Centralized provision of public goods: static vs dynamic performance in the presence of political pressure, lobbying and heterogeneity of tastes

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Abstract

This paper analyses the efficiency of centralized public goods provision in a model of incomplete contracts. Politicians determine the level of provision through wasteful yet publicly unobservable lobbying efforts. Thereby a threat of dismissal from office caused by regional expectations in terms of reservation utility induces politicians to push for influence of their region's taste. In a static setting the performance of central governance is solely hampered by larger diversity of regional preferences. On the contrary, in a repeated game setting the ability to cooperate depends crucially on voter expectations. Via endogenous discounting it can be shown that rather too much national pressure hinders efficiency-sustaining cooperation. Contrasting static results furthermore high levels of heterogeneity within regional preferences support the implementation of efficient outcomes.

JEL classification: H11, H73

I. Introduction

Many contributions to the literature of fiscal federalism investigate the pros and cons of centralized public goods provision in a static setting. A seminal result for regional public goods can be found in Oates (1972). Remedying decentralization's externality problem, benevolent central governance is restricted to uniform provision levels thus encountering costs in terms of a neglect for heterogeneous regional preferences. Trading off these costs against externalities induced by provision at sub-central layers of government reveals the efficient level of decentralization. The result, referred to as the 'decentralization theorem',

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states that sufficiently large (small) spillovers and/or homogenous (heterogeneous) regional tastes favour (reject) centralization. Oates' approach has though become subject to criticism primarily as his results depend crucially on exogenous uniformity of provision levels.[1] Whereas this assumption, combined with efficiency-seeking central planning, can still be found in many frameworks[2], some recent contributions (surveyed below) explicitly consider the political process in explaining centralization's deficits.

In modern federations central government involves institutions consisting of elected member state representatives. Implementing policies the latter are confronted with the task of aggregating possibly diametrically opposed regional preferences. This process comprises multiple sources of inefficiency, as the following selected literature exemplifies. First of all politicians might feel insufficient incentives to represent their region's taste when facing respective disutility of effort. Seabright (1996) shows that, due to a lack of political accountability, centralization tempts officials to excessively cater the needs of those regions most likely responsible for their re-election. In a sophisticated political economy approach Besley and Coate (1999) demonstrate that strategic delegation on the part of regional voters may lead to inefficiencies. Aiming to exploit a budgetary externality stemming from cost sharing voters select politicians with extreme tastes for the public good thus entailing a distorted representation of regional preferences. Finally, Ellingsen (1998) emphasizes a neglect of minority preferences resulting from majority voting in central governments. Despite their different sources of centralization's inefficiency these models, in line with the remaining literature of fiscal federalism, suggest a normative rejection of centralization in cases of large heterogeneity within regional preferences.[3]

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1 Referring to benevolence of central governance Lockwood (1998, p. 5) argues that with a dismissal of exogenous policy uniformity the theoretical case for decentralization is questionable in general. In Caillaud, Jullien and Picard (1996) the latter may arise in a multi-layer principal-agent model with asymmetric information due to the assumption, that communication between layers is prohibitively costly.

2 To name but a few, Alesina and Wacziarg (1999) assume uniform expenditure levels of public services in regional production, Bolton and Roland (1997) restrict central government to uniform regional tax rates, Alesina and Spolaore (1997) trade off scale effects versus uniform regional public goods provision.

3 Seabright (p. 85) finds that "diversity in the circumstances of different localities strengthens the case for decentralized government". Referring to regional preferences Besley and Coate (p. 12) show that "for sufficiently diverse districts, decentralization is better than centralization when spillovers are maximal", i.e. in the presence of pure public goods. This result contradicts the 'decentralization theorem' as the latter calls for universal centralization of pure public goods administration. Ellingsen (p. 261) concludes that decentralization performs better as the relation of regional tastes becomes sufficiently large.

