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Discussion Paper Series nr: 04-10

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Conspicuous Public Goods and Leadership Selection

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January 2004

Abstract
If voters care for the relative supply of public goods compared to other jurisdictions, decentralized provision of public goods will be too high. Potentially, centralization internalizes the negative externalities from the production of these `conspicuous' public goods. However, in a model of strategic delegation of policy making, we show that in the decentralized policy making case the median voter may delegate to a politician who cares less for conspicuous public goods than she does herself. By doing so, she commits to lower public goods in the home and in the foreign country. In contrast, with centralization the median voter anticipates the reduction in public goods supply by delegating to a policy maker who cares more for public goods than she does herself. This last effect mitigates the expected benefits of centralization.

Keywords: Conspicuous goods, strategic delegation, policy centralization

JEL classification: H21, H23, H41, F36

1 Introduction

In this paper we focus on the provision of public goods in an environment where groups are antagonistic to each other. Group members are depicted as receiving positive marginal utility from own public good provision, but receive negative marginal utility from public good provision by an opposing group. To motivate this one can imagine nations in which the citizens are envious of public projects undertaken by their neighbors. The projects or policies must always be conspicuous, so that they are clearly visible to each group. In this sense, each group imposes a negative externality on their neighbors and in a non-cooperative setting public good provision will be too high. This obviously leads to the conclusion that centralization should internalize the externality and provide for optimal good provision.

We consider these two standard cases, but then investigate what would happen if political leaders were chosen strategically both in non-cooperative and cooperative settings. The two settings provide opposite results. The median voter in each group in the decentralized case may reason that any leader will overproduce public goods and therefore will elect a leader with a preference for a lower level of public goods. Alternatively, in a centralized setting, the median voter will realize that the overall production of public goods in the two countries will be restricted. In this case it is rational to vote for a leader with a preference for a higher level of public goods. In this way, the median voter will hope to gain at the expense of the other group.

It is easy to think of examples where this logic may apply. Any setting where antagonism exists between groups or nations is amenable to this analysis. For instance, we could consider competition between the member states of the EU and ask how we might expect a movement towards higher level decision-making to effect the choice of political leaders in the respective countries. In situations where conflicting ethnic, religious or nationalistic preferences exist, groups may wish to invest in symbols of group identity, not just for its own sake but in response to the opposing group. This investment may depend on whether the groups cooperate or not. An interesting finding is that we may find the choice of more

extreme leaders when cooperation exists than when it does not. We do not, however, analyze the issue of how antagonism may spill over into actual violence or how cooperation emerges.[1]

The notion that individuals value their consumption relative others first emerged in the finance literature (Abel 1990, Gali 1994, Campbell and Cochrane 1999). Here, relative consumption of snob goods serves to explain the equity premium puzzle by showing why persons take too high gambles in the financial markets. It is easy to envisage yuppies gambling on dot-com stocks to finance a newer BMW than their peers. Recently, Chang and Kogan (2002) allow for heterogeneous preferences for stock market gambles. Dupor and Liu (2003) argue that, with regard to consumption externalities, 'keeping up with Joneses' should be distinguished from jealousy. The first effect occurs when consumption by others raises an individual's own marginal utility from the consumption of certain types of goods. Jealousy implies that humans simply envy other people's consumption. Both are part of a negative consumption externality, but only the first effect raises overall consumption.

If individuals could commit to lower spending on conspicuous consumption goods, this would increase social welfare. However, for individual consumption it is hard to see how, in the absence of government intervention, this may come about. In any case, if citizens could draw up a contract, they would restrain themselves and each other from spending too much on conspicuous goods. Clearly, there is a role for government to provide such a binding contract if the keeping up with Joneses effect results in too high a level of conspicuous goods consumption (Ljungqvist

