 1.

Step II: We follow Lizzeri (1999) and show that if both candidates reform with probability 1 and candidate A does not run the maximal deficit, $\delta^A < 1+\bar{\rho}$, then candidate B can beat candidate A for sure by choosing the maximal deficit $\delta^B = 1+\bar{\rho}$ and the following first period distribution plan:

$$F^B(x) = \begin{cases} 0, & \text{if } x \leq -1, \\ \frac{1+\bar{\rho}-(1+\rho^A)}{5+3\bar{\rho}-2c-(1+\rho^A)}, & \text{if } -1 \leq x \leq -1 + \bar{\rho} - \rho^A, \\ \frac{1+\bar{\rho}-(1+\rho^A)}{5+3\bar{\rho}-2c-(1+\rho^A)} + \frac{2(2+\bar{\rho}-c)(x+1-(\bar{\rho}-\rho^A))}{(3+\bar{\rho}-2c+(1+\rho^A))(5+3\bar{\rho}-2c-(1+\rho^A))}, & \text{if } -1 + \bar{\rho} - \rho^A \leq x \leq 3 + 2(\bar{\rho} - c), \\ 1, & \text{if } x \geq 3 + 2(\bar{\rho} - c). \end{cases} \quad (9)$$

Given that candidate B chooses the maximal deficit, $\rho^B = \bar{\rho}$, from equation (9) we get

$$\hat{F}^B(x) = \begin{cases} 0, & \text{if } x \leq -2 + (e - \bar{\rho}), \\ \frac{1+\bar{\rho}-(1+\rho^A)}{5+3\bar{\rho}-2c-(1+\rho^A)}, & \text{if } -2 + (e - \bar{\rho}) \leq x \leq -2 + (e - \rho^A), \\ \frac{1+\bar{\rho}-(1+\rho^A)}{5+3\bar{\rho}-2c-(1+\rho^A)} + \frac{2(2+\bar{\rho}-c)(x+2-(e-\rho^A))}{(3+\bar{\rho}-2c+(1+\rho^A))(5+3\bar{\rho}-2c-(1+\rho^A))}, & \text{if } -2 + (e - \rho^A) \leq x \leq 2(1 + \bar{\rho} - c) + (e - \bar{\rho}), \\ 1, & \text{if } x \geq 2(1 + \bar{\rho} - c) + (e - \bar{\rho}). \end{cases} \quad (10)$$

Note that candidate A will never offer more than the upper bound of candidate B 's distribution, $2(1 + \bar{\rho} - c) + (e - \bar{\rho})$, since offering exactly this upper bound to a voter is enough to get the vote for sure since candidate B is offering less than $2(1 + \bar{\rho} - c) + (e - \bar{\rho})$ with probability 1.

The share of the votes of candidate A is given by:

$$\begin{aligned} S^A &= \int_{-2+(e-\rho^A)}^{2(1+\bar{\rho}-c)+(e-\bar{\rho})} \hat{F}^B(x) d\hat{F}^A(x) \\ &= \int_{-2+(e-\rho^A)}^{2(1+\bar{\rho}-c)+(e-\bar{\rho})} \frac{1 + \bar{\rho} - (1 + \rho^A)}{5 + 3\bar{\rho} - 2c - (1 + \rho^A)} \\ &\quad + \frac{2(2 + \bar{\rho} - c)(x + 2 - (e - \rho^A))}{(3 + \bar{\rho} - 2c + (1 + \rho^A))(5 + 3\bar{\rho} - 2c - (1 + \rho^A))} d\hat{F}^A(x) \\ &= \frac{8 - (\bar{\rho} - \rho^A)^2 + 2(\bar{\rho} - c)(4 + \bar{\rho} - c)}{(3 + \bar{\rho} - 2c + (1 + \rho^A))(5 + 3\bar{\rho} - 2c - (1 + \rho^A))}. \end{aligned}$$

To obtain this expression we used equation (10), and the fact that, by the budget constraint for the reform option, $\int_{-2+(e-\rho^A)}^{2(1+\bar{\rho}-c)+(e-\bar{\rho})} x d\hat{F}^A(x) = e - c$. The value of S^A achieves a maximum of $\frac{1}{2}$ for $\rho^A = \bar{\rho}$ and is strictly less than $\frac{1}{2}$ otherwise. This can be seen by taking the derivative of S^A with respect to ρ^A

$$\frac{\partial S^A}{\partial \rho^A} = \frac{4(2 + \bar{\rho} - c)(\bar{\rho} - \rho^A)}{(3 + \bar{\rho} - 2c + (1 + \rho^A))^2(5 + 3\bar{\rho} - 2c - (1 + \rho^A))^2}$$

the sign of which is determined by $(\bar{\rho} - \rho^A)$ since $\bar{\rho} > c$ by assumption.

Therefore, if candidate A chooses less than the maximal deficit, she is beaten for sure. This implies that in any equilibrium both candidates must run the maximal deficit.

Step III: We have shown that in equilibrium both candidates reform and raise the maximal debt level $1 + \bar{\rho}$. The latter also corresponds to the per-capita resources that are additionally available for first-period transfer offers. Therefore, we are back to a divide-the-dollar game with an exactly specified amount of resources to divide. We can therefore apply Myerson (1993) and Lizzeri (1999), and construct the first-period offer distribution analogously to the second-period offer distribution in the previous section. Using the first-period budget constraint (2) for the case of reform, we can calculate the upper bound of the distribution following the same steps as in section 4. In total we then find that both candidates will draw first period offers to voters from a uniform distribution on $[-1, 3 + 2(\bar{\rho} - c)]$. That this is the unique equilibrium in such a divide-the-dollar game has been established by Myerson (1993) for symmetric equilibria and by Lizzeri (1999) for the general case.