Following the idea that “political bargaining to align regional interests seems to be the rule rather than the exception both in national assemblies and in supra-national federal systems”[4] this paper assumes delegates at a central tier to negotiate the level of public goods provision. Confirming the standard result of negative correlation between high preference heterogeneity and centralization’s performance in a static setting the present model yields an opposite result when allowing for dynamic interaction. Furthermore it sheds light on regional political pressure as a main source for inefficiencies in central governance.

The remainder is organized as follows. Chapter II presents the basic model and analyses the influence of political pressure and preference heterogeneity on the performance of centralized public goods provision in a static game setting. Chapter III analyses the very same correlation in a repeated game setting. Chapter IV discusses the results and gives some examples for the underlying mechanism in III.

II. Static setting

The economy is divided into two distinct regions indexed by $i \in \{1,2\}$ each comprising an equal share of immobile residents, with total population amounting to n individuals. An individual in region i is represented by a utility function $U_i(G, x_i) = b_i \Psi(G) + x_i$ with $b_i > 0$, $b_1 \neq b_2$, $\Psi'(G) > 0$ and $\Psi''(G) < 0$ where G and x denote a pure public and a pure private good respectively. All individuals posses sufficient amounts of income ω to allow for strictly positive consumption of the private good.

Centralized provision

The level G_C of public goods provision under centralization is determined by maximization of weighed representative regional utility

1) $$G_C = \arg\max_{G, x_1, x_2} \sum_{i=1}^{2} a_i U_i(G, x_i).$$

In the course of negotiations e_i represents an effort level for region i’s delegate. Increasing e_i the delegate is c.p. able to raise the relative weight a_i of his region’s utility, with

[4] Lülfesmann (2001), p. 2.

$a_i(e_i, e_{-i}) = \frac{e_i}{e_i + e_{-i}}$ and $a_i(0,0) = \frac{1}{2}$. Public goods supply is financed in both regions via an identical head tax $t = \frac{G}{n}$ leading to an individual budget constraint of $x + \frac{G}{n} = w$. Substituting these budget constraints into 1) the unrestricted maximization program[5] can be written as

$$2) \qquad G_C = \operatorname{argmax}_G \sum_{i=1}^{2} a_i \left(b_i \Psi(G) - \frac{G}{n} + w \right)$$

yielding the corresponding first-order-condition

$$3) \qquad \sum_{i=1}^{2} a_i \left(b_i \Psi'(G_C) - \frac{1}{n} \right) = 0 \Leftrightarrow n\Psi'(G_C) \sum_{i=1}^{2} a_i b_i = 1.$$

Consequently G_C essentially depends on the weight by which each region's marginal willingness to pay for the public good is taken into account. Note that for $e_i = e_{-i}$, i.e. for identical effort levels, 3) corresponds to the Samuelson-condition. Compared to latter region *i*'s marginal willingness to pay is excessively represented for $e_i > e_{-i}$.

It can be shown that raising e_i c.p. results in an increase (reduction) of G_C, if region *i*'s marginal willingness to pay is higher (lower) than region *-i's*.[6] This result comes to no surprise as, due to G_C's reflection of average preferences, centralized provision is then perceived as too low (high) by region *i* for the given taxation scheme.

$$4) \qquad \frac{\partial G_C}{\partial e_i} \begin{Bmatrix} > \\ < \end{Bmatrix} 0 \Leftrightarrow b_i \begin{Bmatrix} > \\ < \end{Bmatrix} b_{-i}$$

Politician's effort level induces disutility $\Gamma(e_i)$[7] with $\Gamma(0) = 0$, $\Gamma', \Gamma'' > 0$ for the people living in his constituency. With net utility resulting from centralized provision defined as $U_i^C(G, x_i, e_i) = U_i(G, x_i) - \Gamma(e_i)$ it follows that

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5 With quasi-linear utility maximization of identically weighed utility functions is equivalent to Paretian analysis (see appendix A.1).