[1]This is a theme picked up on in (Hamlin and C.Jennings 2004). A key result in this paper is that where members of groups are far-sighted or *instrumental* in their motivation, it is found that when conflict costs are high (a situation that mirrors a non-cooperative setting in this paper) groups would select more moderate leaders in order to avoid a conflict. However, by doing so they give up the benefit of hard-line negotiation that a more extreme leader would provide. When conflict costs are low, the result is reversed. Now the groups will select extreme leaders because they are willing to suffer a low-level conflict in order to reap the benefit of hard-line negotiation. Low conflict costs could be thought of as mirroring the cooperative setting depicted in this paper. As such, both papers predict the selection of more extreme leaders in a more cooperative setting and more moderate leaders in a less cooperative setting where group members choose instrumentally.

and Uhlig 2000).[2]

In our case, where we analyze conspicuous *public* goods, a commitment devise in the form of the preferences of the policy maker is at hand. Voters may strategically select a leader who has preferences different from that of their own so as to bind their own hands. This mechanism of strategic delegation of policy making has been well know since Rogoff's conservative central banker (Rogoff 1985). Strategic delegation in an election setting was first analyzed in Besley and Coate (1997). In Besley and Coate (2003) these authors show that strategic delegation of policy making authority in a centralized setting may result in perverse policy outcomes. The reason is that the median voter may delegate bargaining authority to a leader who cares more for public goods than she does herself. By doing so, the median voter commits to obtaining a higher share of the centralized funds that are spent on public goods. Dur and Roelfsema (forthcoming) extend this analysis to allow for non-shareable cost in public goods provision. They argue that this may lead to the delegation of 'conservatives' to the centralized decision making body so as to avoid these costs, while at the same time benefitting from positive spill over effects of public goods produced in other jurisdictions.

The paper is organized as follows. Section 2 introduces the model and analyses the choice of public good provision by the median voter in a decentralized and in a centralized setting. Section 3 allows for strategic delegation and asks how this would effect the choice of leader by the median voter in the two different settings. Section 4 offers some concluding comments. The Appendix extends the results to a more general utility function than the one used in the main text.

[2] This may already have been foreseen in the Bible by making the Sunday a mandatory work-free day, possible to restrain individuals from working to hard to keep up appearances (Dupor and Liu 2003).

2 The Model

Consider two countries $i \in \{1, 2\}$, each inhabited by a continuum of citizens j. The typical citizen has a utility function of:

$$U^j(q_i, q_{-i}, p_i, \lambda^j) = y - cg_i + h(g_i, g_{-i}, \lambda_j) \tag{1}$$

where g_i are the public goods in the home country, g_{-i} public goods in the foreign country, y is income that is identical for all individuals in i, c are the constant marginal production costs of a unit of g_i (so that $y - cg_i$ is the consumption of private goods p_i), and $\lambda_j > 0$ is the preference parameter for public goods for which we assume a uniform distribution over the population in country i. For the h-function we assume the following derivative properties: $h_i > 0$, $h_{-i} < 0$, $h_\lambda > 0$. Further, public goods are strategic complements such that for good g_1 the cross derivative $h_{12} > 0$. This last effect captures the 'keeping up with the Joneses' effect as the marginal utility of public goods in country i increases in the level of public goods in country $-i$. For simplicity, we propose the following utility function:

$$V_i^j = \lambda_i^j \log(g_i - \alpha g_{-i}) + y - cg_i \tag{2}$$

Here the parameters λ and α capture the extent to which citizen j values keeping up with the Joneses. A person with a high λ cares more for public goods in general, but also more for the relative level of public goods if compared to the other region. Hence, as in Ljungqvist and Uhlig (2000), in our paper keeping up with the Joneses and jealousy are intrinsically wed. We assume that the parameter α is identical for all citizens. This parameter measures the extent to which the public goods are strategic complements. A high α means that the individual greatly envies public goods provision in other countries. A positive α also means that higher public good provision in the foreign country raises the marginal utility of home production of public goods. Hence, a useful interpretation of $\alpha > 0$ is that foreign production creates a negative externality in the home country. Further, producing one unit of g_i involves a fixed mar-

ginal cost per unit, that for simplicity we have normalized so that $c = 1$.