Furthermore, if $\bar{\delta} \geq 1 + e$, the full amount of future resources is needed for debt repayment in the second period and second period offers are degenerate on $-(1 + e)$. Otherwise, the amount of resources available after debt repayment in the second period is $e - \bar{\rho}$ and second period offers are drawn from a uniform distribution on $[-1, -1 + 2(e - \bar{\rho})]$, as has been established in Proposition 1. Each candidate then wins with probability $\frac{1}{2}$.

A.2 Proof of Theorem 2

The proof consists of three steps: in Step I, we show that in any equilibrium, both candidates must reform with probability 1. In Step II, we show that in any equilibrium, both candidates must raise the maximal deficit. In Step III, we characterize the equilibrium distributions.

Step I: First we show that in any equilibrium, both candidates must reform with positive probability. Consider the case where candidate A does not reform, raises any deficit $\delta^A \leq 1$, or equivalently $\rho^A \leq 0$, and plays any associated distribution. We show that if candidate B follows the equilibrium strategy where he is doing the reform, he defeats candidate A with probability 1.

The strategy of candidate B consists in doing the reform, running maximal deficit, and drawing first period offers to voters from a uniform distribution on $[-1, 3 + 2(\bar{\rho} - c)]$, and second period offers are drawn from a uniform distribution $[-1, -1 + 2(e - \bar{\rho})]$.

The ex ante total expected offers that voters get from candidate B are thus drawn from the following distribution:

$$\hat{F}^B(x) = \begin{cases} 0, & \text{if } x \leq -2 + (e - \bar{\rho}), \\ \frac{x+2-(e-\bar{\rho})}{2+2(1+\bar{\rho}-c)}, & \text{if } -2 + (e - \bar{\rho}) \leq x \leq 2(1 + \bar{\rho} - c) + (e - \bar{\rho}), \\ 1, & \text{if } x \geq 2(1 + \bar{\rho} - c) + (e - \bar{\rho}). \end{cases}$$

Since candidate A does not reform, her budget constraint becomes $\int_{-2-\rho^A}^{+\infty} x d\hat{F}_1(x) = 0$. The share of the votes of candidate A is given by

$$S^A = \int_{-2-\rho^A}^{+\infty} \hat{F}^B(x) d\hat{F}^A(x).$$

Suppose $-2 - \rho^A \geq -2 + (e - \bar{\rho})$, then

$$\begin{aligned} S^A &= \int_{-2-\rho^A}^{+\infty} \hat{F}^B(x) d\hat{F}^A(x) \\ &\leq \frac{2 - (e - \bar{\rho})}{2 + 2(1 + \bar{\rho} - c)} < \frac{1}{2}, \end{aligned}$$

since $e > c$ by assumption (A1).

Suppose $-2 - \rho^A < -2 + (e - \bar{\rho})$, then

$$\begin{aligned} S^A &= \int_{-2-\rho^A}^{+\infty} \hat{F}^B(x) d\hat{F}^A(x) \\ &\leq \int_{-2+(e-\bar{\rho})}^{+\infty} \frac{x+2-(e-\bar{\rho})}{2+2(1+\bar{\rho}-c)} d\hat{F}^A(x) \\ &= \frac{1}{2+2(1+\bar{\rho}-c)} \left[2 - (e - \bar{\rho}) - \int_{-2-\rho^A}^{-2+(e-\bar{\rho})} x + 2 - (e - \bar{\rho}) d\hat{F}^A(x) \right], \end{aligned}$$

where $-\int_{-2-\rho^A}^{-2+(e-\bar{\rho})} x + 2 - (e - \bar{\rho}) d\hat{F}^A(x)$ is a positive term that is maximized for $\rho^A = 0$ and by offering -2 to half of voters, the other half of voters getting strictly more than $-2 + (e - \bar{\rho})$ so that $\hat{F}^A(-2 + (e - \bar{\rho})) = \frac{1}{2}$. Hence,

$$\begin{aligned} S^A &\leq \frac{1}{2+2(1+\bar{\rho}-c)} \left[2 - (e - \bar{\rho}) - \int_{-2-\rho^A}^{-2+(e-\bar{\rho})} x + 2 - (e - \bar{\rho}) d\hat{F}^A(x) \right] \\ &\leq \frac{1}{2+2(1+\bar{\rho}-c)} \left[2 - (e - \bar{\rho}) + \frac{1}{2}[e - \bar{\rho}] \right] \leq \frac{1}{2}, \end{aligned}$$

because $e - \bar{\rho} \geq 2(c - \bar{\rho})$.

Therefore, a candidate that plays reform with zero probability can be beaten for sure. The argument, that the probability of reform must not only be positive but equal to one is analogous to Theorem 1.

Steps II and III: These steps are similar to the ones in the proof of Theorem 1.

A.3 Proof of Theorem 3

The proof is the same as for Theorem 4, up to equation (17) where

$$(1 - \beta) \frac{1}{2} \frac{1}{H} < \beta \frac{1}{4 - 2(c - \bar{\rho})}.$$

For the proportional system, we have claimed $\beta = \frac{1}{2}(2 - H)$. With this the above equation is equivalent to $e > c$, which holds by assumption (A1).

