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Abstract

In this paper we examine the impact of tax contracts as a novel institution on elections, policies, and welfare. We consider a political game in which three parties compete to form the government. Parties have policy preferences about the level of public-good provision and benefit from perks when in office. A government raises taxes for both purposes. We show that tax contracts yield moderate policies and lead to lower perks by avoiding the formation of grand coalitions in order to win government. Moreover, in polarized societies they unambiguously improve the welfare of the median voter.

Keywords: political contracts, elections, government formation, tax promise.

JEL: D72, D82, H55

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“The coalition is being judged against the promises made in the election campaign. That is unfair!”

Franz Müntefering, head of the Social Democratic Party in Germany, press conference on Aug. 29, 2006, Berlin, Germany

1 Introduction

The fiscal commons problem represents one of the most prominent explanations of excessive spending in democracies. The original reasoning by Buchanan and Tullock (1962) and Weingast et al. (1981) runs as follows: The government budget represents a common pool for political decision-makers. A larger number of decision-makers on the public budget is called higher fragmentation of government. Higher fragmentation tends to increase government spending. The reason for this is that political decision-makers are concerned with targeting resources from the public budget to projects that benefit their supporting interest groups. Through the tax scheme, the costs of these special expenditure programs are spread over the whole population. Hence, a politician in the government and the interest group he represents fully appropriate the benefits of their targeted project, while only bearing a fraction of $1/m$ of the costs, where m stands for the appointed decision-makers representing particular constituencies. Accordingly, the higher the number of appointed decision-makers (the higher the fragmentation of government), the smaller is the share of internalized project costs, thus increasing the government budget, government size, and socially wasteful spending.

In this paper we propose the fiscal institution tax contracts as a remedy for the fiscal commons problem. This novel institution works as follows: During campaigns parties can make promises in the form of limitations on tax rates that they want to honor when in power. For example, one party may promise not to increase tax rates, while another party may specify a range of value-added taxes. Such tax promises are approved by a public certification body and are called tax contracts. If a party becomes part of the government at the end of the term of office, the certification body evaluates whether the tax promise has been kept by the government. As tax rates are verifiable, a simple yes/no decision is possible when the contract is up for review. If yes, there are no further consequences. If the tax promise has been violated, the party is heavily punished. For instance, its public funding will be cut or, even more extremely, the party will lose its

right to nominate candidates for the next election. We assume that such punishments are so severe that tax contracts will never be violated. Hence tax contracts enable a party to commit to a range of tax rates during campaigns.

We consider a political game in which three parties compete to form the government. Parties have policy preferences about the level of public-good provision, and they benefit from perks when in office. A government raises taxes for both purposes. One party is an extremist party, while the others are conventional parties. They either form the government as a single party, if one of them receives a majority of seats, or they form a grand coalition. The observation that grand coalitions are likelier in the presence of an extremist party is a common attribute of democracies with proportional representation. Recent examples include elections in Germany, 2005, Austria, 2008, 2006, 1995, 1990, 1986, Turkey, 1999, and Hungary, 1994.¹

The model produces three insights. First, tax contracts yield moderate policy platforms. The reason is as follows: With tax contracts, parties will commit to tax rates close to the ones preferred by the median voter. When parties are in power, they do not have an incentive to choose extreme levels of public good provision (high or low), as they balance their own perks and benefits from public goods. Thus moderate policy outcomes emerge during legislative periods. However, as parties will always choose some perks when they are in power, the policy outcome will differ from the one preferred by the median voter.

Second, tax contracts lead to lower perks by avoiding the formation of grand coalitions. The reason is that, without tax contracts, voters on one side of the political spectrum have little incentive to vote strategically for the party on the other side of the political spectrum. Such strategic voting would indeed yield the benefit of avoiding the formation of a grand coalition, which is associated with higher perks. However, this comes at the cost of having a party in government that would choose taxes and public good provision that are very unattractive to voters on the other side of the political spectrum. If societies are polarized, with tax contracts, strategic voting and thus avoidance of grand coalitions becomes attractive, as a governing party will not deviate from the tax promise and will choose moderate public good provision. This implies smaller utility losses for voters on the other side of the political spectrum than the utility gains from having lower perks for the government.

¹Source: Social Science Research Center Berlin (WZB).

Third, tax contracts tend to improve the welfare of the median voter. This is due to the moderating effect of tax contracts with respect to policy. By contrast, without tax contracts there may be extremely high or low levels of public good provision plus – according to the intuition in the previous paragraph – a low incentive to avoid large amounts of perks associated with grand coalitions. There is one exception: very low levels of polarization, i.e. where the ideal points of parties are very close. Public good provision is reduced with tax contracts, whereas without tax contracts taxes are increased. As increasing taxes is less expensive in terms of utility losses than reducing public good provision, the regime without tax contracts may be favorable in societies with very little polarization.

The paper is organized as follows: The next section relates our paper to the literature. In Section 3 we develop the model. Section 4 examines the formation of coalition governments without contracts. In Section 5, we introduce tax contracts into the legislative game and characterize the equilibria. The effects of tax contracts are identified in Section 6. In Section 7 we examine how tax contracts affect the welfare of the median voter, and in Section 8 we discuss possible extensions of our model. Section 9 concludes.

2 Relation to the Literature

One of the most prominent explanations for excessive spending in democracies is the fiscal commons problem caused by fragmented governments. Several causes for fragmented governments have been put forward in the literature. Buchanan and Tullock (1962) and Weingast et al. (1981) have derived the fiscal commons problem from geographical fragmentation, as representatives at the federal level represent electoral districts. Roubini and Sachs (1989) and Roubini et al. (1989) have focused on coalition size as an indicator of fragmentation. Further interpretations of fragmented government refer to the number of spending ministers and cabinet size (Schaltegger and Feld, 2009). Recent theoretical examinations of a dynamic version of the fiscal commons problem can be found in Battaglini and Coate (2008).

There exists a large body of empirical literature on how more fragmented governments affect the size of the government and policy outcomes like unemployment and inflation. This literature is surveyed in Schaltegger and Feld (2009), who themselves find that the number of ministers in Swiss cantons is associated with large government sizes.

They also indicate that fiscal referenda tend to alleviate the fiscal commons problem. A variety of institutional provisions exist that might help to remedy the fiscal commons problem. Feld and Kirchgässner (2001) and Feld and Matsusaka (2003) indicate that fiscal referenda help to restrain overspending by governments. Poterba and von Hagen (1999) provide a detailed account of how formal fiscal rules affect fiscal performance, while Persson and Tabellini (2003) relate constitutional rules shaping a particular type of democracy to economic outcomes, including government spending. Tax contracts are a new type of institution that may help to tame the fiscal commons problem and foster welfare.²

Our paper is broadly related to the issue whether political competition will reduce or eliminate the rents of competing political parties. This literature indicates that competition reduces rents, either because there is uncertainty regarding the preferences of parties (Polo, 1998) or because coordination of voting on non-corrupt parties in democracies with proportional representation is difficult to achieve (Myerson, 1993). In our model, all parties will choose some rents when they are in government, as they cannot commit to renouncing perks altogether. However, tax contracts can reduce these rents.

3 The Model

3.1 Voters and policies

We consider a representative democracy with an electorate that consists of a set of voters, \mathcal{I} . Voters are identified by their income level y_i , $i \in \mathcal{I}$. The density function $f(y)$ over the interval $[y_{min}, y_{max}]$ describes the income distribution. The median voter's income level is denoted by y_m .

Aggregate income Y is given by

$$Y = \int_{y_{min}}^{y_{max}} y f(y) dy.$$

Voters elect a parliament, which in its turn elects a government. The activities of the government are:

²A companion paper (Gersbach and Schneider, 2008) examines the impact of tax contracts on government formation in a four-party system.

- choosing the level of a public good $g \in [0, \infty)$ and the perks for the parties in power. Perks comprise targeting expenditures that are welfare-reducing but benefit interest groups and the constituency supporting politicians in power. Perks also include all government expenditures that benefit politicians in power directly, such as administrative empires or prestige projects.³ Both the public good and the perks are financed by a linear income tax with tax rate t . We assume that taxation is distortionary. Let $\lambda > 0$ denote the shadow cost of public funds. Accordingly, taxation uses $(1 + \lambda)$ of taxpayer resources in order to levy 1 unit of resources for public projects and for perks. The costs of providing the amount g of the public good is gc , where $c > 0$ is the unit cost.
- choosing a binary policy $d \in \{0, \bar{d}\}$, $\bar{d} > 0$, where $d = 0$ represents the status quo. The binary policy \bar{d} describes large changes, such as waging a war, international agreements on arms control or trade, implementing large-scale regulatory reforms, etc.

The utility of a voter with income y_i is given by

$$U_i = U(y_i, \delta_i) = A \ln g + (1 - t)y_i - \delta_i d,$$

where $\delta_i \in \{-1, 1\}$. We assume that the characteristic $\delta = -1$ is distributed identically to income over the electorate. Ex ante, this could also be interpreted as every citizen possessing the same probability of being in favor of the extreme policy change.

Before we introduce parties, it is useful to look at voters. Suppose a government (single party or coalition of parties) is elected with s_k seats in parliament. As voters cannot prevent the government from choosing perks, the desired policy and financing scheme of a voter characterized by $(y_i, \delta_i = 1)$ is the solution of the following problem:

$$\begin{aligned} \max_{t, g, d \geq 0} U_i \\ \text{s.t. } tY = (1 + \lambda)(gc + s_k b), \end{aligned}$$

where b denotes the fixed amount of perks per governmental parliamentary member. Substituting t in U_i , the first-order condition with respect to g is

$$\frac{A}{g} - y_i \frac{(1 + \lambda)c}{Y} = 0,$$

³An extreme form of perks is the overly generous possibility of using public money for private expenditures. The examples revealed in Great Britain in 2009 show how far such attempts can go. See e.g. Economist (2009).

which yields

$$t_i^* = \frac{A}{y_i} + \frac{(1 + \lambda)s_k b}{Y}, \quad (1)$$

$$g_i^* = \frac{YA}{y_i(1 + \lambda)c}, \quad (2)$$

$$d_i^* = 0. \quad (3)$$

Equations (1) and (2) reveal that voters with higher incomes prefer lower tax rates and lower levels of public good provision.

3.2 Parties

The total number of seats in the parliament is given by S . There are two conventional parties denoted by $j, k = \{L, R\}$ with platforms $(y_L, 1)$ and $(y_R, 1)$ competing for seats in the parliament. Accordingly, party L (R) is the left (right) party. We refer to parties as ‘conventional’ if their platform involves $\delta = 1$.

We assume that $y_L < y_m < y_R$. The utility of a party k is given by

$$V_k = U(y_k, 0) + 2\theta s_k \sqrt{b},$$

where θ is a weighting factor and b are the perks in office per member of party k if party k is part of the government. The variable s_k denotes the number of party k 's parliamentary seats. The utility formulation of V_k implies decreasing marginal utility with respect to g_k . Further, V_k has the property that the first unit of g_k possesses infinite marginal utility, which induces parties to choose positive levels of public goods. If it is the sole party in power, i.e. if s_k secures a legislative majority, then the party's policy will result from the following utility-maximization problem:

$$\begin{aligned} & \max_{t, g, d \geq 0} V_k \\ & \text{s.t. } tY = (1 + \lambda)(gc + s_k b) \end{aligned}$$

Accordingly, party k will choose

$$t_k^* = \frac{A}{y_k} + \frac{(1 + \lambda)s_k b}{Y}, \quad (4)$$

$$g_k^* = \frac{YA}{y_k(1 + \lambda)c}, \quad (5)$$

$$d_k^* = 0. \quad (6)$$

Comparing (5) with (2), we find that the optimal policy of parties with regard to the public good corresponds to the preferred policy of the respective voter with the characteristic $(y_k, 1)$. The tax rate, however, is higher than voter y_k 's preferred tax rate (which would be $\frac{A}{y_k}$) as the party finances perks for its members.