Suppose that, as a starting point, in a decentralized political system the median voter $j = m$ is elected as policy maker. From the first-order condition of (2) it follows that:

$$\frac{\lambda_i^m}{g_i - \alpha g_{-i}} - 1 = 0 \qquad \Rightarrow \qquad g_i = \alpha g_{-i} + \lambda_i^m \tag{3}$$

In equilibrium, the optimal level of of public goods is:

$$g_i = \frac{1}{1-\alpha^2}\lambda_i^m + \frac{\alpha}{1-\alpha^2}\lambda_{-i}^m \tag{4}$$

The first-order condition (3) and the decentralized supply (4) show two properties that will later prove useful in building intuition for the results. First, by applying the explicit function theorem to equation (3) it can be shown that the keeping up with the Joneses effect in equilibrium is $dg_i = \alpha dg_{-i}$: an increase of one unit of g_{-i} raises the desired public goods by α that amount. Hence, for $\alpha < 1$ the median voter in i does not demand full compensation for the increase in public goods in the other country.

This result carries over to (4). Both stronger preferences of the median voter in home and in the foreign country increase equilibrium public goods supply in the home country. However, in equilibrium $dg_{-i}/d\lambda_i = \alpha dg_i/d\lambda_i$, hence, stronger preferences for the public good of the home policy maker increases public goods in the foreign country by a fraction α of the increase in the home country**.** The reason is that higher preferences for the public good in the home country raises public goods supply there, which spill over as higher marginal benefits of foreign public goods as perceived by the foreign median voter.

Also note that, as $dg_i/d\lambda_i = 1/(1-\alpha^2) > 1$, stronger home preferences for public goods result in a more than proportional increase in equilibrium public goods supply. Recall that stronger preferences not only increase the marginal benefits from public goods supply directly, they also increase the desired public goods supply in the foreign country. This last effect spills back to the public goods supply in home by raising

the optimal level of home production. This spill-back effect then also manifests itself in the foreign country, so that $dg_{-i}/d\lambda_i = \alpha/1-\alpha^2 > \alpha$. This means that, as the increase in public goods supply in home is higher than proportional to the increase in preferences, the increase in foreign public goods supply is also higher than the fraction α that results from (3). In the symmetric equilibrium ($\lambda_i^m = \lambda_{-i}^m$) equation (4) reduces to:

$$g_i = \frac{\lambda_i^m}{(1-\alpha)} \tag{5}$$

Clearly, the decentralized equilibrium level of public goods supply is increasing in the preferences λ of the median voter and increasing in the level of α.[3]

To see the oversupply more clearly, consider the socially optimal level of production $V_s = V_i^m + V_{-i}^m$.[4] The first-order conditions for g_i and g_{-i} that maximize V_s are:

$$\frac{dV_s}{dg_i} = \frac{\lambda_i^m}{g_i - \alpha g_{-i}} - \alpha\frac{\lambda_{-i}}{g_{-i} - \alpha g_i} - 1 = 0 \tag{6}$$

$$\frac{dV_c}{dg_{-i}} = \frac{\lambda_{-i}^m}{g_{-i} - \alpha g_i} - \alpha\frac{\lambda_i^m}{g_i - \alpha g_{-i}} - 1 = 0 \tag{7}$$

After considerable manipulation we find that in equilibrium:

$$g_i = \frac{1}{1+\alpha}\lambda_i^m + \frac{\alpha}{1+\alpha}\lambda_{-i}^m \tag{8}$$

Note that, as $1/(1+\alpha) < 1$, an increase in preferences of the home median voter results in a less than proportionate increase in home public goods supply. The reason is that the foreign median voter dislikes the increase in home public goods supply and, as policies are coordinated, this will be a counter force to increasing the supply of public goods in the home country. Further, it is then also clear that, with centralized

[3] Clearly, this result would be reversed if voters care about the relative tax levels between countries. Although we do not offer a formal proof, one may imagine that this would result in sub-optimally low provision of (normal) public goods.

[4] This follows from the assumption that preferences are distributed uniformly over the population.

policy making, increasing the preferences of the home median voter has less effect on public goods supply in the foreign country if compared to the decentralized equilibrium in (4).