Proceeding analogously to Theorem 4, we can conclude that whenever $\max\{M_{LN}, M_{HN}\} > 0$, the best response \hat{F}_N to the equilibrium strategy under no-reform satisfies $\hat{F}_N(2 - H) - \hat{F}_N(-2 + (e - \bar{\rho})) = 0$. Recall that for deviations that fulfill this requirement, candidate A's vote share when meeting the equilibrium no-reform distribution is:

$$\begin{aligned} S(\hat{F}_N^*, \hat{F}_N) &= \frac{1}{2} \left[2 \left(\frac{2 - H}{H} \right) \hat{F}_N(2 - H) - 2 \left(\frac{2 - H}{H} \right) + \frac{2}{H} \right] \\ &= \frac{1}{2H} [2(2 - H)\hat{F}_N(2 - H) + 2H - 2]. \end{aligned}$$

If candidate B, who plays the equilibrium strategy, chooses reform instead, then candidate A's vote share is

$$S(\hat{F}_R^*, \hat{F}_N) = 1 - \hat{F}_N(2 - H).$$

Candidate B chooses reform with probability $\beta = \frac{1}{2}(2 - H)$ and non-reform with probability $1 - \beta = 2 - \frac{1}{2}H$. Therefore, candidate A's expected vote share when playing \hat{F}_N is

$$\begin{aligned} S(\hat{F}_R^*, \hat{F}_N) &= \frac{1}{2}(2 - H)(1 - \hat{F}_N(2 - H)) \\ &\quad + (2 - \frac{1}{2}H) \frac{1}{2(H)} [2(2 - H)\hat{F}_N(2 - H) + 6 - 2H] \\ &= \frac{1}{2}. \end{aligned}$$

If candidate B plays the equilibrium strategy, candidate A's vote share is therefore $\frac{1}{2}$ for any distribution \hat{F}_N . In particular, it is $\frac{1}{2}$ when playing the equilibrium no-reform distribution \hat{F}_N^* . Similarly, as we have shown in the proof of Theorem 2, for candidate B playing the equilibrium strategy, candidate A also gets $\frac{1}{2}$ of the votes if he plays the

equilibrium reform distribution \hat{F}_R^* . Therefore, given the equilibrium probability to do the reform of $\beta = \frac{1}{2}(2 - H)$, it is indeed an equilibrium for candidate A to play the equilibrium strategy.

The proof of uniqueness follows the same steps as for Theorem 4 and is available from the authors upon request.

A.4 Proof of Theorem 4

The proof is composed of two parts: in Part I, we show that there is no profitable deviation from the equilibrium. In Part II, we show that the equilibrium is unique. The proof of Part I follows similar steps as the proof of Theorem 5 in Lizzeri and Persico (2001), but adjusts for the dynamic setup and the use of public debt.

Preliminaries. For the proof we will again work with distributions \hat{F} that add to the above distributions the expected value of transfers that each voter expects in the second period. The resulting equilibrium distributions are:

$$\hat{F}_N^*(x) = \begin{cases} 0, & \text{if } x \leq -2, \\ \frac{1}{2} \left(\frac{x+2}{H} \right), & \text{if } -2 \leq x \leq -2 + H, \\ \frac{1}{2}, & \text{if } -2 + H \leq x \leq 2 - H, \\ \frac{1}{2} \left(1 + \frac{x-2+H}{H} \right), & \text{if } 2 - H \leq x \leq 2, \\ 1, & \text{if } x \geq 2; \end{cases} \quad (11)$$

and

$$\hat{F}_R^*(x) = \begin{cases} 0, & \text{if } x \leq -2 + (e - \bar{\rho}), \\ \frac{x+2-(e-\bar{\rho})}{4-2(e-\bar{\rho})}, & \text{if } -2 + (e - \bar{\rho}) \leq x \leq 2 - H, \\ 1, & \text{if } x \geq 2 - H. \end{cases} \quad (12)$$

Part I. The proof of Part I has two steps: Step I shows the optimality of \hat{F}_N^* and Step II the optimality of \hat{F}_R^* .

Step I: Optimality of \hat{F}_N^* . Consider candidate A when he decides not to reform and assume he deviates from the equilibrium distribution under no-reform, F_N^* , to another distribution F_N . When this candidate A meets a candidate B not reforming and offering

money according to F_N^* , the vote share of candidate A is:

$$\begin{aligned} S^A &= \int_{-2}^{\infty} \hat{F}_N^*(x) d\hat{F}_N(x) \\ &= \frac{1}{2} \left\{ \frac{M_{LN} + M_{HN}}{H} + \frac{-2 + H}{H} [\hat{F}(2 - H) - \hat{F}(-2 + H)] \right. \\ &\quad \left. + \left(1 - \frac{4 - H}{H} \right) [1 - \hat{F}_N(2 - H)] + \frac{2}{H} \right\}, \end{aligned} \quad (13)$$

where $H = 2(c - \bar{\rho}) - (e - \bar{\rho})$,

$$M_{LN} = \int_{-2}^{-2+H} x d\hat{F}_N(x), \quad (14)$$

and

$$M_{HN} = \int_{2-H}^2 x d\hat{F}_N(x). \quad (15)$$

Equations (14) and (15) are the transfers to the lowest and highest interval, respectively. candidate A chooses \hat{F}_N under the constraint that

$$M_{LN} + M_{HN} + M_{MN} = 0,$$

where

$$M_{MN} = \int_{-2+H}^{2-H} x d\hat{F}_N(x). \quad (16)$$

It is easy to see that candidate A will not make offers in the interval $(-2 + H, -2 + (e - \bar{\rho}))$. This is because $-2 + (e - \bar{\rho})$ is the lowest offer that the equilibrium distribution in case of reform, \hat{F}_N^* , contains. Therefore in order to win additional votes, candidate A must provide definitely more than $-2 + (e - \bar{\rho})$. In the following, we will argue that if \hat{F}_N is a best response to the equilibrium strategy, then this distribution will contain no offers in the interval $(-2 + (e - \bar{\rho}), 2 - H)$. This is less straightforward to argue, because offers in this interval are made to some voters under the equilibrium distribution in case of reform.