Finally, there is a protest or extreme party E with platform $(y_E, -1)$ and utility⁴

$$V_E = U(y_E, -1) + 2\theta_{s_E}\sqrt{b_E}.$$

According to the preferences of its constituency, the extreme party would like to implement \bar{d} . Throughout the paper we assume that policy \bar{d} is sufficiently important in the sense that a voter with $\delta_i = -1$ is better off with the optimal choice of party E than with any choice of the conventional parties that involves $d_k = 0$.

3.3 Rules and information

We consider a parliamentary democracy with proportional seat allocation, i.e. the parliamentary seats are distributed among the parties according to their vote shares. In order to obtain seats in parliament, parties need a certain share of votes denoted by z ($z > 0$).

The informational environment is as follows:

- At the beginning of the political race and when parties sign the tax contracts, it is common knowledge among all voters and the parties that
 - with probability p the platform of party E will find a response from voters, thereby generating a share of $\frac{s_E}{S}$ votes in favor of \bar{d} over $d = 0$. This share is sufficient to enter parliament ($\frac{s_E}{S} \geq z$).
 - with probability $1-p$ the platform of party E will not attract sufficient votes for party E to enter parliament.⁵
- Before the election takes place, voters observe their characteristic δ , which will remain private information. Voters have the same information as before regarding the likelihood that E or $\neg E$ will occur.

⁴The particular value of y_E is not important for our analysis. As the voters of the extreme party are distributed identically as income, the median income in the set of voters supporting the extreme party is y_m .

⁵The size of the vote share of the extreme party does not matter, as the number of seats for the conventional parties depends only on their relative vote shares.

We refer to the event of the extreme party entering parliament as event E. The opposite case is called event $\neg E$. We assume

Assumption 1

$$\frac{s_E}{S} < 1 - \frac{\sqrt{8}}{4}$$

This upper bound on the seats simplifies the analysis and justifies calling party E an extreme party. The extreme party can however be quite large, for example a 25% share of seats is allowed.

3.4 The political process

The political process involves three main stages:

Stage 1: Tax contracts

Stage 2: Election

Stage 3: Government formation

In the first stage we allow parties to sign tax contracts. A tax contract of a party contains a range of tax rates that this party voluntarily commits to during the campaign. The tax contract becomes effective if the party is part of the coalition that forms the government. We assume that there are sufficiently severe sanctions if a party violates the tax contract when in government such that violation will never occur. Such sanctions might be severe fines or drastic reduction or elimination of public financing for such a party.

In the second stage the election takes place, followed by the formation of the government in stage 3. We proceed as follows: In the next section we examine the political process in the absence of tax contracts. This case not only captures what occurs in present-day practice in representative democracies, it also serves as a benchmark for the scenario with tax contracts. If no tax contracts are allowed, only stages 2 and 3 occur. In stage 3 either a single party is able to form the government or two parties j and k form a coalition. We assume that coalitions are formed only by the conventional parties, i.e. party E is excluded from the government formation process. This is justified by the indivisibility of the policy option d and the role of ideology as a constraint

on bargaining by parties, which is a prominent theme and an important argument in the political economy literature (see Mueller (2003), Benabou (2008)). The defining characteristic of party E is policy $d = \bar{d}$. Hence for ideological reasons a compromise in this political dimension is not possible for the extreme party. The following stages ensue if j and k form a coalition:

Stage 3.1: Parties maximize

$$\sigma_k V_k + \sigma_j V_j$$

over $(t, g, d = 0)$ subject to the budget constraint

$$tY = (1 + \lambda)(gc + (s_j + s_k)b),$$

where $\sigma_k = \frac{s_k}{s_k + s_j}$ represents the share of seats of party k within the coalition.

Stage 3.2: Vote of confidence. The proposed government coalition is elected if it receives a majority of votes in parliament. If the vote of confidence fails, a “caretaker government” assumes power, which will implement policy vector $(g, t, (b_j)_{j \in \{L, R, E\}}, d) = (\frac{t_{ct}Y}{1+\lambda}, t_{ct}, \mathbf{0}, 0)$.

To simplify the analysis, we assume that the two conventional parties are symmetric, i.e. the median voter is indifferent between the most desired policy/financing scheme of parties L and R if both parties receive half the seats.⁶

4 Election and Government Formation without Tax Contracts

4.1 Government formation

We first outline the detailed game for government formation. Recall that our major assumption is that only conventional parties can form a government. If a conventional party has a majority of votes, it forms the government and implements its desired policy and financing scheme. If no conventional party has a majority of seats, they

⁶Formally, from $A \ln(\frac{YA}{y_L(1+\lambda)c}) - A \frac{y_m}{y_L} - \frac{S(1+\lambda)b y_m}{2Y} = A \ln(\frac{YA}{y_R(1+\lambda)c}) - A \frac{y_m}{y_R} - \frac{S(1+\lambda)b y_m}{2Y}$ we obtain that the platforms of the parties have to satisfy $\ln(\frac{y_R}{y_L}) = y_m(\frac{1}{y_L} - \frac{1}{y_R})$.

bargain and maximize a weighted sum of their utilities.

In the following we characterize the outcome with a coalition government consisting of the two conventional parties.

Lemma 1

Suppose that both conventional parties form a coalition government. Then the financing/policy outcome is given by

$$t_{LR} = \frac{A}{y_{LR}} + \frac{(1 + \lambda)(s_L + s_R)b}{Y}, \tag{7}$$

$$g_{LR} = \frac{YA}{c(1 + \lambda)y_{LR}}, \tag{8}$$

where $y_{LR} = \frac{s_L y_L + s_R y_R}{s_L + s_R}$.

The proof follows directly from solving the maximization problem described in Stage 3.1 of the government formation process.

4.2 Election

In the next step we examine the decision of the voters and the associated political outcome. We assume that voters with $\delta_i = -1$ vote in favor of party E .⁷

As we have a continuum of voters, an individual voter has no influence on the outcome and any voting outcome may be supported as a Nash equilibrium. Accordingly, we use the following selection criteria: A combination of voting strategies, policy, and financing decisions by the party or coalition in power is called an equilibrium if

- (i) it is a subgame-perfect Nash equilibrium
- (ii) there is no subset of conventional voters that can do better by changing their voting behavior.

Essentially, we are looking for subgame-perfect equilibria with coalition-proof voting. If there are multiple equilibria, we will invoke a further refinement and require that in any equilibrium the set of citizens who vote strategically be minimal.⁸

⁷Sincere voting for the extreme party can also be justified by ideological considerations, see Benabou (2008).

⁸The justification is that coordination of voting e.g. through interest groups is costly and difficult to achieve if the set is large relative to the electorate. If there are multiple equilibria, they are qualitatively equivalent in the sense that government formation is the same across parties.

Voting strategies are denoted by $\mu_i \in \{L, R, E\}$. If the entire constituency votes sincerely, there will be a single-party government of either L or R with probability $\frac{1}{2}$ if the extreme party does not enter parliament. If E enters, only a grand coalition of L and R will be possible.

A grand coalition in event E can be avoided if a sufficiently large subset of the electorate votes strategically. Let the minimal sets of strategic voters preventing a grand coalition in the case of party E entering parliament be $[\hat{y}_R, y_m]$ and $[y_m, \hat{y}_L]$, where $\hat{y}_R < y_m$ and $\hat{y}_L > y_m$. The income levels of the critical voters \hat{y}_L and \hat{y}_R are defined by

$$\begin{aligned}\hat{y}_L &= F^{-1}\left(\frac{S}{2(S-s_E)}\right), \\ \hat{y}_R &= F^{-1}\left(\frac{S-2s_E}{2(S-s_E)}\right).\end{aligned}$$

The notation means that the critical voter \hat{y}_k will vote for party k when voting strategically but will prefer party j when voting sincerely.

There are three types of voting outcomes that can be induced by strategic voting.

- (1) A subset of voters of measure $|[y_m, \hat{y}_k]|$ ($k = L$ or R) deviates from sincere voting, thereby allowing party k to form a single-party government with a minimal majority in event E and with a supermajority comprising $\frac{S^2}{2(S-s_E)}$ seats in event $\neg E$.
- (2) A subset of voters greater than $|[y_m, \hat{y}_k]|$ deviates from sincere voting. This enables party k to build a single-party government with supermajorities in both events E and $\neg E$. In this case, the number of seats for party k will exceed $\frac{S}{2}$ in event E and $\frac{S^2}{2(S-s_E)}$ in event $\neg E$.
- (3) A subset of voters smaller than $|[y_m, \hat{y}_k]|$ deviates from sincere voting. This implies that in event E a grand coalition will still come about, albeit with a policy tilted towards party k 's ideal policy. In event $\neg E$, party k will form a single-party government with a supermajority of seats.

Note that in general there are several possible coalitions of voters for establishing a certain voting outcome, e.g. achieving a single-party government with a minimal majority of seats in event E. We focus on strategic voting by voters with incomes closest to the median income. The reason is as follows:

Suppose an arbitrary subset of voters that would vote for R when voting sincerely switches to party L. This implies that L will form a single-party government in $\neg E$. In event E either a grand coalition will be established, where L has larger bargaining power than R, or a single-party government of L will materialize. Due to the single-peaked preferences, the closer a voter's income is to the median income, the less he will suffer from this policy shift toward L. Hence, if no subset of voters closest to the median has an incentive to deviate from sincere voting, then no subset of voters farther away from the median will have such an incentive either.

The next lemma rationalizes why there may be strategic voting.

Lemma 2

A grand coalition involves higher perks than a single-party government with $\frac{S^2}{2(S-s_E)}$ seats.

The proof follows simply from showing that $S - s_E > \frac{S^2}{2(S-s_E)}$ reduces to $s_E < S(1 - \frac{\sqrt{8}}{4})$, which is given according to Assumption 1.

A detailed analysis of the incentives for strategic voting is given in Appendix A. Here we provide a brief summary. Before we start, note that we do not consider strategic voting for the extreme party in order to reduce perks. There are various possible justifications. For instance, there could be ethical reluctance on the part of conventional voters to vote for extremists. Another reason may be associated with trembles. If by error some small subset of voters additionally votes for E, then this party may come to power and implement an extreme policy change, which is extremely undesirable for conventional voters.

We start our summary by examining the conditions under which deviation (1) may be profitable. As a grand coalition occupies more seats in the legislature than a single-party government, it is associated with higher perks. A subset of voters may thus consider deviating from sincere voting to avoid a grand coalition in case the extreme party becomes part of the legislature. The minimal set of strategic voters needed to avoid a grand coalition is such that in event E a single-party government will occupy a minimal majority of seats in the legislature. To be willing to deviate from sincere voting, this set of voters has to accept a single-party government formed by the less-preferred party in both events – whether E enters the legislature or not – in exchange for lower perks.