In the symmetric equilibrium ($\lambda_i^m = \lambda_{-i}^m$ and $g_i = g_{-i}$) equation (8) reduces to:

$$g_i = \lambda_i^m \tag{9}$$

Clearly, this is identical to the decentralized level of public goods provision when $\alpha = 0$, and there is no policy externality. In this last case, there is no 'national pride' argument for public goods and centralized and decentralized provision of public goods is socially efficient.

3 Strategic delegation

In this section we consider delegation of policy making when the median voter in i strategically elects a political leader so as to maximize her welfare. As we will see below, both in the decentralized and in the centralized case there is scope for strategic delegation.

3.1 Decentralized equilibrium

Suppose that the median voter in i has a continuum of candidates with $\lambda_i^d > 0$ to her disposal for delegation of policy making. The optimum candidate will solve:

$$\frac{\partial V_i^m}{\partial \lambda_i^d} = \frac{dh(g_i, g_{-i}, \lambda_j)}{dg_i}\frac{\partial g_i}{\partial \lambda_i^d} + \frac{dh(g_i, g_{-i}, \lambda_j)}{dg_{-i}}\frac{\partial g_{-i}}{\partial \lambda_i^d} - \frac{\partial g_i}{\partial \lambda_i^d} = 0 \tag{10}$$

From (4) the median voter in i anticipates that the equilibrium provision of public goods will be:

$$g_i = \frac{1}{1-\alpha^2}\lambda_i^d + \frac{\alpha}{1-\alpha^2}\lambda_{-i}^d \tag{11}$$

$$g_{-i} = \frac{1}{1-\alpha^2}\lambda_{-i}^d + \frac{\alpha}{1-\alpha^2}\lambda_i^d \tag{12}$$

Combining (10), (11), and (12) we obtain:

$$\frac{\partial V_i^m}{\partial \lambda_i^d} = \frac{\lambda_i^m}{g_i - \alpha g_{-i}} \frac{1}{1-\alpha^2} + \frac{\alpha \lambda_i^m}{g_i - \alpha g_{-i}} \frac{\alpha}{1-\alpha^2} - \frac{1}{1-\alpha^2} = 0$$

From (3) we know that $g_i - \alpha g_{-i} = \lambda_i^d$ so that the optimal preferences of the delegate in country i are described by:

$$\lambda_i^{d*} = \lambda_i^m \left(1 - \alpha^2\right) \tag{13}$$

This result carries an important intuition. For $\alpha > 0$, the median voter delegates to a policy maker who cares *less* for conspicuous public goods supply than she does herself. The reason is that by doing so, the median voter commits to lower public goods spending in the home country *and lower spending in the foreign country.* Hence, the benefits from lower tax costs in home plus the gain in utility from lower public goods in the foreign country are higher than the loss in utility from lower home public goods supply.

Another way to develop this intuition is by the following thought experiment. Suppose that both median voters are elected as policy makers and both have preferences $\lambda_i = \lambda_{-i} = 1$ so that, in the absence of strategic delegation, public goods supply will be $g_i = g_{-i} = 1/(1-\alpha)$. In that situation, noting that $dg_{-i} = \alpha dg_i$, the median voter realizes that the net marginal benefits of the public goods are:

$$\left| dg_i \frac{1}{(1-\alpha)g_i} - \alpha dg_i \frac{\alpha}{(1-\alpha)g_i} - dg_i \right|_{g_i = g_{-i} = 1/(1-\alpha)} = dg_i(1-\alpha^2) - dg_i < 0$$

Hence, when the median voters are policy makers, in equilibrium the marginal benefits of the public good in country i is lower than it's marginal costs. Clearly, the median voter would be better off by reducing home public goods supply.

A natural question to ask is why the median voter does not herself reduces the level of public goods to (14), but instead delegates to a policy maker who cares less for public goods herself. To see this, suppose that both median voters reduce public goods supply to $g_i = g_{-i} = 1 + \alpha$.

However, the median voter in foreign realizes that if she were to stick to $g_{-i} = 1 + \alpha$, the marginal benefits from increasing public goods to the home median voter are:

$$\left| \frac{1}{(1-\alpha)g_i} \right|_{g_i=1+\alpha} = \frac{1}{1-\alpha^2} > 1$$

Hence, if the median voter herself is the policy maker, an announcement of producing the efficient level of public goods supply is not credible.