6 See appendix A.2.

7 With effort measured in time this disutility might represent voters' impatience with respect to a result of central negotiations. If an issue is viewed as urgent the same policy resulting from intense (moderate) negotiations might be perceived as inadequate (adequate). On the other hand Γ might reflect physical costs of

5) $$\frac{\partial U_i^C}{\partial e_i} = \underbrace{\left(b_i \Psi'(G_C) - \frac{1}{n} \right)}_{\substack{>0 \text{ for } b_i > b_{-i} \\ <0 \text{ for } b_i < b_{-i}}} \underbrace{\frac{\partial G_C}{\partial e_i}}_{\substack{>0 \text{ for } b_i > b_{-i} \\ <0 \text{ for } b_i < b_{-i}}} - \Gamma'(e_i)$$

with $\lim_{e_i \to 0} \frac{\partial U_i^C}{\partial e_i} > 0$ and $\lim_{e_i \to \infty} \frac{\partial U_i^C}{\partial e_i} < 0$, i.e. increasing his effort a politician is merely up to a critical effort level able to raise his constituency's net utility.

Subsequent to public goods provision a regional-specific additive shock $\tilde{e}_i$ occurs which is assumed to be uniformly distributed on $[-a, a]$, resulting in a density of $f = \frac{1}{2a}$.

Re-elected for another term in office politicians obtain a rent R whereas receiving 0 when dismissed from office with this fact providing incentives for individual effort. At term's end region i's representative is re-elected, if net utility in his constituency exceeds exogenous reservation utility $\bar{U}_i$ including the realisation of shock $\tilde{e}_i$. Thus re-election ensues if

6) $$U_i^C(G, x_i, e_i) \geq \bar{U}_i + \tilde{e}_i .$$

With this condition probability $\Pr_i^r$ of re-election to central government can be written as $\Pr\left(\tilde{e}_i \leq U_i^C - \bar{U}_i\right)$ which is equal to the cumulative distribution of $\tilde{e}_i$ evaluated at $U_i^C - \bar{U}_i$.[8] Politicians, assumed to be risk-neutral, then maximize expected utility $\Pr_i^C(e_i, e_{-i}) R$. Due to simultaneity of lobbying decisions respective effort levels

7) $$e_i^* = \arg\max_{e_i} \Pr_i^r\left(e_i, e_{-i}^*\right) R \qquad i = 1, 2$$

constitute a Nash-equilibrium.[9] Corresponding first order conditions

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employing a bureaucracy for lobbying purposes. Despite leaving the result in 2) unchanged Γ should then actually be represented in regional budget constraints.

[8] Or formally $\Pr_i^r = \int_{-a}^{U_i^C - \bar{U}_i} \frac{1}{2a} dx = \frac{U_i^C - \bar{U}_i + a}{2a}$. As an increase in $\bar{U}_i$ c.p. reduces probability of re-election for the affected politician, I interpret $\bar{U}_i$ as a yardstick in terms of national expectations.

[9] To guarantee uniqueness regional levels of reservation utility are assumed to satisfy the following condition $\bar{U}_i^{\min} := U_i^{Co} - a < \bar{U}_i < U_i^E + a =: \bar{U}_i^{\max}$ with $U_i^{Co} = U_i(0;0)$ representing utility if both politicians abstain from lobbying and $U_i^E = U_i\left(e_i^*, e_{-i}^*\right)$ representing equilibrium utility. These restrictions ensure positive probability

$$8)\qquad \underbrace{f\left(U_i^C-\bar{U}_i\right)}_{>0}\frac{\partial U_i^C}{\partial e_i}R=0 \qquad i=1,2$$

can be reduced to

$$9)\qquad \frac{\partial U_i^C}{\partial e_i}=\frac{\partial U_i}{\partial e_i}-\Gamma'\left(e_i\right)=0 \Leftrightarrow \left(b_i\Psi'\left(G_C\right)-\frac{1}{n}\right)\frac{\partial G_C}{\partial e_i}=\Gamma'\left(e_i\right) \quad i=1,2\,,$$

i.e. politicians choose effort levels for which marginal benefits in terms of an increase of their region's utility equal marginal costs of lobbying. It can be shown that, despite heterogeneity within regional preferences, politicians choose identical lobbying efforts in equilibrium. Furthermore this effort and with it disutility from central negotiations rises monotonically with an increase in preference heterogeneity.[10] Because of that centralized public goods provision satisfies the Samuelson-condition, i.e. the necessary condition for efficiency. However the corresponding allocation is not Pareto-efficient owing to resources wastefully employed in negotiations.