For example, suppose that subset $[y_m, \hat{y}_L]$ of the electorate votes strategically for party

L. With probability p , the extreme party will enter parliament and party L will form a single-party government with a minimal majority of seats $\frac{S}{2}$. Without the deviation from sincere voting, a grand coalition had been formed with $S - s_E$ seats. Hence the perks associated with $\frac{S}{2} - s_E$ seats can be avoided with the help of the strategic voters. However, from the perspective of those who consider voting strategically, the beneficial effect of lower perks comes at the price of a policy tilted toward their less-preferred party rather than the moderate policy of a grand coalition. Moreover, if the extreme party cannot enter the legislature, party L will definitely form the single government with a supermajority of $\frac{S^2}{2(S-s_E)}$ seats. With sincere voting, the strategic voters, who actually prefer party R, would have a chance of $\frac{1}{2}$ that their preferred party forms the government in event $\neg E$. Also with sincere voting, there would be minimal majorities for the single-party governments. Hence, we can say that from the perspective of those who consider voting strategically, the only benefit is lower perks in event E from avoiding a grand coalition. The costs are a worse policy in event E and a worse policy in expectation and higher perks in event $\neg E$. Therefore we can infer that strategic voting will only occur if the perks associated with a grand coalition are large and the probability of the extreme party entering parliament is high.

Let us now turn to the question whether deviations (2) and (3) can dominate deviation (1). A comparison of (1) and (2) according to the descriptions given in the list above reveals that the policy outcome would be no different. The only difference is with perks. As deviation (2) yields a larger number of governmental seats and thus larger amounts of perks in any of the possible cases, it is strictly dominated by deviation (1). The result of a comparison between (1) and (3) is not so clear. There may be parameter constellations of a kind making deviation (3) favorable. These are however rather special cases.⁹ Accordingly, we concentrate on strategic voting according to deviation (1) in the remainder of the paper.

In equilibrium we obtain

Proposition 1

(i) If p is small, then there exists a unique equilibrium of the political process with

⁹A more detailed discussion can be found in Appendix A.

1.

$$\mu_i = \begin{cases} E & \text{if } \delta_i = -1, \\ R & \text{if } \delta_i = 1, y_i > y_m, \\ L & \text{if } \delta_i = 1, y_i < y_m, \\ L \text{ or } R & \text{if } \delta_i = 1, y_i = y_m. \end{cases}$$

2. If E does not enter, L and R have a chance of $\frac{1}{2}$ to form the government. The policy outcome if party k assumes power is given by

$$t_k^* = \frac{A}{y_k} + \frac{(1+\lambda)bS}{Y} \frac{1}{2},$$

$$g_k^* = \frac{YA}{y_k(1+\lambda)c}.$$

3. If E does enter, L and R form a grand coalition with outcome

$$t_{LR}^* = \frac{A}{y_{LR}} + \frac{(1+\lambda)b(S - s_E)}{Y},$$

$$g_{LR}^* = \frac{YA}{y_{LR}(1+\lambda)c},$$

where $y_{LR} = \frac{y_L + y_R}{2}$.

(ii) If p is at an intermediate level, then there exists an equilibrium with

1.

$$\mu_i = \begin{cases} E & \text{if } \delta_i = -1 \\ R & \text{if } \delta_i = 1, y_i > \hat{y}_j, \\ L & \text{if } \delta_i = 1, y_i < \hat{y}_j, \\ j & \text{if } \delta_i = 1, y_i = \hat{y}_j, \end{cases}$$

where j is either L or R .

2. Party j will form a single-party government independently of whether the extreme party enters parliament. The policy outcome will be

$$t_j^* = \begin{cases} \frac{A}{y_j} + \frac{(1+\lambda)bS}{Y} \frac{1}{2}, & \text{if } E \text{ enters parliament,} \\ \frac{A}{y_j} + \frac{(1+\lambda)bS}{Y} \frac{s_E}{S - s_E}, & \text{if } E \text{ does not enter parliament,} \end{cases}$$

$$g_j^* = \frac{YA}{y_j(1+\lambda)c}.$$

(iii) If p is large, then there exist two equilibria with

1.

$$\mu_i = \begin{cases} E & \text{if } \delta_i = -1, \\ R & \text{if } \delta_i = 1, y_i > \hat{y}_l, \\ L & \text{if } \delta_i = 1, y_i < \hat{y}_l, \\ l & \text{if } \delta_i = 1, y_i = \hat{y}_l, \end{cases}$$

$l \in \{R, L\}$, i.e. l can be both L and R .

2. Party l will form a single-party government independently of whether the extreme party enters parliament. The policy outcome will be

$$t_l^* = \begin{cases} \frac{A}{y_l} + \frac{(1+\lambda)b}{Y} \frac{S}{2}, & \text{if } E \text{ enters parliament,} \\ \frac{A}{y_l} + \frac{(1+\lambda)b}{Y} \frac{S}{2} \frac{s_E}{S-s_E}, & \text{if } E \text{ does not enter parliament,} \end{cases}$$

$$g_l^* = \frac{YA}{y_l(1+\lambda)c}.$$

The precise threshold values for p distinguishing the three cases in Proposition 1 are given in the extended version of this proposition in Appendix A. There we also provide a formal proof of the proposition. Here we give an intuitive explanation.

According to the intuition of the strategic voter's trade-off given above, the benefits of strategic voting accrue in event E when the formation of a grand coalition is avoided. In event $\neg E$, strategic voting bears utility losses relative to sincere voting. Hence if the probability p for event E to occur is low, the probability of reaping the benefits of strategic voting is low but the complementary probability $1 - p$ of realizing the costs is high. Thus strategic voting is unattractive and will not occur in equilibrium for low probabilities of party E entering parliament. In such cases, both conventional parties receive the same share of votes. A grand coalition forms in event E and a single-party government by either L or R with a minimal majority of seats comes about in event $\neg E$.

For higher values of p , strategic voting becomes attractive. Note that the preferences of voters are symmetric in the sense that half of the electorate would prefer either of the conventional parties if they voted sincerely, but in general utility derived from policies is not symmetric.¹⁰ Therefore it is possible that, for a given probability p , all individuals

¹⁰As an example, consider two individuals characterized by incomes y_l and y_r that have the same relative position to the median income, i.e. $y_l/y_m = y_m/y_r$. Our model does not possess the feature that both individuals enjoy the same level of utility from the median voter's most-preferred policy (t_{y_m}, g_{y_m}) .

in the set $[y_m, \hat{y}_L]$ prefer to vote strategically. But this is not the case for all individuals in the set $[\hat{y}_R, y_m]$ and vice versa. As a consequence, at an intermediate level of p a coordination of voters can occur only in the direction of one of the two conventional parties. In both events E and $\neg E$, this results in a single-party government formed by the party that the strategic voters have coordinated on. In event E, the government possesses a minimal majority of seats, whereas in event $\neg E$ it occupies a supermajority of seats.

In the third case distinguished in the proposition where p is high, coordination on any of the two conventional parties is an equilibrium. The outcome is essentially the same as in the case of an intermediate level of p , except that now there are subsets of voters on both sides of the political spectrum that have an incentive to vote strategically.

5 Tax Contracts

We now allow parties to sign tax contracts in which a party k restricts its tax policy to an interval $\tau_k = [\underline{t}_k^C, \bar{t}_k^C]$ before the election takes place. We solve the political process by backward induction. Voters take optimal voting decisions, and conventional parties offer optimally chosen tax contracts anticipating voting decisions and government formation.

5.1 Preliminary analysis

Again we are looking for subgame-perfect equilibria that are coalition-proof among conventional voters. As preliminary steps for this analysis we establish the following results:

Lemma 3

Suppose that party k can form the government and has signed the tax contract τ_k .

1. *If $t_k^* \in \tau_k$, party k chooses t_k^* .*
2. *If $\bar{t}_k^C < t_k^*$, party k chooses \bar{t}_k^C .*
3. *If $\underline{t}_k^C > t_k^*$, party k chooses \underline{t}_k^C .*

Lemma 3 says that a party that is the sole party in power will always implement its most-preferred tax rate given this is allowed by its tax contract. If its most-preferred

tax rate is not included in the tax contract, then the party will choose the boundary of its tax contract that is closest to its ideal tax rate.

Without tax contracts voters can be unambiguously attributed to preferring a certain party. That is, for any given amount of governmental seats, individual i will prefer party k to party j . In general, this is not possible in the setting with tax contracts. As the parties fix a tax rate they will implement once in office, it depends on the election outcome how much is spent on the public good and how much on perks. Accordingly, their preferences depend on their (rational) expectations about the result of the election. We adopt the following definition of sincere voting when tax contracts are offered:

Definition 1 (sincere voting)

A voter votes sincerely if he votes for the party whose policy he likes best given that both conventional parties receive the same number of seats.

The assumption that not all voters will behave as strategic players in the usual game-theoretic sense appears to be very realistic and has a long tradition in the literature. The most prominent line is Baron (1994), Grossman and Helpman (1996), McKelvey and Ordeshook (1987), and Ortin and Schultz (2005). Using sincere voting in our model makes it easy to construct the equilibria in which some voters vote strategically. However, as we will discuss at the end of this section, we could dispense with the above definition and assume that all conventional voters will correctly predict the election outcome and vote accordingly. Additionally, our equilibria with and without tax contracts would not change if all conventional voters voted entirely strategically.

In the next step we examine what is the median voter's most preferred tax rate under sincere voting. We use

$$g(t, s_k) := \frac{tY - (1 + \lambda)s_k b}{(1 + \lambda)c} \tag{9}$$

to denote the level of public goods party k chooses if it forms a government with s_k seats and is committed to a tax rate t . Similarly, $g(t, s_L + s_R)$ is the level of public goods parties L and R choose if they form a coalition government with $s_L + s_R$ seats and are committed to a tax rate t .

Under sincere voting, two situations can occur if the extreme party enters parliament. First, the conventional parties' tax contracts overlap and a grand coalition accedes to power with $S - s_E$ seats. Second, the tax contracts do not overlap, and there will be a caretaker government. If the parties' tax sets are not disjunct, the median voter's

preferred (second-best) policy¹¹ is the solution of the following problem:

$$\max_t E[U_{y_m}] = p(A \ln g(t, S - s_E) + (1 - t)y_m) + (1 - p)(A \ln g(t, S/2) + (1 - t)y_m).$$

We obtain

Lemma 4

There exists a unique tax rate $t_{y_m}(S/2, S - s_E)$ that maximizes the median voter's expected utility under sincere voting if $t_{y_m}(S/2, S - s_E)$ is in the intersection of the conventional parties' tax sets. It is given implicitly by

$$\frac{Y}{(1 + \lambda)c} \left(\frac{pA}{g(t, S - s_E)} + \frac{(1 - p)A}{g(t, S/2)} \right) = y_m \quad (10)$$

The proof is obvious. As $g(t, S - s_E)$ and $g(t, S/2)$ are strictly increasing in t , the left-hand side of (10) is strictly decreasing in t . Hence there is unique $t_{y_m}(S/2, S - s_E)$, which can be determined by solving (10) for t .

Now we turn to the situation where the conventional parties' tax sets do not intersect. In this case there will be a caretaker government in event E whose value to the median voter is independent of the parties' tax-contract choices, so the problem of finding the optimal tax rate boils down to

$$\max_t E[U_{y_m}] = (1 - p)(A \ln g(t, S/2) + (1 - t)y_m).$$

The solution is given by equation (1) in Section 3, i.e.

$$t_{y_m}(S/2, ct) := \frac{A}{y_m} + \frac{(1 + \lambda)bS}{Y} \frac{S}{2}, \quad (11)$$

where ct stands for caretaker government.

In general, the tax rates $t_{y_m}(S/2, S - s_E)$ and $t_{y_m}(S/2, ct)$ are different. We next observe that $\tau_L = \tau_R = t_{y_m}(S/2, S - s_E)$ cannot be an equilibrium. Each party has an incentive to deviate because by choosing a tax rate closer to $t_{y_m}(S/2, ct)$, it can win more votes under sincere voting. Consequently, if a subset of voters coordinates on one party to avoid a caretaker government, it will be the one that deviated due to the minimal strategic voters refinement. Hence, the two conventional parties signing a tax contract with $t_{y_m}(S/2, S - s_E)$ cannot be an equilibrium. By contrast, the two conventional parties choosing $t_{y_m}(S/2, ct)$ is an equilibrium, as stated in the next proposition. To simplify notation we abbreviate $t_{y_m}(S/2, ct)$ by t_{y_m} in the following.