Using (5), in the symmetric equilibrium public goods supply will be:

$$g_i = (1+\alpha)\lambda_i^m \tag{14}$$

If compared to the decentralized equilibrium without delegation in (5), the level of conspicuous public goods is lower in the presence of strategic delegation. However, decentralized public goods supply is to high if compared to the socially optimal level.

3.2 Centralized equilibrium

If policies are coordinated at the centralized level, we assume that the delegates maximize their joint welfare. However, the delegation decision itself is not coordinated. Again the median voter solves (10). Recall also that in equilibrium the delegates set policy according to (8). Therefore we find that in equilibrium:

$$\frac{\partial V_i^m}{\partial \lambda_i^d} = \lambda_i^m \left[\frac{1}{g_i - \alpha g_{-i}} (\frac{1}{1+\alpha}) - \frac{\alpha}{g_i - \alpha g_{-i}} (\frac{\alpha}{1+\alpha}) \right] - (\frac{1}{1+\alpha}) = 0 \tag{15}$$

The first term within the squared brackets shows the increase in welfare

of increasing the preferences of the home delegate by raising public goods supply in the home country. The second term shows that delegating to a policy maker with a higher λ increase foreign public goods by $\alpha/(1+\alpha)$, which in turn reduces welfare by $\alpha/(g_i - \alpha g_{-i})$ that amount. The last term shows the increase in tax cost of increasing public goods supply in home. In the symmetric equilibrium from (9) we know that $g_i = g_{-i} =$

λ_i^d, which gives the optimal preferences of the delegate of:

$$\lambda_i^{d*} = (1+\alpha)\lambda_i^m \tag{16}$$

In the symmetric equilibrium, public goods supply will be:

$$g_i = \lambda_i^m (1+\alpha) \tag{17}$$

For $\alpha > 0$ he median voter delegates leadership to a politician who cares more for public goods than she does herself. The intuition is as follows. The median voter anticipates that centralization will reduce public goods supply in home and foreign if compared to the decentralized equilibrium. Hence, the tax costs fall. Given this anticipated reduction in tax costs, and given the preferences of the policy maker in the foreign country, the median voter benefits from higher public goods supply in home. The means to do so are to commit to slightly higher spending in the home country by delegating to a leader who cares more for conspicuous public goods than she does herself. However, in doing so, the median voter in home anticipates that sending a more nationalistic leader induces the foreign policy maker to demand more public goods as well. This effects mitigates the incentives for strategic delegation. Public goods supply will be higher than the socially optimal level. According to (16) both median voters delegate to policy makers that care more for public goods than they do themselves. Thus, public goods supply will be inefficiently high.

To build more intuition for the result, let us consider again the thought experiment of the previous sub-section. If both median voters are policy makers, then $g_i = g_{-i} = 1$. In that equilibrium, noting that $\frac{dg_{-i}}{d\lambda_i} = \alpha \frac{dg_i}{d\lambda_i}$, the net benefits from delegation are:

$$\left| dg_i \frac{1}{(1-\alpha)g_i} - \alpha^2 dg_i \frac{1}{(1-\alpha)g_i} - dg_i \right|_{g_i=g_{-i}=1} = dg_i(1+\alpha) - dg_i > 0$$

Hence, if both median voters are policy makers, the marginal benefits of delegation are positive.

Note that public goods supply with centralized decision making equals that of decentralized provision as presented in (14). Hence, the potential benefits of centralization are fully absorbed by the adverse delegation effect. The intuition of this result is that, although policies are coordinated, the leadership selection is not. With decentralized decision making there are two strategic decisions: relative public goods supply and delegation of policy making. With centralization, the strategic decision shifts to the delegation stage only. However, at the margin, the incentives of the median voter for conspicuous public goods supply do not differ between decision making modes and, hence, one may expect the equilibrium allocation of public goods to remain unaltered if policies are centralized.