Proposition 1: In a static setting centralized public goods provision performs best with similar regional preferences. Compared to Pareto-efficiency this performance is reduced monotonically by an increase in respective heterogeneity whereas results do not depend on the level of national expectations.

III. Repeated setting

As in the stage game politicians maximize expected utility. Now, potentially interacting over several periods, politicians can choose their actions within one term contingent on the game's history up to that point. Evaluating strategies they will take into account possible changes in future pay-offs resulting from their current behaviour. Whereas in the one shot game there exists a unique and inefficient (both for politicians and voters) Nash-equilibrium, there exist several mutually optimal strategies in the repeated game. A strategy aiming to resolve

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of re-election in equilibrium as well as mutual incentives to deviate from a cooperative solution in the one shot game. An interesting though difficult extension might consider an additional pre-stage with voters determining $\bar{U}_i$.

[10] See appendix A.3.

inefficiencies in dilemma-games is the well-known trigger-strategy.[11] Let B_{it} denote a delegate from region *i* during term *t*, who is assumed to be perfectly informed about previous negotiation behaviour comprised in history $h_t\left(\{e_1,e_2\}_1,...,\{e_1,e_2\}_{t-1}\right)$. The trigger-strategy for B_{it} is then

$$10)\qquad e_{it}=\begin{cases}0 & \text{for} \quad t=1\\ 0 & \text{if} \quad h_t=\left(\{0,0\}_1,...,\{0,0\}_{t-1}\right) \quad t>1\\ e^* & \text{otherwise}\end{cases}$$

Politicians employing this kind of strategy always choose the cooperative effort level in the first period. Politicians delegated for subsequent periods, not necessarily according to former, choose the cooperative effort level if these were chosen by all delegates during all previous terms. Otherwise there is Nash reversion with all politicians playing the stage game equilibrium from that point on.[12]

Politicians face incentives to deviate, as already a minute effort induces public goods provision to exclusively represent their region's preference thus resulting in a short-term jump of re-election probability. With Nash reversion the long-term consequences of such a deviation though include a decrease in re-election probability compared to cooperation. As rents from office do not depend on individual behaviour politicians evaluate their strategies via endogenous discounting.[13]

Let $\Pr_{Co}$ denote politician's re-election probability with mutual cooperation after his first term, $\Pr_E$ denote re-election probability with mutual stage game equilibrium efforts and $\Pr_D$ denote re-election probability for a politician deviating from cooperation.[14] Whereas receiving *R* in case of re-election an ejection from office entails no further pay-offs in subsequent terms.

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[11] This strategy was introduced by Friedman (1971). Employing trigger-strategies Pecorino (1999) analyses the possibility of efficient decentralized public goods provision in a repeated game setting.

[12] A more appealing strategy can be expressed as follows: In case of a deviation everybody plays the stage game equilibrium until the deviant is ejected from office. In subsequent terms politicians return to choosing cooperative effort levels until another deviation occurs. Players' ability to interpret effort as active deviation and retaliation of deviation respectively is guaranteed by perfect recall. Though this strategy induces the same incentives as 10), it allows for a return to cooperation once deviation has occurred.

[13] I am yet only aware of repeated games with players evaluating forthcoming pay-offs via exogenous discount factors $(d\leq 1)$.

[14] To keep notification simple index *i* is dropped.