¹¹Recall that perks cannot be avoided.

5.2 Equilibria with tax contracts

To characterize the equilibria of the entire game with tax contracts, let us define the probability

$$\hat{p} = \frac{\ln \left(\frac{g(t_{ym}, S/2)}{g(t_{ym}, \frac{S^2}{2(S-s_E)})} \right)}{\ln \left(\frac{g(t_{ym}, S/2)}{g(t_{ym}, S-s_E)} \right) + \ln \left(\frac{g(t_{ym}, S/2)}{g(t_{ym}, \frac{S^2}{2(S-s_E)})} \right)}. \quad (12)$$

Now we obtain

Proposition 2

The following equilibria exist:

(i) If $p \leq \hat{p}$,

1. $\tau_L = \tau_R = \{t_{ym}\}$.

2.

$$\mu_i = \begin{cases} R & y_i > y_m, \\ L & y_i < y_m, \\ R \text{ or } L & y_i = y_m. \end{cases}$$

3. If E does not enter, each conventional party will win the election with probability $\frac{1}{2}$, form the government, and choose $g_k(t_{ym}, \frac{S}{2})$. If E does enter, both conventional parties form a grand coalition and choose $g_k(t_{ym}, S - s_E)$.

(ii) For all $p > \hat{p}$,

1. $\tau_L = \tau_R = \{t_{ym}\}$.

2. either

(a)

$$\mu_i = \begin{cases} R & y_i > \hat{y}_L, \\ L & y_i \leq \hat{y}_L. \end{cases}$$

Party L forms the government independently of whether E enters. Party L chooses $g_L(t_{ym}, \frac{S}{2})$ if E does enter and $g_L(t_{ym}, \frac{S^2}{2(S-s_E)})$ if E does not enter.

or

(b)

$$\mu_i = \begin{cases} R & y_i \geq \hat{y}_R, \\ L & y_i < \hat{y}_R. \end{cases}$$

Party R forms the government independently of whether E enters. Party R chooses $g_R(t_{y_m}, \frac{S}{2})$ if E enters parliament and $g_R(t_{y_m}, \frac{S^2}{2(S-s_E)})$ if E does not enter.

The main conclusions from Proposition 2 are that strategic voting to avoid a grand coalition occurs when p is larger than a certain threshold, and that tax contracts yield moderate policy outcomes. That is, the conventional parties will commit themselves to a tax rate close to the one preferred by the median voter and, as perks are restricted by $(S - s_E)b$, the amount of public good provision cannot be extremely low or excessively high. However, recall from section 5.1 that the policy outcome in event E with tax contracts is not the policy most preferred by the median voter. In the next section we will provide detailed intuitive explanations for Proposition 2 by comparing the policy outcomes of the political process with and without tax contracts in societies that exhibit different degrees of political polarization. First however, it is useful to note the following corollary:

Corollary 1

The equilibria in Proposition 2 remain the same if all voters correctly predict the election outcome.

Corollary 1 follows from the proof of Proposition 2. Given that the parties offer $\tau_L = \tau_R = \{t_{y_m}\}$ and given e.g. the voting decisions of voters in $[\hat{y}_L, y_m]$ in the case of (ii) 2.(a), it is optimal for voters in $[y_{min}, \hat{y}_L)$ to vote for party L and voters in $(y_m, y_{max}]$ to support R . Next to voting behavior on the basis of $\tau_L = \tau_R = \{t_{y_m}\}$, the crucial issue is whether parties gain an incentive to deviate from t_{y_m} once all voters possess correct expectations of the voting outcome. To show that this is not the case, the reasoning in the proof of Proposition 2 can be readily applied as long as the deviating party loses vote shares. The latter must be the case for the following reason: First, holding perks fixed, the policy of the deviating party attracts fewer voters. Since it attracts fewer voters, the perks may decline, which acts to increase the vote share. However, this (positive) effect on vote share from lower perks can never outweigh the (negative) effect on vote shares from the deviation in policy (i.e. tax rates). Our definition of sincere voting neglects this ‘perks effect’. However the proof of Proposition 2 still holds true if voters have correct expectations, as the neglected perks effect is dominated by

the ‘policy effect’ on vote shares.

6 Effects of Tax Contracts

Tax contracts have two effects on policy outcomes. First, tax contracts keep policies moderate, and second, they help to avoid the large amounts of perks associated with grand coalitions. The first effect follows directly from Proposition 2. In this section we explain why grand coalitions are less likely to occur in a regime with tax contracts than in a regime without tax contracts.

We start by defining the degree of political polarization as the distance between the two conventional parties’ platforms:

Definition 2

$$\Delta_y = y_R - y_L$$

When varying the degree of political polarization, we keep the symmetry assumption, i.e. the median voter will receive the same utility from both parties’ preferred policies.

If, in the regime with tax contracts, the probability of the extreme party entering parliament is higher than \hat{p} , then a subset of voters will deviate from sincere voting to reduce the perks associated with a grand coalition. In the next lemma we state that this already happens if the probability of the extreme party becoming part of the parliament is smaller than $\frac{1}{2}$.

Lemma 5

$$\hat{p} < \frac{1}{2}.$$

The proof is given in the appendix.

Without tax contracts, the costs of a deviation from sincere voting in terms of public-good policy clearly depend on the political polarization of the society. It is interesting to ask how the two regimes – with and without tax contracts – compare with respect to preventing a grand coalition by strategic voting. Without tax contracts, this will happen if p is not too small. The critical threshold is denoted by p^{nc} such that grand coalitions are avoided if $p > p^{nc}$. The formal derivation of p^{nc} can be found in Appendix A (Equation (24) and Proposition 1 (Extended Version)). We obtain

Proposition 3

For all degrees of political polarization, $\hat{p} < p^{nc}$.

A formal proof is given in Appendix B. Proposition 3 says that for all probabilities p for which grand coalitions are avoided by strategic voting in the regime without tax contracts, they will also be avoided in the regime with tax contracts. Moreover, there is a set of p values for which strategic voting occurs with tax contracts but not without tax contracts. In these situations tax contracts reduce the perks enjoyed by the government.

To sharpen the intuition, we consider the case without political polarization, i.e. where both parties have the median voter's utility as their political platform. Then the only difference between a regime with and without tax contracts is the way in which the additional seats of supermajorities are financed. Recall that in both regimes supermajorities occur with sincere voting in event E and with strategic voting in event $\neg E$. To switch to strategic voting means to exchange a large supermajority with probability p and minimal majority governments with probability $1 - p$ for a smaller supermajority with probability $1 - p$ and a minimal majority with probability p .

In the regime without tax contracts, an additional governmental seat is financed by a tax increase that involves constant marginal utility losses for the voters. A tax increase in the event of the extreme party entering parliament is not possible in the regime with tax contracts, and additional governmental seats are financed by lower public good provision. Due to the strict concavity of voters' utility from the public good, the marginal utility loss of an additional seat increases with the size of the supermajority. Due to the increasing marginal utility losses of financing additional perks via cuts in public good provision, the relative benefit from having a smaller supermajority is larger in the regime with tax contracts. Therefore the critical probability of switching from sincere voting to strategic voting is lower in the tax-contract regime than in the regime without tax contracts.

In addition, when there is political polarization, the attractiveness of voting strategically declines in the regime without tax contracts. The reason is that in order to avoid the perks associated with a grand coalition, the set of strategic voters also incurs the cost of a less favorable policy pursued by the party on the other side of the political spectrum. In this way, the weight attached to the utility gain from avoiding a grand coalition, p , must be higher for strategic voting to occur. In fact, the costs for the strategic voters increases with the degree of political polarization. Therefore the critical probability p^{nc} for strategic voting in the regime without tax contracts is higher, the more polarized the society is. By contrast, the critical probability for strategic voting

in the regime with tax contracts is not affected by the level of political polarization, as parties commit themselves to moderate tax rates. Hence, the cost incurred by the strategic voters in terms of less favorable policies is absent with tax contracts. In this way, the effect of tax contracts on avoiding large amounts of perks in grand coalitions is particularly significant in polarized societies.

7 Welfare of the Median Voter

In this section we examine how the welfare of the median voter is affected by the introduction of tax contracts. In particular, we are interested in how tax contracts impact on taxes, public good provision, and perks, and how this is evaluated by the median voter. According to the results in the previous section, we have to distinguish three cases with respect to the probability of the extreme party entering parliament.

- $p \leq \hat{p}$: sincere voting equilibrium occurs in both regimes – with and without tax contracts.
- $\hat{p} < p < p^{nc}$: strategic voting to avoid a grand coalition occurs only in the regime with tax contracts but not in the regime without tax contracts.
- $p > p^{nc}$: strategic voting occurs with and without tax contracts.

We summarize the main insights in the next proposition:

Proposition 4

Case 1: $p \leq \hat{p}$: The median voter benefits from tax contracts if polarization is high. The opposite is the case for very low levels of polarization.

Case 2: $\hat{p} < p < p^{nc}$: The median voter benefits from tax contracts if polarization is high. He may also benefit if the level of polarization is low.

Case 3: $p > p^{nc}$: The median voter benefits from tax contracts if polarization is high. The opposite is the case for very low levels of polarization.

The following reasoning establishes the proof of the proposition. Consider the first case where $p < \hat{p}$. The condition that tax contracts yield higher welfare for the median voter is

$$\begin{aligned}
& (1-p) U_{y_m}(t_{y_m}, S/2) + p U_{y_m}(t_{y_m}, S - s_E) \\
& > \frac{1-p}{2} [(U_{y_m}(t_L(S/2), S/2) + U_{y_m}(t_R(S/2), S/2))] + p U_{y_m}(t_{RL}(S - s_E), S - s_E). \tag{13}
\end{aligned}$$

$U_y(t, s)$ represents the utility a conventional voter ($\delta = 0$) with income y derives from a policy characterized by a tax rate t and implemented by a government with s seats.¹² In condition (13) we explicitly write the tax rates in the regime without tax contracts as functions of the number of governmental seats. $t_k(s_k)$ and $t_{LR}(s_L + s_R)$ are defined by (4) and (7), respectively. By contrast, the equilibrium tax rate t_{y_m} in the regime with tax contracts as characterized in (11) does not react to different sizes of the government. Condition (13) expresses the utility of the median voter with tax contracts on the left-hand side and without tax contracts on the right-hand side. For the following arguments it is convenient to rewrite (13) in the following way:

$$\begin{aligned}
(1-p) [U_{y_m}(t_{y_m}, S/2) - 1/2 (U_{y_m}(t_L(S/2), S/2) + U_{y_m}(t_R(S/2), S/2))] \\
> p [U_{y_m}(t_{RL}(S - s_E), S - s_E) - U_{y_m}(t_{y_m}, S - s_E)] \tag{14}
\end{aligned}$$

Now, the left-hand side represents the utility difference between the regimes with and without tax contracts in event $\neg E$ and the right-hand side the utility difference in event E . We note again that t_{y_m} represents the most-preferred tax rate of the median voter in the case of a minimal majority. However, in case of a supermajority he would prefer higher taxes. Hence, if the tax rate t_{RL} of the grand coalition without tax contracts is not too far from the median voter's most-preferred tax rate in the case of a government with $S - s_E$ seats, the right-hand side of (14) is clearly positive. As already indicated, this reflects the fact that the median voter prefers to finance the supermajority of the grand coalition via tax increases rather than cuts in public good provision. In event $\neg E$, which is represented on the left-hand side of the equation, there will be minimal winning coalitions of single-party governments. The left-hand side is positive since (1) the outcome under tax contracts reflects the median voter's most-preferred policy, and (2) the voters' utilities are concave, so the convex combination of two policies yields lower utility than the voters' most-preferred policy. Although the left-hand side of (14) is always positive, it is zero if there is no political polarization, i.e. if party L and party R both have the median voter as their platform voter. Moreover, in this case the right-

¹²Note that the tax rate and the number of seats of the government (t, s) are sufficient to characterize the policy with respect to public good provision via the budget constraint, as each seat carries perks b with it.

hand side becomes positive. Consequently, we can infer that with very low levels of polarization the regime without tax contracts gives higher utility for the median voter than the regime with tax contracts. This changes when the degree of polarization becomes sufficiently large. Then the left-hand side is highly positive, compensating for a potentially positive right-hand side of condition (14). This is due to the moderating effect of tax contracts on policy.