Suppose \hat{F}_N is a best response to the equilibrium strategy and spends a positive amount on offers in the interval $(-2 + (e - \bar{\rho}), 2 - H)$. Then we can arrive at a contradiction by constructing a profitable deviation. In particular, whenever $\max\{M_{LN}, M_{HN}\} > 0$, we construct a deviation \widetilde{F}_N such that $\widetilde{F}_N(-2 + (e - \bar{\rho})) = \hat{F}_N(-2 + (e - \bar{\rho}))$ and $\widetilde{F}_N(2 - H) = \hat{F}_N(2 - H)$, but $\widetilde{M}_{MN} > M_{MN}$. We then show that the expected vote share increases when using the deviation \widetilde{F}_N . This allows us to conclude that whenever $\max\{M_{LN}, M_{HN}\} > 0$, it must be that at equilibrium $\hat{F}_N(-2 + (e - \bar{\rho})) = \hat{F}_N(2 - H)$.

When candidate B , who plays the equilibrium strategy, chooses not to reform, then for candidate A a deviation from \hat{F}_N to \widetilde{F}_N is detrimental. As we can see from (13), increasing M_{MN} to \widetilde{M}_{MN} , decreases candidate A 's vote share by $\frac{1}{2} \frac{\widetilde{M}_{MN} - M_{MN}}{H}$.

When candidate B chooses to reform, then candidate A 's vote share is

$$\begin{aligned} S(\hat{F}_R^*, \hat{F}_N) &= 1 - \hat{F}_N(2 - H) + \int_{-2+(e-\bar{\rho})}^{2-H} \frac{x + 2 - (e - \bar{\rho})}{4 - 2(c - \bar{\rho})} d\hat{F}_N(x) \\ &= \frac{M_{MN}}{4 - 2(c - \bar{\rho})} + \frac{2 - (e - \bar{\rho})}{4 - 2(c - \bar{\rho})} [\hat{F}_N(2 - H) - \hat{F}_N(-2 + (e - \bar{\rho}))] \\ &\quad + 1 - \hat{F}_N(2 - H). \end{aligned}$$

By the first term, a deviation of candidate A from \hat{F}_N to $\widetilde{\hat{F}_N}$ increases his vote share by $\frac{\widetilde{M_{MN}} - M_{MN}}{4 - 2(c - \bar{\rho})}$.

In total, it is beneficial to increase M_{MN} to $\widetilde{M_{MN}}$ if and only if

$$(1 - \beta) \frac{1}{2} \frac{1}{H} < \beta \frac{1}{4 - 2(c - \bar{\rho})}. \quad (17)$$

For the winner-take-all system, in equilibrium $\beta = \frac{1}{2}$, so (17) is equivalent to

$$c - \bar{\rho} > \frac{2 + (e - \bar{\rho})}{3}. \quad (18)$$

Notice that the condition in Theorem 4, $e - \bar{\rho} < 2(c - \bar{\rho})$, or equivalently $c - \bar{\rho} > e - c$, can only hold for $c > \bar{\rho}$. Under assumption (A1) that the net benefit of the reform is smaller than the initial endowment of the economy, we get

$$\frac{2 + (e - \bar{\rho})}{3} > \frac{2(e - c) + (e - \bar{\rho})}{3} > \frac{3(e - c)}{3} = e - c, \quad (19)$$

where the last inequality holds due to $c > \bar{\rho}$. This shows that condition (18) implies the condition $e - \bar{\rho} < 2(c - \bar{\rho})$ in Theorem 4. Thus for the winner-take-all-system a stricter condition is actually needed. Under condition (19), we have therefore shown that whenever $\max\{M_{LN}, M_{HN}\} > 0$, the best response \hat{F}_N to the equilibrium strategy satisfies $\hat{F}_N(2 - H) - \hat{F}_N(-2 + (e - \bar{\rho})) = 0$. It is still possible that putting some mass on $2 - H$ is an optimal strategy, but such a strategy can be approximated by a strategy without mass points at $2 - H$ for which $\hat{F}_N(2 - H) - \hat{F}_N(-2 + (e - \bar{\rho})) = 0$. It will therefore be enough to check for deviations of this latter form. For deviations that fulfill this requirement, equation (13) for candidate A 's vote share becomes:

$$\begin{aligned} S(\hat{F}_N^*, \hat{F}_N) &= \int_{-2}^{\infty} \hat{F}_N^*(x) d\hat{F}_N(x) \\ &= \frac{1}{2} \left[\frac{M_{LN} + M_{HN}}{H} + 2 \left(\frac{2 - H}{H} \right) \hat{F}_N(2 - H) \right. \\ &\quad \left. - 2 \left(\frac{2 - H}{H} \right) + \frac{2}{H} \right]. \end{aligned}$$

Candidate A chooses \hat{F}_N to maximize this expression under the constraint $M_{LN} + M_{HN} \leq 0$. It is clear that this constraint will not be slack, so $M_{LN} + M_{HN} = 0$ and the vote share becomes:

$$S(\hat{F}_N^*, \hat{F}_N) = \frac{1}{2} \left[2 \left(\frac{2-H}{H} \right) \hat{F}_N(2-H) - 2 \left(\frac{2-H}{H} \right) + \frac{2}{H} \right].$$

Whenever $\hat{F}_N(2-H) < \frac{1}{2}$ then

$$S(\hat{F}_N^*, \hat{F}_N) < \frac{1}{2} \left[\frac{2-H}{H} - 2 \left(\frac{2-H}{H} \right) + \frac{2}{H} \right] = \frac{1}{2},$$

so candidate A is sure to lose against candidate B if the latter plays non-reform and the respective equilibrium distribution of offers. However, she is sure to win against candidate B if the latter reforms, because the equilibrium distribution in case of reform offers not more than $2-H$ to any voter.