Then $\Pr_{Co}{}^2$ equals politician's ex-ante probability of re-election after his second term with mutual cooperation. Accordingly politician's expected utility from cooperation Π_{Co} can be written as[15]

$$\Pi_{Co} = R\frac{\Pr_{Co}}{1-\Pr_{Co}}.$$

Due to stationarity any deviation will be carried out in the first period[16] resulting in payoff

$$\Pi_D = R\frac{\Pr_D}{1-\Pr_E}.$$

The trigger-strategies in 10) constitute an equilibrium of the repeated game if the following condition is satisfied for both politicians:

11) $$\frac{1-\Pr_E}{1-\Pr_{Co}} \geq \frac{\Pr_D}{\Pr_{Co}}$$

In this condition short-term gain from deviation is measured by a unique relative raise in re-election probability from $\Pr_{Co}$ to $\Pr_D$. This gain must not surpass long-term costs from deviation measured by a relative raise in discounting from $1-\Pr_{Co}$ to $1-\Pr_E$ caused by a permanent raise in ejection probability.[17] Condition 11) can be written as

12) $$\underbrace{\frac{1+\dfrac{h}{1-\Pr_{Co}}}{1+\dfrac{s}{\Pr_{Co}}}}_{LHS} \geq 1$$

with $h = \Pr_{Co} - \Pr_E > 0$ and $s = \Pr_D - \Pr_{Co} > 0$, where η as well as σ do not depend on reservation utility $\bar{U}_i$. It is readily checked that $\frac{\partial LHS}{\partial \bar{U}_i} < 0$ rendering deviation more attractive

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15 Corresponding computations can be found in appendix A.4.

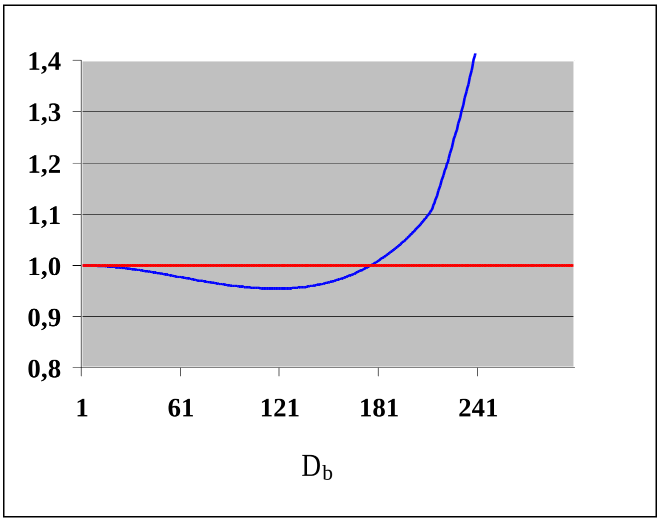
16 The proof is found in appendix A.4.

17 In standard models with exogenous discounting efficiency-sustaining cooperation can be guaranteed with individuals' "δs" sufficiently close to 1. As discounting occurs endogenously in this model there exists an endogenous upper bound for cooperation limiting equilibrium prediction.

as reservation utility increases. For $\bar{U}_i \rightarrow \bar{U}_i^{\min}$ the above condition is satisfied as *LHS* converges to $+\infty$ with $\Pr_{Co}$ converging to 1. Consequently cooperation may be established for sufficiently low levels of national expectations. For $\bar{U}_i \rightarrow \bar{U}_i^{\max}$ *LHS* converges to $\frac{\Pr_{Co}}{(1-\Pr_{Co})\Pr_D}$ with $\Pr_E$ converging to 0. The specific value for this term hinges on model's parameters and is either lower or higher than 1.

Surprisingly, more heterogeneity within regional preferences can act to support cooperation. For a given aggregate preference the difference between $\Pr_{Co}$ and $\Pr_E$ increases monotonically with an increase in heterogeneity. This is due to the fact that this difference exclusively results from disutility of negotiations with latter increasing in heterogeneity. With voters expecting admissible values of reservation utility punishment for deviation thereby turns out increasingly severe whilst relative gain from deviation is bounded due to $\Pr_D \leq 1$. For sufficiently high heterogeneity cooperation therefore can be sustained. Figure 1 illustrates this relation for specific parameter values.[18]

Figure 1- Heterogeneity and cooperation



In this figure Δ_b represents different levels of preference heterogeneity. The blue (red) line represents *LHS* (*RHS*) of condition 12) for one region. Whereas cooperation in this example

[18] The corresponding calculations can be found in table 1 in appendix A.5 with curve's qualitative characteristics being identical when computed for the other region.

cannot be sustained for small and moderate values of Δ_b high values of heterogeneity facilitate cooperation.