In the case where $\hat{p} < p < p^{nc}$, tax contracts may yield higher welfare than the regime without tax contracts, even in societies with a low degree of polarization. The reason is that tax contracts not only lead to moderate tax rates, they also lower perks by avoiding a grand coalition in event E. The condition for tax contracts to be favorable for the median voter is

$$(1-p) \left[U_{y_m} \left(t_{y_m}, \frac{S^2}{2(S-s_E)} \right) - \frac{1}{2} (U_{y_m} (t_L(S/2), S/2) + U_{y_m} (t_R(S/2), S/2)) \right] > p [U_{y_m} (t_{RL}(S-s_E), S-s_E) - U_{y_m} (t_{y_m}, S/2)]. \quad (15)$$

Now, the right-hand side is strictly negative as the grand coalition is avoided in the regime with tax contracts but not in the one without tax contracts. However, there is a utility loss associated with strategic voting in event $\neg E$, due to the supermajority of the single-party government. Consequently, for small degrees of polarization, the left-hand side becomes negative as well. However, condition (15) may still hold meaning that tax contracts are also favorable with low polarization.

Finally, when p is large, we again obtain a situation where tax contracts are welfare-improving for the median voter if the society is polarized but are less favorable for very low degrees of polarization. In this case, the regime with tax contracts is preferred to that without tax contracts if

$$(1-p) \left[U_{y_m} \left(t_{y_m}, \frac{S^2}{2(S-s_E)} \right) - \frac{1}{2} (U_{y_m} \left(t_L \left(\frac{S^2}{2(S-s_E)} \right), \frac{S^2}{2(S-s_E)} \right) + U_{y_m} \left(t_R \left(\frac{S^2}{2(S-s_E)} \right), \frac{S^2}{2(S-s_E)} \right)) \right] > p [U_{y_m} (t_{RL}(S-s_E), S/2) - U_{y_m} (t_{y_m}, S/2)] \quad (16)$$

Again we see that the median voter prefers supermajorities to be financed by a tax increase rather than a decrease in the provision of the public good. Consequently, for small degrees of polarization the left-hand side can be negative, whereas the right-hand side is close to zero. However, for a sufficiently high degree of polarization, the political costs of strategic voting in the regime without tax contracts become large, and the moderating effect of tax contracts is dominant.

We might conclude from this discussion that it would be useful to consider an extended framework for the introduction of tax contracts. For instance, if voters could decide on election day whether they would like the tax contracts to be enforced, tax contracts would only be introduced if they are supported by the median voter. This would occur in highly polarized societies.

8 Extensions

An important assumption of our model is that the number of seats in a grand coalition is larger than the number of seats in a single-party government if voters coordinate on one party and the extreme party does not enter parliament. As there are fixed perks per member of parliament, a grand coalition is always more expensive for the voters than a single-party government.

Alternatively, one could make the following assumption: A single-party government involves a fixed amount of perks of P_{sg} , whereas a grand coalition takes an amount P_{gc} of perks with $P_{gc} > P_{sg}$. With this assumption, the results would differ slightly. Without tax contracts, the results remain the same if perks are adjusted correspondingly. However, with tax contracts the voters always coordinate on a single-party government. The difference to this paper's assumption is that single-party governments are now equally expensive with respect to perks, i.e. there is no difference between a single-party government with $S/2$ seats and one with $S^2/2(S - s_E)$ seats. In this way, tax contracts would always prevent a grand coalition, whereas without tax contracts this would only be the case in a society with sufficiently low polarization or a sufficiently high probability p of the extreme party entering parliament. Hence choosing this alternative formulation would reinforce our main results.

9 Conclusion

We have examined a novel institution called tax contracts and find that, particularly in polarized societies, it exhibits socially desirable properties. In addition, allowing parties to make binding tax promises may have further advantages. It gives parties access to political leadership that can be trusted to fulfill their promises and to provide public services. While such leadership can be gained by maintaining a reputation for appropriately rewarding agents and citizens (Myerson, 2008) in a society, tax contracts

could function as a complementary measure.

Appendix

A Formal Details on Strategic Voting Without Tax Contracts

In this section we formally depict the trade-off of strategic voters between avoiding large amounts of perks associated with a grand coalition and the expense of a less desirable policy. Then we argue that only deviation (1) of the three possible deviations from sincere voting given in section 4.2 is of interest for the paper. Finally, we give a formal version of Proposition 1.

To formally depict the trade-off that strategic voters face, we can write the tax rate of a party k with s_k seats in the legislature by using equation (4) as

$$t_k(s_k) := \frac{A}{y_k} + \frac{(1+\lambda)b}{Y}s_k = \frac{A}{y_k} + \frac{(1+\lambda)bS}{Y} \frac{1}{2} + \frac{(1+\lambda)b}{Y} \left(s_k - \frac{S}{2} \right). \quad (17)$$

This notation separates the share of the tax rate that finances the perks for a super-majority government from the tax rate of this party if it were to form a single-party government with a minimal majority of seats. (17) can also be written as

$$t_k(s_k) = t_k(S/2) + \frac{(1+\lambda)b}{Y} \left(s_k - \frac{S}{2} \right).$$

Accordingly, we refer to the tax rate of a grand coalition as

$$t_{jk} = \frac{A}{y_{jk}} + \frac{(1+\lambda)bS}{Y} \frac{1}{2} + \frac{(1+\lambda)b}{Y} \left(\frac{S}{2} - s_E \right) = t_{jk}(S/2) + \frac{(1+\lambda)b}{Y} \left(\frac{S}{2} - s_E \right).$$

The difference in a voter i 's utility from the policies of two different parties j and k can then be expressed in the following way:

$$\begin{aligned} A \ln g_k - t_k(S/2)y_i - (A \ln g_j - t_j(S/2)y_i) - \frac{y_i(1+\lambda)b}{Y} \left[\left(s_k - \frac{S}{2} \right) - \left(s_j - \frac{S}{2} \right) \right] \\ = U_{y_i}(t_k, S/2) - U_{y_i}(t_j, S/2) - \frac{y_i(1+\lambda)b}{Y} \left[\left(s_k - \frac{S}{2} \right) - \left(s_j - \frac{S}{2} \right) \right]. \end{aligned} \quad (18)$$

Equation (18) reveals that utility differences can be separated into two parts: the difference in the political orientation of parties k and j and the different sizes of super-majorities in the legislature. Note that a party's public good provision is unaffected by the number of governmental seats. The latter merely determine how expensive the

respective level of public good provision will be. Accordingly, (18) illustrates that a voter preferring the political orientation of party k may trade off a better policy with respect to public good provision, which is more expensive due to a large supermajority, for a worse public good policy that is cheaper. For this reason, a subset of voters could decide to vote strategically for L , although when voting sincerely they would support R , and vice versa.

A necessary condition for the respective subset to deviate from sincere voting is that the outmost members of the sets, the voters characterized by \hat{y}_L and \hat{y}_R , will vote strategically. Thus, coordination on L is possible if and only if

$$\begin{aligned} & \frac{1-p}{2}[U_{\hat{y}_L}(t_R, S/2) + U_{\hat{y}_L}(t_L, S/2)] + p[U_{\hat{y}_L}(t_{RL}, S - s_E)] \\ & < (1-p)U_{\hat{y}_L}(t_L, \frac{S^2}{2(S - s_E)}) + pU_{\hat{y}_L}(t_L, S/2). \end{aligned}$$

According to the previous notation, this condition can be rewritten to directly illustrate the trade-off between public good policy and perks.

$$\begin{aligned} & \frac{1-p}{2}[A \ln g_R^* - t_R(S/2)\hat{y}_i - (A \ln g_L^* - t_L(S/2)\hat{y}_i)] \\ & + p(A \ln g_{LR}^* - t_{RL}(S/2)\hat{y}_i - (A \ln g_L^* - t_L(S/2)\hat{y}_i)) \\ & < \frac{\hat{y}_i}{Y}(1 + \lambda)b \left(p(S/2 - s_E) - (1-p)\frac{S}{2}\frac{s_E}{S - s_E} \right). \end{aligned}$$

The left-hand side of the inequality reflects the utility loss of voting strategically for the less-preferred party. With respect to \hat{y}_L , this is the utility loss from having L 's preferred level of public good provision in both events, E and $\neg E$. The right-hand side represents the utility gain from lower perks. For \hat{y}_L we can write

$$\begin{aligned} & \frac{1-p}{2}[U_{\hat{y}_L}(t_R, S/2) - U_{\hat{y}_L}(t_L, S/2)] + p[U_{\hat{y}_L}(t_{RL}, S/2) - U_{\hat{y}_L}(t_L, S/2)] \\ & < \frac{\hat{y}_L}{Y}(1 + \lambda)b \left(p(S/2 - s_E) - (1-p)\frac{S}{2}\frac{s_E}{S - s_E} \right). \end{aligned} \tag{19}$$

The condition for subset $[\hat{y}_R, y_m]$ to deviate from sincere voting is

$$\begin{aligned} & \frac{1-p}{2}[U_{\hat{y}_R}(t_L, S/2) - U_{\hat{y}_R}(t_R, S/2)] + p[U_{\hat{y}_R}(t_{RL}, S/2) - U_{\hat{y}_R}(t_R, S/2)] \\ & < \frac{\hat{y}_R}{Y}(1 + \lambda)b \left(p(S/2 - s_E) - (1-p)\frac{S}{2}\frac{s_E}{S - s_E} \right). \end{aligned} \tag{20}$$

In a next step, we will examine possible motives for deviations from sincere voting according to items (2) and (3) of the list in section 4.2. We start with deviation (2),

i.e. subset $[y_m, \tilde{y}_k]$ with measure greater than $[y_m, \hat{y}_k]$ votes strategically. In this case party k forms a single-party government in events E and $\neg E$. Without loss of generality, we let $k = L$. We can write the participation constraint for voter \tilde{y}_L as follows:

$$\begin{aligned} & \frac{1-p}{2}[U_{\tilde{y}_L}(t_R, S/2) - U_{\tilde{y}_L}(t_L, S/2)] + p[U_{\tilde{y}_L}(t_{RL}, S/2) - U_{\tilde{y}_L}(t_L, S/2)] \\ & < \frac{\hat{y}_i}{Y}(1+\lambda)b(p(S/2 - s_E) - [(1-p)(s_L^{-E} - S/2) + p(s_L^E - S/2)]), \end{aligned} \quad (21)$$

where s_k^E and s_k^{-E} denote the number of seats of party k in events E and $\neg E$, respectively. Further, we have $s_L^{-E} - S/2 > \frac{S}{2} \frac{s_E}{S-s_E}$ and $s_L^E - S/2 > 0$.