Whenever $\hat{F}_N(2-H) > \frac{1}{2}$, then $S(\hat{F}_N^*, \hat{F}_N) > \frac{1}{2}$ and candidate A is sure to win against the equilibrium distribution in case of no reform, but will surely lose against candidate B playing reform. To see the latter note that candidate A 's vote share when meeting the equilibrium distribution under reform, \hat{F}_R^* , is

$$S(\hat{F}_R^*, \hat{F}_N) = 1 - \hat{F}_N(2-H) + \int_{-2+(e-\bar{\rho})}^{2-H} \frac{x+2-(e-\bar{\rho})}{4-2(c-\bar{\rho})} d\hat{F}_N(x).$$

This expression is smaller than $\frac{1}{2}$ since $\hat{F}_N(2-H) > \frac{1}{2}$ and there is no mass between $-2+(e-\bar{\rho})$ and $2-H$.

Finally, when $\hat{F}_N(2-H) = \frac{1}{2}$, then candidate A ties against candidate B in case the latter chooses no reform and in case of reform. The latter case can be seen in the following argument. When candidate B plays reform, half of the voters will vote for candidate B because voters get less than $2-H$ from candidate A and $F_N(2-H) = \frac{1}{2}$.

From all this it follows that with a probability of reform $\beta = \frac{1}{2}$, candidate A is indifferent between any \hat{F}_N such that $M_{LN} + M_{HN} = 0$. In particular, she is happy to play \hat{F}_N^* when she chooses not to reform.

Step II: Optimality of \hat{F}_R^* . A candidate who reforms must optimally allocate the net benefits that are targetable in the first period, $\bar{\rho} - c$, taking into account that the deficit limit will imply that every voter gets additional resources of $e - \bar{\rho}$ in expectation in the second period, which are not targetable.

Define

$$M_{MR} = \int_{-2+(e-\bar{\rho})}^{2-H} x d\hat{F}_R(x) \text{ and } M_{HR} = \int_{2-H}^2 x d\hat{F}_R(x).$$

Then the problem of candidate A , if she opts for reform, is to choose \hat{F}_R with $\hat{F}_R(-2+(e-\bar{\rho})) = 0$ and $M_{MR} + M_{HR} \leq e - c$.

When meeting reform and \hat{F}_R^* , the vote share of candidate A using \hat{F}_R is

$$\begin{aligned} S(\hat{F}_R^*, \hat{F}_R) &= 1 - \hat{F}_R(2-H) + \int_{-2+(e-\bar{\rho})}^{2-H} \frac{x+2-(e-\bar{\rho})}{4-2(c-\bar{\rho})} d\hat{F}_R(x) \\ &= 1 - \hat{F}_R(2-H) + \frac{M_{MR}}{4-2(c-\bar{\rho})} + \frac{2-(e-\bar{\rho})}{4-2(c-\bar{\rho})} \hat{F}_R(2-H). \end{aligned} \quad (20)$$

When meeting no-reform, the vote share is

$$\begin{aligned} S(\hat{F}_R^*, \hat{F}_R) &= \frac{1}{2} + \frac{1}{2} \int_{2-H}^2 1 + \frac{x-2+H}{H} d\hat{F}_R(x) \\ &= \frac{1}{2} \left[1 + \int_{2-H}^2 1 + \frac{-2+H}{H} d\hat{F}_R(x) + \frac{M_{HR}}{H} \right] \\ &= \frac{1}{2} \left[1 + \left(1 + \frac{-2+H}{H} \right) (1 - \hat{F}_R(2-H)) + \frac{e-c-M_{MR}}{H} \right]. \end{aligned}$$

Analogously to before, whenever $M_{HR} > 0$, we can consider a deviation \widetilde{F}_R with $\widetilde{F}_R(2-H) = \widetilde{F}_R(2-H)$ and $\widetilde{F}_R(-2+(e-\bar{\rho})) = \widetilde{F}_R(-2+(e-\bar{\rho}))$ that shifts money by decreasing M_{HR} and increasing M_{MR} . Notice now that whenever we have a mass point for \widetilde{F}_R at $-2+(e-\bar{\rho})$ we can approximate this with a mollification for which there are no mass points at $-2+(e-\bar{\rho})$. It will therefore be enough to check for deviations such that $\widetilde{F}_R(-2+(e-\bar{\rho})) = 0$. The shift in money from M_{HR} to M_{MR} increases the vote share when meeting reform by $\frac{\Delta M_{MR}}{4-2(c-\bar{\rho})}$ and decreases the vote share when meeting no-reform by $\frac{1}{2} \frac{\Delta M_{MR}}{H}$. Analogously to the first part of this proof, we find that it will pay to do this shift when

$$(1-\beta) \frac{1}{2} \frac{1}{H} < \beta \frac{1}{4-2(c-\bar{\rho})}.$$

As before, for the winner-take-all system with $\beta = \frac{1}{2}$ we get that as long as $c - \bar{\rho} > \frac{2+(e-\bar{\rho})}{3}$, we can find this profitable deviation. Under this condition, as long as $M_{HR} > 0$, it has to be the case in equilibrium that $\hat{F}_R(x) = 0 \forall x \in [-2+(e-\bar{\rho}), 2-H)$. Given this, the lowest that any individual is offered under \hat{F}_R is $2-H$, but this already surmounts the average resources that are available for transfers, $e - c$:

$$2 - H = 2(1 + \bar{\rho} - c) + (e - \bar{\rho}) = e - c + \bar{\rho} + 2 - c > e - c.$$