4 Concluding remarks

In a theoretical model we showed that when public goods are conspicuous by nature, decentralized decision making causes supply to be too high. Centralization of decision making potentially solves this problem. However, if we allow for endogenous leadership selection this picture changes. In the decentralized case, voters may realize the externality and the resulting perverse symmetric outcome. Hence, they have an incentive to commit to lower spending by electing a more moderate leader than the median of their group. Consequently, overspending on conspicuous public goods will be lower. This delegation effect is reversed under centralized decision making. Voters anticipate that the externalities are internalized. Therefore, they have an incentive to select a more nationalistic leader to obtain more public goods than the other group. Hence, centralization and policy coordination may not solve the conspicuous public goods problem.

The central contribution of this paper is that by endogenizing leadership selection we show that centralization may well fail to improve social welfare if groups are antagonistic. The reason is that centralization induces voters to swap prudent leaders for more hawkish ones. A loose interpretation is that if voters care for the payoffs for other groups, the potential of conflict may convince group members to select a moderate

leader to reduce tensions between groups. This incentive is reduced as soon as groups are forced to cooperate and, hence, members strategically select a leader who will be more aggressive at the bargaining table.

Extending the intuition of the paper to the domain of high politics may oversell the results. However, in many high politics negotiation situations, voters care about the payoffs to the other group or country in relation to those of their own. An example of this mechanism may be that under British rule, the median voters among Protestants and Catholics in Northern Ireland in a situation of conflict may select a leader who shows restraint towards the other group. As soon as both parties have to cooperatively distribute a pie in a independent congress, they may select leaders who care more for the relative pay-off if compared to the other group. Indeed, elections in Northern Ireland since the signing of the Belfast Agreement have shown a movement towards the more extreme Democratic Unionist Party and Sinn Fein and away from the more moderate Ulster Unionists and Social Democratic and Labour Party.[5] Perhaps the electorate of Northern Ireland prefer to elect hard-line negotiators when they believe that there is little likelihood of a resumption of political violence, but are inclined to vote for moderates when conflict exists in an effort to secure peace. As noted before, however, this paper is applicable to studying the investment in group symbols, rhetoric and identity in cooperative and non-cooperative environments, rather than endogenizing the movement from conflict to peace. So, in the case of Northern Ireland, while the more cooperative environment has not necessarily diluted the investment in identity made by the two communities there is obviously a very real benefit due to the current existence of peace.[6]

The implications of this paper might depress at first sight. However, there are policy options to resolve the problem. First, if policies are coordinated, it might be easier to impose spending limits on the production of conspicuous public goods. The reason is that free riding of the

[5] See http://www.ark.ac.uk/elections/.

[6] However, to fully model the results for these cases, one should rely on cooperative Nash-bargaining outcomes that specify fall-back positions, instead of the joint welfare maximalization allied in this paper.

other country can be resolved at the constitutional stage. With spending limits, the incentive to delegate strategically is reduced, so that in equilibrium voters may decide to select leaders that have median preferences. It should also be noted within such a constitutional setting policy makers anticipate repeated interaction of delegates. Hence, reputational concerns may prevent strategic delegation to overly nationalistic policy makers.

A second option is to impose ex ante policy uniformity. Our results crucially depend on the assumption that centralized conspicuous public goods supply can be differentiated among groups. If there is no scope for differentiation, this takes away the incentive for strategic delegation. A third related solution to avoid overspending is to delegate to a single policy maker who does not originate from one of the countries. This last option implies that if public goods are conspicuous, it is best to delegate to a centralized institution that has low regard for the jealous spirits of the citizens that they govern.

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Appendix

Consider the two objective functions of the delegated policy makers in country 1 and 2.

$$V_1 = \lambda_1^d b(g_1 - \alpha g_2) - g_1 \tag{A1a}$$

$$V_2 = \lambda_2^d b(g_2 - \alpha g_1) - g_2 \tag{A1b}$$

Decentralized Policy Making

The first order conditions in the decentralized equilibrium are:

$$\frac{dV_1}{dg_1} = \lambda_1 b' - 1 = 0 \Rightarrow b' = \frac{1}{\lambda_1} \tag{A2a}$$

$$\frac{dV_2}{dg_2} = \lambda_2 b' - 1 = 0 \Rightarrow b' = \frac{1}{\lambda_2} \tag{A2b}$$