If we compare deviation (2) with deviation (1) using equations (19) and (21), we observe that voter \tilde{y}_L would enjoy the same utility from public good provision with both deviations. However, the reduction in perks from avoiding a grand coalition in event E is smaller with deviation (2) than with deviation (1). In this sense the set $[\hat{y}_k, \tilde{y}_k]$ has an incentive to return to sincere voting. Hence we conclude that deviation (2) would not occur in equilibrium.

This may be different for deviation (3). Here the subset of strategic voters $[y_m, \tilde{y}_k]$ is smaller than $[y_m, \hat{y}_k]$, which implies that in event E a grand coalition will be formed. Consider now the participation constraint of voter \tilde{y}_k .

$$\begin{aligned} & \frac{1-p}{2}[U_{\tilde{y}_k}(t_j, S/2) + U_{\tilde{y}_k}(t_k, S/2)] + p[A \ln \left[\frac{2AY}{c(1+\lambda)(y_k+y_j)} \right] - \frac{2A\tilde{y}_k}{y_k+y_j} - (1+\lambda)(S-s_E)b\frac{\tilde{y}_k}{Y}] \\ & < (1-p)U_{\tilde{y}_k}(t_k, s_k^{-E}) + p[A \ln \left[\frac{(S-s_E)AY}{c(1+\lambda)(s_k^E y_k + s_j^E y_j)} \right] - \frac{(S-s_E)A\tilde{y}_k}{s_k^E y_k + s_j^E y_j} - (1+\lambda)(S-s_E)b\frac{\tilde{y}_k}{Y}], \end{aligned} \quad (22)$$

with $s_k^E > s_j^E$.

The trade-off for voter \tilde{y}_k is to accept a single-party government formed by his less-preferred party with a supermajority of seats for a better policy with respect to public good provision of a grand coalition in event E. This trade-off can be illustrated by rewriting condition (22) as follows:

$$\begin{aligned} & \frac{1-p}{2}[U_{\tilde{y}_k}(t_j, S/2) - U_{\tilde{y}_k}(t_k, S/2)] + (1-p)(1+\lambda)b\frac{\tilde{y}_k}{Y}(s_k^{-E} - S/2) < \\ & p \left[A \ln \left[\frac{(S-s_E)AY}{c(1+\lambda)(s_k^E y_k + s_j^E y_j)} \right] - \frac{(S-s_E)A\tilde{y}_k}{s_k^E y_k + s_j^E y_j} - A \ln \left[\frac{2AY}{c(1+\lambda)(y_k+y_j)} \right] + \frac{2A\tilde{y}_k}{y_k+y_j} \right]. \end{aligned} \quad (23)$$

The left-hand side of (23) reflects the expected loss of a less desirable policy with

respect to public good provision in $\neg E$, as well as the amount of additional perks for the supermajority of the single-party government of k . On the right-hand side is the expected utility gain from party k having greater weight in coalition bargaining. Two points are worth mentioning. For this deviation to be profitable for the critical voter, his income \tilde{y}_k must be in $(y_m, \frac{y_k + y_j}{2})$. Accordingly, the changes in the policy of a grand coalition due to the additional vote share $(y_m, \tilde{y}_k]$ are not very high. By contrast, depending on the polarization of society, the policy change in $\neg E$ may be strong, as party k can now form a single-party government implementing its preferred policy. Additionally, party k possesses a supermajority involving higher perks than with sincere voting. Taken together, it seems that deviation (3) is favorable in those rather special cases where e.g. p is very high.¹³ Thus we retain the focus of the paper on deviation (1) rather than on deviation (3). In principle, we could just neglect a possible equilibrium that is supported by this type of deviation from sincere voting. To establish a clear formal basis for the analysis we make the following assumption:

Assumption 2

There does not exist a \tilde{y}_k where $k \in \{R, L\}$ and $||[y_m, \tilde{y}_k]|| < ||[y_m, \hat{y}_k]||$ such that (23) holds.

We now obtain the following lemma:

Lemma 6

Given assumption 2,

- (i) *if p is sufficiently small, no subset of voters will vote strategically,*
- (ii) *if $[U_{\hat{y}_L}(t_{RL}, S/2) - U_{\hat{y}_L}(t_L, S/2)] < \frac{\hat{y}_L}{Y}(1 + \lambda)b(S/2 - s_E)$, there exists a unique $p_L^{nc} \in (0, 1)$ such that for all $p \leq p_L^{nc}$ the subset of voters $[y_m, \hat{y}_L]$ does not deviate from sincere voting and for $p > p_L^{nc}$ the subset of voters $[y_m, \hat{y}_L]$ may vote strategically,*
- (iii) *if $[U_{\hat{y}_R}(t_{RL}, S/2) - U_{\hat{y}_R}(t_R, S/2)] < \frac{\hat{y}_R}{Y}(1 + \lambda)b(S/2 - s_E)$, there exists a unique $p_R^{nc} \in (0, 1)$ such that for all $p \leq p_R^{nc}$ the subset of voters $[\hat{y}_R, y_m]$ does not deviate from sincere voting and for $p > p_R^{nc}$ the subset of voters $[\hat{y}_R, y_m]$ may vote strategically.*

The proof can be found in the Appendix.

¹³More precisely, deviation (3) is favorable if (23) holds.

In order to characterize the equilibria, let us define

$$p^{nc} = \begin{cases} p_L^{nc}, & \text{if } p_L^{nc}, p_R^{nc} \in (0, 1) \text{ and } p_L^{nc} \leq p_R^{nc}, \\ p_R^{nc}, & \text{if } p_L^{nc}, p_R^{nc} \in (0, 1) \text{ and } p_R^{nc} < p_L^{nc}, \\ p_L^{nc}, & \text{if } p_L^{nc} \in (0, 1) \text{ and } p_R^{nc} \notin (0, 1) \\ p_R^{nc}, & \text{if } p_R^{nc} \in (0, 1) \text{ and } p_L^{nc} \notin (0, 1) \\ 1, & \text{if } p_L^{nc}, p_R^{nc} \notin (0, 1) \end{cases} \quad (24)$$

and

$$p_h^{nc} = \begin{cases} p_L^{nc}, & \text{if } p^{nc} = p_R^{nc} \text{ and } p_R^{nc} \in (0, 1), \\ p_R^{nc}, & \text{if } p^{nc} = p_L^{nc} \text{ and } p_L^{nc} \in (0, 1), \\ 1, & \text{else.} \end{cases}$$

We obtain

Proposition 1 (Extended Version)

(i) If $p \leq p^{nc}$, then there exists a unique equilibrium of the political process with

$$1. \mu_i = \begin{cases} E & \text{if } \delta_i = -1 \\ R & \text{if } \delta_i = 1, y_i > y_m \\ L & \text{if } \delta_i = 1, y_i < y_m \\ L \text{ or } R & \text{if } \delta_i = 1, y_i = y_m \end{cases}$$

2. If E does not enter, L and R have a chance of $\frac{1}{2}$ to form the government. If party k assumes power the policy outcome is given by

$$t_k^* = \frac{A}{y_k} + \frac{(1 + \lambda)bS}{Y} \frac{1}{2},$$

$$g_k^* = \frac{YA}{y_k(1 + \lambda)c},$$

3. If E does enter, L and R form a grand coalition with outcome

$$t_{LR}^* = \frac{A}{y_{LR}} + \frac{(1 + \lambda)b(S - s_E)}{Y},$$

$$g_{LR}^* = \frac{YA}{y_{LR}(1 + \lambda)c},$$

$$\text{with } y_{LR} = \frac{y_L + y_R}{2}$$

(ii) If $p^{nc} < p \leq p_h^{nc}$, then there exists an equilibrium with

$$1. \mu_i = \begin{cases} E & \text{if } \delta_i = -1 \\ R & \text{if } \delta_i = 1, y_i > \hat{y}_j \\ L & \text{if } \delta_i = 1, y_i < \hat{y}_j \\ j & \text{if } \delta_i = 1, y_i = \hat{y}_j \end{cases}$$

2. Party j will form a single-party government independently of whether the extreme party enters parliament. The policy outcome will be

$$t_j^* = \begin{cases} \frac{A}{y_j} + \frac{(1+\lambda)b}{Y} \frac{S}{2}, & \text{if E enters parliament} \\ \frac{A}{y_j} + \frac{(1+\lambda)b}{Y} \frac{S}{2} \frac{s_E}{S-s_E}, & \text{if E does not enter parliament} \end{cases}$$

$$g_j^* = \frac{YA}{y_j(1+\lambda)c}.$$

- (iii) If $p_h^{nc} < p$, then there exist two equilibria with

$$1. \mu_i = \begin{cases} E & \text{if } \delta_i = -1 \\ R & \text{if } \delta_i = 1, y_i > \hat{y}_l \\ L & \text{if } \delta_i = 1, y_i < \hat{y}_l \\ l & \text{if } \delta_i = 1, y_i = \hat{y}_l \end{cases}$$

$l \in \{R, L\}.$

2. Party l will form a single-party government independently of whether the extreme party enters parliament. The policy outcome will be

$$t_l^* = \begin{cases} \frac{A}{y_l} + \frac{(1+\lambda)b}{Y} \frac{S}{2}, & \text{if E enters parliament} \\ \frac{A}{y_l} + \frac{(1+\lambda)b}{Y} \frac{S}{2} \frac{s_E}{S-s_E}, & \text{if E does not enter parliament} \end{cases}$$

$$g_l^* = \frac{YA}{y_l(1+\lambda)c}.$$

The proof is given in Appendix B.

B Proofs

Proof of Lemma 3

The first point is obvious, as t_k^* is the utility-maximizing tax rate.

The second and third point follow from the single-peakedness of the parties' preferences, i.e. the strict concavity of $U_k(t) = A \ln\left(\frac{tY - (1+\lambda)s_k b}{(1+\lambda)c}\right) - ty_k + 2\theta s_k \sqrt{b}$. The second derivative of $U_k(t)$ is

$$\frac{d^2 U_k(t)}{dt^2} = -A \left(\frac{Y}{tY - (1+\lambda)s_k b} \right)^2 < 0.$$

■

Proof of Lemma 5

By using (9), we can write $g(t, s_k) = g(t, S/2) - \frac{b}{c}(s_k - S/2)$. Inserting into (12), we obtain for the critical probability \hat{p}

$$\hat{p} = \frac{\ln \left[\frac{1}{1 - \frac{b}{cg(t_{y_m}, S/2)} \frac{S}{2} \frac{s_E}{S - s_E}} \right]}{\ln \left[\left(\frac{1}{1 - \frac{b}{cg(t_{y_m}, S/2)} \left(\frac{S}{2} - s_E \right)} \right) \left(\frac{1}{1 - \frac{b}{cg(t_{y_m}, S/2)} \frac{S}{2} \frac{s_E}{S - s_E}} \right) \right]}.$$

Multiplying both the denominator and the numerator by (-1) and applying some minor mathematical manipulations yields

$$\hat{p} = \frac{\ln \left(1 - \frac{b}{cg(t_{y_m}, S/2)} \frac{S}{2} \frac{s_E}{S - s_E} \right)}{\ln \left(1 - \frac{b}{cg(t_{y_m}, S/2)} \left(\frac{S}{2} - s_E \right) \right) + \ln \left(1 - \frac{b}{cg(t_{y_m}, S/2)} \frac{S}{2} \frac{s_E}{S - s_E} \right)}. \quad (25)$$

We will now show that

$$\left| \ln \left(1 - \frac{b}{cg(t_{y_m}, S/2)} \left(\frac{S}{2} - s_E \right) \right) \right| > \left| \ln \left(1 - \frac{b}{cg(t_{y_m}, S/2)} \frac{S}{2} \frac{s_E}{S - s_E} \right) \right|. \quad (26)$$

If this is the case, the denominator can be estimated from below by $2 \ln \left(1 - \frac{b}{cg(t_{y_m}, S/2)} \frac{S}{2} \frac{s_E}{S - s_E} \right)$, which directly implies that \hat{p} must be smaller than 0.5.