This follows from assumption (A2), in which we stated that the reform can always be financed: $c < 1$. So for $M_{HR} > 0$ the budget constraint would be violated. Therefore, we must have $M_{HR} = 0$ and $\hat{F}_R(2 - H) = 0$. Any distribution that fulfills these requirements will be an equilibrium because the vote share when meeting reform or no-reform is $\frac{1}{2}$ in either case. In particular \hat{F}_R^* is therefore an equilibrium.

Finally, when candidate B plays the equilibrium strategy, candidate A is indifferent between offering reform and no-reform because the probability of victory is $\frac{1}{2}$ in either case.

Part II: Uniqueness. The proof follows similar steps as in Lizzeri and Persico (1998) and is available from the authors upon request.

B Three-period model

One could imagine that the results hinge on the assumption of only two periods. In particular, in a multi-period setup one might wonder if a less stringent debt limit might incentivize short-term reforms at the expense of reforms in the future. To check the robustness of our results to an extension of the time horizon, the simplest possible setup is an extension to 3 periods. In the following we investigate this extension.

B.1 Setup

We modify the above model by adding a third period and discuss in the following the modifications necessary. Everything that is not explicitly mentioned remains the same compared to the 2-period model. For instance, we still have the same two candidates A and B that now compete in an election at the beginning of each of the three periods. There is the possibility of a pie-increasing reform in the first and the 2nd period. For simplicity both reforms have cost c , which has to be incurred in the period in which the reform is enacted, and benefit $e > c$, which accrues one period after the reform was done. The possibility to raise debt exists in the first and second period, while outstanding debt has to be repaid by the 3rd period.

The policies proposed by the candidates in the first period now consist of the following parts. First there are the probabilities of reform in the first two periods: $\beta_1^i, \beta_{2,R_1}^i, \beta_{2,N_1}^i$, where R_1 indicates reform in period 1 and N_1 indicates no reform in period 1. The debt

levels for the first two periods ($s \in \{1, 2\}$) under reform and no reform in the first two periods are denoted by: $\delta_{s,R,R}^i, \delta_{s,R,N}^i, \delta_{s,N,R}^i, \delta_{s,N,N}^i$. The second subscript refers to the reform decision in the first period, and the third subscript refers to the reform decision in the second period. Finally, the offer distributions under reform and no reform in the three periods ($s \in \{1, 2, 3\}$) are denoted by: $F_{s,R,R}^i, F_{s,R,N}^i, F_{s,N,R}^i, F_{s,N,N}^i$.

B.2 Analysis of last two periods

The last two periods are just like our 2-period model with the only modification that outstanding debt from a previous period has to be repaid over these two periods. Denote by δ_1^* the actual debt inherited from the first period, i.e. $\delta_1^* = \delta_{1,N,R}^A$ if and only if candidate A won the first period election, did not reform in the first period and planned to do the reform in the second period and implemented his corresponding debt proposal $\delta_{1,N,R}^A$.

Lemma 5 *Any candidate i will always raise the maximal possible debt in the second period. Said differently, as much as possible of the outstanding debt from the first period will be repaid in the third period and only the then remaining outstanding debt will be repaid in the second period.*

Proof The proof follows the arguments in Lizzeri (1999).

B.2.1 Natural debt limit in second period

Assume first that there is no exogenous debt limit in the second period except for the natural one. We have to distinguish several cases, given what happened in the first period.

Case 1: Reform in first period and maximal debt

Denote by a star the realized values inherited from the first period. In the case with first period reform, we therefore have $\beta_1^* = 1$. Furthermore, the maximal debt in this case, that is the natural debt limit, is given by $\delta_1^* = 2(1 + e) - c$. With this amount of first period debt, all resources in periods 2 and 3 that are not necessary for financing the second period reform are bound for the repayment of the inherited first-period debt. Note that we cannot have $\delta_1^* > 2(1 + e) - c$. In that case, given repayment of first-period debt, there would not be enough money left to finance reform in the second period and then over the last 2 periods, the maximal amount that could be repaid would be $2 + e < 2(1 + e) - c$. Therefore, full repayment would not be possible and so the natural debt limit is $2(1 + e) - c$. With δ_1^* equal to this natural debt limit, to honor these debt obligations, each candidate is therefore forced to do the reform in the second period with

probability 1. Furthermore, any candidate will repay $(1 + e) - c$ in the second period and $(1 + e)$ in the 3rd period.

This first case already illustrates well the intuition why no restrictions on debt except for the natural debt limit will not hamper the second period reform. That is there is no trade-off between incentivizing the short term (first-period) reform at the expense of endangering the future (second-period) reform. The crucial point is that the second-period reform is again pie-increasing and creates a net gain. This means that without any exogenously imposed restrictions on debt¹⁹, doing the second-period reform will lead to more resources available for voter targeting in the first period than without this reform. More specifically, given its pie-increasing character, the reform is self-financing. The costs c that need to be left in the last two period for financing the second-period reform can be covered completely out of the 3rd-period reform benefits. The net gain $(e - c)$ of the second-period reform, can *additionally* be drawn to the first period and makes the targeting pie in first period bigger than without second-period reform. But since repayment needs to be ensured, the debt market will not allow a debt level that is drawing more than the net gain to the first period. In that sense financing of the second-period reform will not be endangered.