Using the implicit function theorem we know that from (A2a):

$$d\lambda_1^d(b'\,(g_1 - \alpha g_2)) + dg_1(\lambda_1 b'') + dg_2(-\alpha\lambda_1 b'') = 0$$

and from (A2b)

$$dg_1(-\alpha\lambda_2 b'') + dg_2(\lambda_2 b'') = 0 \quad \Rightarrow \quad dg_2 = \alpha dg_1$$

Combining these provides for:

$$\frac{dg_1}{d\lambda_1^d} = -\frac{b'}{(1-\alpha^2)\lambda_1^d b''} \tag{A3a}$$

$$\frac{dg_2}{d\lambda_1^d} = -\frac{\alpha b'}{(1-\alpha^2)\lambda_1^d b''} \tag{A3b}$$

And in the symmetric equilibrium:

$$\frac{dg_2}{d\lambda_1^d} = \alpha\frac{dg_1}{d\lambda_1^d} \tag{A4}$$

The first order condition to the objective function of the median voter

in country 1 is given by:

$$\frac{\partial V_i^m}{\partial \lambda_1} = \lambda_1^m \left[\frac{db}{dg_1}\frac{\partial g_1}{\partial \lambda_1^d} + \frac{db}{dg_2}\frac{\partial g_2}{\partial \lambda_1^d} \right] - \frac{\partial g_1}{\partial \lambda_1^d} = 0 \tag{A5}$$

Recognizing that $db/dg_2 = -\alpha b'$, $dg_2/d\lambda_1^d = \alpha dg_1/d\lambda_1^d$, and $b' = 1/\lambda_1^d$, in the symmetric equilibrium:

$$\lambda_i^m \left[\frac{1}{\lambda_i^d} - \alpha^2 \frac{1}{\lambda_i^d} \right] - 1 = 0 \quad \Rightarrow \quad \lambda_i^d = (1-\alpha^2)\lambda_i^m \tag{A6}$$

Centralized Policy Making

The first-order conditions to the joint welfare function $V_c = V_1 + V_2$ are:

$$\frac{dV_c}{dg_1} = \lambda_1^d b' - \alpha \lambda_2^d b' - 1 = 0 \quad \Rightarrow \quad b' = \frac{1}{\lambda_1^d - \alpha \lambda_2^d} \tag{A7a}$$

$$\frac{dW}{dg_2} = \lambda_2^d b' - \alpha \lambda_1^d b' - 1 = 0 \tag{A7b}$$

Using the implicit function theorem, from (A7a)

$$d\lambda_1^d(b') + dg_1(\lambda_1 b'' + \alpha^2 \lambda_2 b'') + dg_2(-\alpha \lambda_1 b'' - \alpha \lambda_2 b'') = 0 \tag{A8a}$$

and from (A7b):

$$d\lambda_1^d(-\alpha b') + dg_1(-\alpha \lambda_1 b'' - \alpha \lambda_2 b'') + dg_2(\lambda_2 b'' + \alpha^2 \lambda_1 b'') = 0 \tag{A8b}$$

We can show that in the symmetric equilibrium:

$$\frac{dg_1}{d\lambda_1^d} = \frac{-b'}{(1-\alpha^2)b''\lambda_1^d} \tag{A9a}$$

$$\frac{dg_2}{d\lambda_1^d} = \frac{-\alpha b'}{(1-\alpha^2)b''\lambda_1^d} \tag{A9b}$$

Hence, again $dg_2/\lambda_1^d = \alpha dg_1/\lambda_1^d$. Using (A5) and recognizing that in equilibrium $b' = 1/\left[(1-\alpha)\lambda_i^d\right]$ it follows that:

$$\lambda_i^m \left[\frac{1}{(1-\alpha)\lambda_i^d} - \alpha^2 \frac{1}{(1-\alpha)\lambda_i^d} \right] - 1 = 0 \quad \Rightarrow \quad \lambda_i^d = (1+\alpha)\lambda_i^m \quad \text{(A10)}$$