Condition (26) transforms to

$$\frac{S}{2} - s_E > \frac{S}{2} \frac{s_E}{S - s_E}.$$

This inequality is equivalent to the grand coalition occupying more seats than a single-party government with $\frac{S^2}{2(S - s_E)}$ seats. We know from Lemma 2 that this is the case, as long as $s_E < 1 - \frac{\sqrt{8}}{4}$, i.e. as long as Assumption 1 holds.

■

Proof of Lemma 6

(i) follows directly from

$$\frac{1}{2} [U_{\hat{y}_L}(t_R, S/2) - U_{\hat{y}_L}(t_L, S/2)] > -\frac{\hat{y}_L}{Y} (1 + \lambda) b \frac{S}{2} \frac{s_E}{S - s_E}$$

and

$$\frac{1}{2}[U_{\hat{y}_R}(t_L, S/2) - U_{\hat{y}_R}(t_R, S/2)] > -\frac{\hat{y}_R}{Y}(1 + \lambda)b\frac{S}{2}\frac{s_E}{S - s_E}$$

(ii) We rewrite (19) as

$$\begin{aligned} \frac{1-p}{2}[U_{\hat{y}_L}(t_R, S/2) - U_{\hat{y}_L}(t_L, S/2)] + p[U_{\hat{y}_L}(t_{RL}, S/2) - U_{\hat{y}_L}(t_L, S/2)] \\ - \frac{\hat{y}_L}{Y}(1 + \lambda)b\left(p\left(\frac{S}{2} - s_E\right) - (1-p)\frac{S}{2}\frac{s_E}{S - s_E}\right) < 0. \end{aligned} \quad (27)$$

From (i) we know that for p sufficiently small, (27) is violated. The condition

$$[U_{\hat{y}_L}(t_{RL}, S/2) - U_{\hat{y}_L}(t_L, S/2)] < \frac{\hat{y}_L}{Y}(1 + \lambda)b(S/2 - s_E)$$

implies that (27) is satisfied for $p = 1$. As the left-hand side of (27) is either strictly increasing or strictly decreasing with p , we infer that in the case where $[U_{\hat{y}_L}(t_{RL}, S/2) - U_{\hat{y}_L}(t_L, S/2)] < \frac{\hat{y}_L}{Y}(1 + \lambda)b(S/2 - s_E)$ holds, it must be increasing with p . Then there is a unique p_L^{nc} where (27), and hence (19), holds with equality.

(iii) The proof of part (iii) follows the same line of argument as that of (ii) but using the condition $[U_{\hat{y}_R}(t_{RL}, S/2) - U_{\hat{y}_R}(t_R, S/2)] < \frac{\hat{y}_R}{Y}(1 + \lambda)b(S/2 - s_E)$ and (20) instead of (19). ■

Proof of Proposition 1 (Extended Version)

Step 1. By construction, the combination of strategies constitutes a subgame perfect equilibrium, as parties respond optimally to the election outcome. Citizens vote according to their preferences.

Step 2.

Consider first situation (i), where $p < p^{nc}$.

We know from Lemma 6 that neither subset of voters $[y_m, \hat{y}_k]$, $k \in \{R, L\}$, has an incentive to deviate from sincere voting. Hence the equilibrium exists. It is unique, as any other candidate equilibrium must involve strategic voting. However, according to Lemma 6 there is no incentive to do so.

(ii) $p^{nc} < p \leq p_h^{nc}$.

In this case, only the voters in set $[y_m, \hat{y}_j]$ have an incentive to deviate from sincere voting but not the voters in set $[y_m, \hat{y}_k]$, as given in Lemma 6. Therefore we have an equilibrium where a subset of voters of measure $|[y_m, \hat{y}_j]|$ will coordinate on party j . It is generally not unique, as there may be many sets of measure $|[y_m, \hat{y}_j]|$, including voters that have an incentive to vote strategically for j .

(iii) $p_h^{nc} < p$.

If p is sufficiently large, both subsets of voters $[y_m, \hat{y}_k]$, $k \in \{R, L\}$, have an incentive to vote strategically. Accordingly, there exist two types of equilibria, one in which a measure of voters $|[y_m, \hat{y}_R]|$ votes strategically for party R, and another where a measure $|[y_m, \hat{y}_L]|$ of voters votes strategically for party L. The equilibria given in the proposition are special cases of these equilibria. ■

Proof of Proposition 2

Consider case (i). I.e. $p \leq \hat{p}$

Step 1. We examine whether the subset of voters $[y_m, \hat{y}_j]$, $j \in \{L, R\}$ can improve their utility by voting strategically, given that $\tau_L = \tau_R = \{t_{y_m}\}$. When the subset $[y_m, \hat{y}_j]$ votes strategically, the expected utility of a voter with income \hat{y}_j is given by

$$U_{\hat{y}_j}^d = p \left(A \ln \left(g \left(t_{y_m}, \frac{S}{2} \right) \right) + (1 - t_{y_m}) \hat{y}_j \right) \\ + (1 - p) \left(A \ln \left(g \left(t_{y_m}, \frac{S^2}{2(S - s_E)} \right) \right) + (1 - t_{y_m}) \hat{y}_j \right).$$

If the subset of voters in $[y_m, \hat{y}_j]$ votes sincerely, the expected utility of voter \hat{y}_j is written as

$$U_{\hat{y}_j}^o = p(A \ln(g(t_{y_m}, S - s_E)) + (1 - t_{y_m}) \hat{y}_j) + (1 - p)(A \ln(g(t_{y_m}, S/2)) + (1 - t_{y_m}) \hat{y}_j).$$

The condition $U_{\hat{y}_j}^d \leq U_{\hat{y}_j}^o$ can be transformed to

$$p \leq \frac{\ln \left(\frac{g(t_{y_m}, S/2)}{g(t_{y_m}, \frac{S^2}{2(S - s_E)})} \right)}{\ln \left(\frac{g(t_{y_m}, S/2)}{g(t_{y_m}, S - s_E)} \right) + \ln \left(\frac{g(t_{y_m}, S/2)}{g(t_{y_m}, \frac{S^2}{2(S - s_E)})} \right)} = \hat{p}$$

Note that this condition is the same for \hat{y}_L and \hat{y}_R , as the tax rate does not differ in the cases with and without strategic voting and the valuation of the public is identical across agents. Hence, in the equilibria with tax contracts there is only one probability threshold for both critical voters \hat{y}_L and \hat{y}_R .

Step 2.

We next examine whether parties might deviate in stage 1 of the political game by offering different tax contracts. In general, we proceed in the following way: For each possible deviation of a party, we have to consider how voting behavior changes and what its implications are for government formation. With respect to voting behavior, we first determine the outcome under sincere voting and check whether subsets of voters can improve by voting strategically. This enables us to determine voting behavior in the case of a deviation from the equilibrium tax contracts, and we can compare the deviating party's utility with the utility it would obtain without the deviation.

Without loss of generality, assume that party R offers $\tau_R^d = [\underline{t}_R^d, \bar{t}_R^d]$. (Note that $\tau_L = \{t_{y_m}\}$.) We consider the following deviations:

- (d1) $\underline{t}_R^d < t_{y_m}$ and $\bar{t}_R^d = t_{y_m}$. That is, party R expands its set of tax rates toward its ideal policy. With this deviation, R is still able to form a grand coalition with policy $(t_{y_m}, S - s_E)$ but can implement a policy closer to its ideal point if it were the only party in government.

As R would implement a policy with $t_R < t_m$ (e.g. (\underline{t}_R^d, s_R)) in a single-party government, with sincere voting there exists a $\tilde{y} > y_m$ such that all voters with income $y_i > \tilde{y}$ vote for R , while the other voters vote for L . This would yield a grand coalition with policy $(t_{y_m}, S - s_E)$ in event E and a single-party government of L in event $\neg E$ involving a policy $(t_{y_m}, S/2 + s^+)$, where s^+ is the number of seats derived from the votes of $[y_m, \tilde{y}]$.

Subsets of voters could now decide to vote strategically in order to either reduce the size of the single-party government of L in event $\neg E$ or to prevent a grand coalition in event E . In the first case, all voters in $[y_m + \varepsilon, \tilde{y}]$, where ε is a positive very small number, vote for R . This would yield the same utility to the voters as in the case of sincere voting without the deviation of party R . According to Step 1 of the proof, this utility level is higher for the critical voter \hat{y}_L than if a subset $[y_m, \hat{y}_L]$ voted for L with the aim of preventing a grand coalition. Hence

the subset of voters $[y_m + \varepsilon, \tilde{y}]$ would coordinate on R, and there would be no subset of voters willing to prevent a grand coalition.

This change in voting behavior implies that the deviating party has no chance of forming a single-party government in event $\neg E$ and will realize the same utility level from a grand coalition in event E. Thus party R would be worse off with the deviation.

- (d2) $\underline{t}_R^d < t_{y_m}$ and $\bar{t}_R^d < t_{y_m}$. In this case, party R does not include t_{y_m} in its tax set to prevent a grand coalition. In a single-party government, R would choose (\underline{t}_R^d, s_R) . Note that we do not preclude $\underline{t}_R^d = \bar{t}_R^d$.

Under sincere voting, there will again exist a critical voter $\tilde{y} > y_m$ such that all voters i with income $y_i > \tilde{y}$ vote for R, and the other voters vote for L. The policy outcome would be a caretaker government in event E and a single-party government of L in event $\neg E$ with policy $(t_{y_m}, S/2 + s^+)$.

Two improvements by strategic voting are conceivable. First, if a caretaker government yields sufficiently low utility for the voters, they can avoid it by a subset $[\tilde{y}, \hat{y}_k]$ coordinating on party $k \in \{R, L\}$. Due to the minimal strategic voting refinement, the party the voters coordinate on is L. A second situation arises when the caretaker government would yield similar (but not higher) utility levels to a grand coalition for the voters. Then, as with deviation (d1), the subset $[y_m + \varepsilon, \tilde{y}]$ would coordinate on R in order to have a minimal majority of the single-party government of L in event $\neg E$.

In both cases – a caretaker government involving very low utility to the voters and a caretaker government yielding moderate utility levels – party R will have no chance of coming into power. Hence deviation (d2) is not profitable.

- (d3) $\underline{t}_R^d \geq t_{y_m}$ and $\bar{t}_R^d > t_{y_m}$. For completeness, we add that a possible deviation by R might also be to expand the set to include policies t farther away from its ideal point or even to have only policies farther away from the ideal point without including t_{y_m} . By the same arguments as above, this deviation leaves R worse off. We omit the details here.

Next we prove case (ii).

Step 1. For the subsets of voters $[y_m, \hat{y}_j]$, $j \in \{L, R\}$ to vote strategically, we can infer from step 1 of the proof of case (i) that $U_{\hat{y}_j}^d > U_{\hat{y}_j}^o$ must hold. Accordingly, these voters

have an incentive to deviate from sincere voting if $p > \hat{p}$.

Step 2.

For case (ii) we consider the same deviations as in (i):

(d1) $\underline{t}_R^d < t_{y_m}$ and $\bar{t}_R^d = t_{y_m}$.

As R would implement a policy with $t_R < t_{y_m}$ in a single-party government, with sincere voting there exists a $\tilde{y} > y_m$ such that all voters with income $y_i > \tilde{y}$ will vote for R and the others for L. This would yield a grand coalition with policy $(t_{y_m}, S - s_E)$ in event E and a single-party government of L in event $\neg E$, involving a policy $(t_{y_m}, S/2 + s^+)$, where s^+ is the number of seats derived from the votes of $[y_m, \tilde{y}]$.