Case 2: Reform in first period and less than maximal debt

In that case, $\beta_1^* = 1$, but $\delta_1^* < 2(1 + e) - c$. Then we can distinguish two subcases. If $2 + e < \delta_1^* < 2(1 + e) - c$, then δ_1^* still big enough such that enacting the reform is necessary to repay all outstanding debt. Hence given the requirement of repaying all debt, reform will be enacted with probability 1.

On the other hand, if $\delta_1^* \leq 2 + e$, then reform is not necessary to ensure debt repayment. Given the self-financing character of a pie-increasing reform, there is enough money to finance the reform. From our result in Theorem 1 we then know that without restrictions on debt there is no targeting advantage of no-reform. Hence the reform should be implemented with probability 1.

Exactly the same arguments can be applied for the cases where no reform occurred in the first period. Combining all these cases, it follows:

Proposition 4 *In the unique equilibrium, if there are no restrictions on raising debt in the second period except for the natural debt limit, then with any admissible first period debt level, both candidates will reform with probability 1 in the second period.*

¹⁹Note that to have δ_1^* equal to the first-period natural debt limit $2(1 + e) - c$, we also cannot have any exogenous debt limit in the first period that is more restrictive than this natural debt limit.

B.2.2 Restrictive debt limit in second period

Let us now turn to the case with an exogenous second-period debt limit that is more restrictive than the natural debt limit. We begin with the following

Definition 6

\mathbf{l}_{N_2} : leftover resources in 3rd period (not bound for repayment of first period debt) given NO reform in second period. Formally, $l_{N_2} = 1 - \delta_1^*$. This corresponds exactly to the concept of the second period endowment 1 that is available for repayment when no reform is undertaken in the original model.

\mathbf{l}_{R_2} : leftover resources in 3rd period given Reform in second period. Formally, $l_{R_2} = 1 + e - \delta_1^* = l_{N_2} + e$.

Define furthermore $\bar{\delta}_2$ as the debt limit in the second period. Note that the natural debt limit under reform is l_{R_2} , so that it makes sense to focus on the case $\bar{\delta}_2 \leq l_{R_2}$ (otherwise the debt limit $\bar{\delta}_2$ will never bind and it would not make sense to investigate its effects). Analogously to before define $\bar{\rho}_2 = \min\{\bar{\delta}_2 - l_{N_2}, e\}$.

Case (i): $\mathbf{l}_{N_2} \geq 0$ That is, after completely repaying the outstanding first-period debt in the third period, there are still positive resources left in this third period. Then we are in the world of our 2-period model from before and Theorems 1-3 go through with conditions like $1 \leq \bar{\delta} \leq 1 + c$ replaced by $l_{N_2} \leq \bar{\delta}_2 \leq l_{N_2} + c$. That is, l_{N_2} takes the place of the endowment 1.

Case (ii): $\mathbf{l}_{N_2} < 0$ but $\mathbf{l}_{R_2} \geq 0$ Given the definitions of l_{R_2} and l_{N_2} , this corresponds to a first period debt level δ_1^* with $1 < \delta_1^* \leq 1 + e$. Note that we can still view l_{N_2} as corresponding to the resources available in the last period for repaying debt when no reform is undertaken. When $l_{N_2} < 0$, this just means that without reform there is even a debt that needs repayment in the third period, so that this debt reduces the available resources in the second period, because it already needs to be repaid there. The no-reform politician can raise zero debt in this case and is furthermore obliged to the repayment of $-l_{N_2}$ in the second period.

The concepts from before can again be replaced:

1. What no reform politician can target more in present period:

$$c - \bar{\rho} \quad \text{now corresponds to} \quad c - \bar{\rho}_2 \quad (\text{or } c + l_{N_2} - \bar{\delta}_2)$$

2. What each voter expects more in future period:

$$e - \bar{\rho} \quad \text{now corresponds to} \quad e - \bar{\rho}_2 \quad (\text{or } e + l_{N_2} - \bar{\delta}_2)$$

The Theorems would therefore go through with the endowment 1 replaced by l_{N_2} and $\bar{\rho}$ replaced by $\bar{\rho}_2$. Note that $l_{R_2} \geq 0$ implies that the debt inherited from the first period is at most $1 + e$. That is, the inherited debt is not so high that reform in the second period would be forced (in order to ensure the repayment of outstanding first period debt). For instance, Theorem 2 would go:

Assume $0 \leq \bar{\rho}_2 < c$ and also assume $e - \bar{\rho}_2 \geq 2(c - \bar{\rho}_2)$. In the unique equilibrium, both candidates reform with probability 1. ...

Therefore, the second period reform will be carried out with probability 1 if and only if

$$\begin{aligned} 2(c - \bar{\rho}_2) &\leq e - \bar{\rho}_2 \\ \Leftrightarrow \bar{\rho}_2 = \bar{\delta}_2 - l_{N_2} &\geq 2c - e \\ \Leftrightarrow l_{N_2} = 1 - \delta_1^* &\leq \bar{\delta}_2 + 2c - e \\ \Leftrightarrow \bar{\delta}_2 &\geq 1 + e - 2c - \delta_1^* \end{aligned}$$

To interpret this last condition, note that it depends on the inherited first-period debt δ_1^* . If this debt is high, we have δ_1^* close to $1 + e$. In that case, the above relation holds for sure. For $\delta_1^* = 1 + e$, the relation reduces to $\bar{\delta}_2 \geq -2c$, which is always the case, assuming we work with positive debt limits. But this means, that for high enough debt inherited from the first period, the second-period reform will be carried out for sure. The intuition is that the high inherited debt combined with the incentive to repay outstanding debt as late as possible works in favor of the second-period reformer. Specifically, the combination of these two factors automatically transfers almost the whole reform benefits to the second-to-last period. For $\delta_1^* = 1 + e$, actually the whole benefit is transferred. To see this, note that the non-reformer has to repay e already in second-to-last period, whereas the reformer can postpone this repayment to the last period. This means that the reformer has $e - c$ additional resources available for targeting in the second-period and this gives him an electoral advantage that will beat any candidate choosing not to reform.

The opposite occurs if inherited first-period debt δ_1^* is low, that is if δ_1^* is close to 1.²⁰ For this constellation, the inherited first period debt does not do much in transferring reform benefits to the second-to-last period. Hence, the exogenous debt restriction $\bar{\delta}_2$ becomes again important in determining if enough reform benefits can be transferred to the present period. Specifically, if $\bar{\delta}_2$ is too stringent, there is again a targeting advantage of the non-reformer, as described in Theorems 3 and 4.

²⁰Recall that the current case is defined by $1 < \delta_1^* \leq 1 + e$.

Case (iii): $l_{R_2} < 0$ In this case, no debt can be raised in the second period, because the last period resources are not even enough for repayment if the second period reform is carried out. The resources available for targeting in the second period are then $-c + l_{R_2}$ under reform, and $l_{N_2} < 0$ under no-reform. We have $-c + l_{R_2} = -c + l_{N_2} + e = l_{N_2} + (e - c) > l_{N_2}$, since $(e - c) > 0$. Therefore more resources are available for targeting under reform, and both candidates should do the reform with probability 1 if it can be financed. This will always be the case, because the debt market knows that when the first-period debt is higher than $1 + e$ we are in this case, and it will not allow a debt so high that in the second period the reform could not be financed anymore. The intuition why more resources are available under reform is the same as in case (ii), the high inherited debt works as a device that transfers all the future reform benefits to the present automatically.

Note that case (iii) and the subcase of case (ii) where reform occurs with probability 1 irrespective of the second period debt limit correspond to the case of a higher inherited first-period debt. A more restrictive first-period debt limit in contrast reduces the implementable first-period debt level and thus will move us out of these cases at some point. In that sense, we can conclude:

Corollary 7 *A more restrictive first-period debt limit makes second-period reform (weakly) less likely.*

Nevertheless, the second-period debt limit still plays the decisive role in case (i) and the subcase of case (ii) where reform does not occur only because of high enough first-period debt. For these cases the second-period debt limit has the same effect as in our original model. Therefore, we have:

Corollary 8 *A more restrictive second-period debt limit makes second-period reform (weakly) less likely.*

B.3 Analysis of the first period

Having analyzed equilibrium in the last two periods, we can now turn to the first period equilibrium. Again, we can distinguish two cases.

Case 1: $\bar{\delta}_1 \leq 2 + e - c$ A candidate with no reform in the first period can raise the same debt as the reform candidate as long as $\bar{\delta}_1 \leq 2 + e - c$ (where the latter is the natural debt limit under no-reform). Under this condition, reform will occur in the first period with probability 1 if and only if $e \geq 2c$. Note that this is equivalent to our usual condition $e - \bar{\rho} \geq 2(c - \bar{\rho})$ for $\bar{\rho} = 0$. That is the debt limit here does nothing

in helping the reformer to overcome the advantage of more targetable resources of the non-reformer. Only when the (non-targetable) benefits surmount the cost-savings of the non-reformer enough, can the targeting advantage of the latter be overcome. Focusing on the case where the benefits are not so high, the 1st-period reform will therefore not be implemented with probability 1 under the condition $\bar{\delta}_1 \leq 2 + e - c$ that defines case 1.

Case 2: $\bar{\delta}_1 > 2 + e - c$ From the discussion of case 1, we can already see that it makes sense to define $\bar{\rho}_1 = \min\{\bar{\delta}_1 - (2 + e - c), e\}$ as the analogue to our previous definitions of $\bar{\rho}$. Then we get analogous versions of our Theorems as in the 2-period model.

Hence Theorem 2 would go:

Assume $0 \leq \bar{\rho}_1 < c$ and also assume $e - \bar{\rho}_1 \geq 2(c - \bar{\rho}_1)$. In the unique equilibrium both candidates reform with probability 1 in the first period. ...

Recall that the condition in case 1, $e \geq 2c$, corresponded to $\bar{\rho}_1 = 0$. This is a very stringent debt limit, for which our condition for reform, $e - \bar{\rho}_1 \geq 2(c - \bar{\rho}_1)$, is hardest to fulfill. Hence again, we get the following

Corollary 9 *A more restrictive first-period debt limit makes first-period reform (weakly) less likely.*

In total, combining the equilibrium analyzes for the first and the last two periods, we therefore get the following results that were stated as Propositions 2 and 3 in the main text:

Proposition *In the unique equilibrium, if there are no debt limits except for the natural ones, then both candidates reform with probability 1 both in the first and second period.*

Proposition *In the unique equilibrium, the more restrictive the exogenous debt limits, the less likely both the first-period and second-period reform occur.*

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