Subsets of voters could now decide to vote strategically in order to either reduce the size of the single-party government of L in event $\neg E$, or to prevent a grand coalition in event E. In the first case, all voters in $[y_m + \varepsilon, \tilde{y}]$ vote for R. This would yield the same utility to the voters as in the case of sincere voting without the deviation of party R. According to Step 1 of case (ii), this utility level is lower for the critical voter \hat{y}_L than when a subset $[y_m, \hat{y}_L]$ votes for L with the aim of preventing a grand coalition. The subset of voters $[\tilde{y}, \hat{y}_L]$ would coordinate on L due to the minimal set of strategic voters refinement.

This change in voting behavior implies that the deviating party R has no chance of forming a single-party government. Thus party R would be worse off with the deviation.

(d2) $\underline{t}_R^d < t_{y_m}$ and $\bar{t}_R^d < t_{y_m}$. In this case, party R does not include t_{y_m} in its tax set. Hence a grand coalition is not possible, and R would form a single-party government with (\underline{t}_R^d, s_R) . Again we do not preclude $\underline{t}_R^d = \bar{t}_R^d$.

Under sincere voting, there exists a critical voter $\tilde{y} > y_m$ such that all voters with income $y_i > \tilde{y}$ vote for R and the other voters vote for L. The policy outcome would be a caretaker government in event E and a single-party government of L in event $\neg E$ with policy $(t_{y_m}, S/2 + s^+)$.

In case (ii), as long as the caretaker government does not involve a higher level of utility than a grand coalition with $(t_{y_m}, S - s_E)$, the subset of voters $[\tilde{y}, \hat{y}_L]$ will vote strategically to have a single-party government of L in both events, E and $\neg E$. Hence deviation (d2) is not profitable for party R.

(d3) $\underline{t}_R^d \geq t_{ym}$ and $\bar{t}_R^d > t_{ym}$. For completeness, we again note the other possible deviations by R, but omit the details as the arguments are similar to those set out above. ■

Proof of Proposition 3

The proof consists of two parts. In the first part (i), we show that without political polarization $\hat{p} < p^{nc}$. In the second part (ii), we verify that p^{nc} increases with the degree of political polarization.

(i)

Using the definition as given by (24), p^{nc} can be written as

$$p^{nc} = \frac{0.5[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)] + \frac{\hat{y}_j}{Y}(1 + \lambda)b\frac{S}{2}\frac{s_E}{S-s_E}}{\frac{\hat{y}_j}{Y}(1 + \lambda)b(\frac{S}{2} - s_E + \frac{S}{2}\frac{s_E}{S-s_E}) - U_{\hat{y}_j}(t_{kj}, S/2) + 0.5[U_{\hat{y}_j}(t_k, S/2) + U_{\hat{y}_j}(t_j, S/2)]}. \quad (28)$$

Without political polarization, both conventional parties possess the same political platform, so in terms of policy the costs of voting strategically are zero. With no political costs for deviating from sincere voting, p^{nc} transforms to

$$p^{nc} = \frac{\frac{S}{2}\frac{s_E}{S-s_E}}{\frac{S}{2} - s_E + \frac{S}{2}\frac{s_E}{S-s_E}}$$

Using \hat{p} as given in equation (25), the condition $\hat{p} < p^{nc}$ is equivalent to

$$\left(1 + \frac{\ln(1 - \frac{b}{cg(t_{ym}, S/2)}(\frac{S}{2} - s_E))}{\ln(1 - \frac{b}{cg(t_{ym}, S/2)}\frac{S}{2}\frac{s_E}{S-s_E})}\right)^{-1} < \left(1 + \frac{\frac{S}{2} - s_E}{\frac{S}{2}\frac{s_E}{S-s_E}}\right)^{-1}.$$

This condition holds iff

$$\frac{\ln(1 - \frac{b}{cg(t_{ym}, S/2)}\frac{S}{2}\frac{s_E}{S-s_E})}{\frac{S}{2}\frac{s_E}{S-s_E}} > \frac{\ln(1 - \frac{b}{cg(t_{ym}, S/2)}(\frac{S}{2} - s_E))}{\frac{S}{2} - s_E}. \quad (29)$$

Note that $1 - \frac{b}{cg(t_{ym}, S/2)}s \in (0, 1)$, where $s = \frac{S}{2}\frac{s_E}{S-s_E}$, $\frac{S}{2} - s_E$. As the function $f(x) = \frac{\ln(1-\gamma x)}{x}$ is strictly declining with x for the constant γ smaller than 1 and $x \in (0, 1/\gamma)$, condition (29) is satisfied, since $\frac{S}{2}\frac{s_E}{S-s_E} < \frac{S}{2} - s_E$.

(ii)

The proof that p^{nc} increases with political polarization proceeds in two steps. First, we prove that $\frac{dp^{nc}}{d\Delta_y} > 0$ under the assumption that

$$\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y} > 0.$$

In the second step, we show that this assumption holds.

(1) Recall the definition of p^{nc} ,

$$p^{nc} = \frac{\frac{1}{2}[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)] + \frac{\hat{y}_j}{Y}(1 + \lambda)b\frac{S}{2}\frac{s_E}{S-s_E}}{\frac{\hat{y}_j}{Y}(1 + \lambda)b(\frac{S}{2} - s_E + \frac{S}{2}\frac{s_E}{S-s_E}) - U_{\hat{y}_j}(t_{kj}, S/2) + 0.5[U_{\hat{y}_j}(t_k, S/2) + U_{\hat{y}_j}(t_j, S/2)]}. \quad (30)$$

The derivative with respect to political polarization is

$$\frac{dp^{nc}}{d\Delta_y} = \frac{\frac{1}{2}\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y}D + N\frac{d(U_{\hat{y}_j}(t_{kj}, S/2) - \frac{1}{2}[U_{\hat{y}_j}(t_k, S/2) + U_{\hat{y}_j}(t_j, S/2)])}{d\Delta_y}}{D^2},$$

where N and D denote the numerator and the denominator of the fraction in (30), respectively.

We want to show that $\frac{dp^{nc}}{d\Delta_y} > 0$. The corresponding condition can be written as

$$1 + p^{nc} \frac{\frac{d(U_{\hat{y}_j}(t_{kj}, S/2) - \frac{1}{2}[U_{\hat{y}_j}(t_k, S/2) + U_{\hat{y}_j}(t_j, S/2)])}{d\Delta_y}}{\frac{1}{2}\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y}} > 0. \quad (31)$$

Note that for this transformation, we have assumed that $\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y} > 0$. Consider the derivative in the numerator.

$$\frac{dU_{\hat{y}_j}(t_{kj}, S/2)}{d\Delta_y} - \frac{1}{2} \left[\frac{dU_{\hat{y}_j}(t_k, S/2)}{d\Delta_y} + \frac{dU_{\hat{y}_j}(t_j, S/2)}{d\Delta_y} \right].$$

Note that the worst policy for \hat{y}_j is $(t_j, S/2)$. By the concavity of the utility function, it must be the case that

$$\frac{d(U_{\hat{y}_j}(t_{kj}, S/2))}{d\Delta_y} > \frac{dU_{\hat{y}_j}(t_j, S/2)}{d\Delta_y}.$$

Hence we can state that

$$\frac{d(U_{\hat{y}_j}(t_{kj}, S/2) - \frac{1}{2}[U_{\hat{y}_j}(t_k, S/2) + U_{\hat{y}_j}(t_j, S/2)])}{d\Delta_y} > -0.5 \left[\frac{U_{\hat{y}_j}(t_k, S/2)}{d\Delta_y} - \frac{U_{\hat{y}_j}(t_j, S/2)}{d\Delta_y} \right].$$

The denominator of (31) can be written as

$$\frac{1}{2} \left[\frac{dU_{\hat{y}_j}(t_k, S/2)}{d\Delta_y} - \frac{dU_{\hat{y}_j}(t_j, S/2)}{d\Delta_y} \right].$$

From this it follows directly that

$$\frac{\frac{d(U_{\hat{y}_j}(t_k, S/2) - 0.5[U_{\hat{y}_j}(t_k, S/2) + U_{\hat{y}_j}(t_j, S/2)])}{d\Delta_y}}{\frac{1}{2} \frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y}} > -1.$$

Since p^{nc} must be smaller than 1, condition (31) is satisfied for all values of p^{nc} , as long as $\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y} > 0$. We will now show that this is the case.

(2) $U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)$ can be written as

$$A \left(\ln \left(\frac{y_j}{y_k} \right) + \hat{y}_j \left(\frac{1}{y_j} - \frac{1}{y_k} \right) \right).$$

We now examine how the utility difference changes when the degree of political polarization Δ_y increases marginally. As we require symmetry with respect to the median voter's utility from both parties' preferred policies, we will formally take the total derivative with respect to y_j , where the term $\frac{dy_k}{dy_j}$ denotes the change in y_k that is necessary after marginally increasing y_j in order to (re-)establish the symmetry of platforms.

$$\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{dy_j} = A \left[\frac{y_k}{y_j} \left(\frac{1}{y_k} - \frac{y_j}{y_k^2} \frac{dy_k}{dy_j} \right) + \hat{y}_j \left(\frac{1}{y_k^2} \frac{dy_k}{dy_j} - \frac{1}{y_j^2} \right) \right].$$

Rearranging terms yields

$$\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{dy_j} = A \left[\frac{1}{y_j^2} (y_j - \hat{y}_j) + \frac{1}{y_k^2} \frac{dy_k}{dy_j} (\hat{y}_j - y_k) \right].$$

Note that for $j = L$, $\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y} = -\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{dy_j}$, whereas for $j = R$ we would have $\frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{d\Delta_y} = \frac{d[U_{\hat{y}_j}(t_k, S/2) - U_{\hat{y}_j}(t_j, S/2)]}{dy_j}$.

Without loss of generality, consider the case $j = R$. For the utility difference to increase with political polarization, we must have

$$\frac{1}{y_R^2} (y_R - \hat{y}_R) + \frac{1}{y_L^2} \frac{dy_L}{dy_R} (\hat{y}_R - y_L) > 0. \quad (32)$$

The first summand is clearly positive. As $\frac{dy_L}{dy_R} < 0$, the second summand is only positive when $\hat{y}_R < y_L$. Hence if $\hat{y}_R < y_L$, the condition holds.

Suppose now that this is not the case, i.e. $\hat{y}_R > y_L$. According to the platform symmetry assumption, if one of the platforms y_k is given, the position of the other platform is unambiguously determined by the equation given in footnote 5. In this way we can view y_L as a function of y_R and obtain

$$\frac{dy_L}{dy_R} = -\frac{y_L^2 y_R - y_m}{y_R^2 y_m - y_L}.$$

Inserting into (32) yields

$$\frac{1}{y_R^2}(y_R - \hat{y}_R) - \frac{1}{y_R^2} \frac{y_R - y_m}{y_m - y_L} (\hat{y}_R - y_L) > 0.$$

As $y_m - y_L > \hat{y}_R - y_L$, we can estimate the second term from below by canceling $y_m - y_L$ and $\hat{y}_R - y_L$. As a consequence, we obtain

$$\frac{1}{y_R^2}(y_m - \hat{y}_R) > 0,$$

which is clearly positive.

Intuitively, this result follows from the strong concavity of the utility function and the platform symmetry with respect to the median voter. More precisely, the argument is that as the bliss point of the critical voter \hat{y}_R is politically to the left of the median voter, the marginal increase of y_R implies a higher utility loss than the corresponding decrease of y_L due to the concavity of the utility function. Hence, the utility difference between the two extremes must increase.

■

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