Proposition 2: In a repeated game setting the relative gain from cooperation decreases monotonically with an increase in national expectations. Cooperation can either be sustained in equilibrium even with maximal expectations or there exists a critical level of expectations $\bar{U}_i^{crit}$ from which on cooperation cannot be sustained anymore. Sufficient heterogeneity within regional preferences supports cooperation.

IV. Conclusion

The static version of this model sheds light on lobbying as a source for inefficiencies in centralized public goods provision. Confirming a result commonly accepted in static models of fiscal federalism it demonstrates a negative correlation between preference heterogeneity and performance of central governance. In a dynamic setting though this performance is rather hampered by political pressure in terms of high voter expectations whereas sufficiently high heterogeneity enables cooperation.

Reflection of the political process in this model may raise criticism. Many democratic institutions employ aggregation rules like majority voting rather than negotiations to decide on political issues. However even in these settings negotiations with respect to political outcomes, agenda setting or logrolling may occur in the political process.[19] On the other hand there exist several political institutions whose mechanisms can best be captured as basing on negotiations. Within the European Union the “bulk of political power lies with the Council of Ministers in Brussels, not with the European Parliament”[20]. As the latter institution comprises member state representatives restricted to unanimity in vital issues its decisions are subject to negotiations.

The impact of national expectations in term of reservation utility should be exemplified. A high fluctuation of Italian representatives in the European Council indicates a low probability of re-election for these politicians. As ejection from office results from voters perceiving their politician’s performance as inappropriate this fluctuation either results from politicians’

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[19] Despite the fact that many policy issues within the European Council may be decided by qualified majority corresponding voting procedures have –with one exception- never been carried out.

[20] Mueller (1997), p. 273. Nowadays the Council of Ministers is called Council of the European Union.

generally poor performances or from an excessive expectation on the part of voters. Assuming the latter an Italian representative is provided with a greater incentive to push through his national interests in European negotiations, as his "gain from deviation" is sufficiently large. Anticipating their Italian counterparts' behaviour representatives from other nations will also want to negotiate at an intense level not willing to unilaterally harm their chances for another term in office.[21] On the other hand the perceived cooperation in terms of mutual renunciation of undue national interests in French-German relations during 13 years of president Mitterand's and chancellor Kohl's simultaneous terms is likely to result from mutually high probabilities of re-election. With both incumbents aware of this fact cooperation may rather have resulted from low incentives for deviation due to moderate pressure on both politicians than from similar national preferences. In this respect the model proves wrong an estimation habitually found in political debates. Voters feeling dissatisfied with representation of their preferences should namely not raise but lower their expectations with respect to political outcomes. Of course a raise in expectations commits delegates to push hard for their nations' preferences. In return though this commitment results in remaining politicians pushing hard as well thus leaving voters worse off.

This mechanism also works with companies trying to absorb monopoly rents in oligopoly markets. With stochastic profits and shareholders making renewal of managers' employment contracts contingent on realised profits these managers find it harder to implement tacit collusion with high profit yardsticks. This is due to the fact that latter raise short-term incentives to deviate from cooperative strategies.

Employing trigger-strategies to implement efficient outcomes in the repeated game setting may encounter problems. First, possible renegotiations might hamper the implementation of trigger-strategies.[22] Furthermore efficiency in this model cannot generally be sustained by these strategies due to endogenous impatience of players. A closer inspection of more sophisticated strategies including ones yielding harsher punishments for deviants or merely more appealing ones like the one described in footnote 12) may yield interesting results as to under which conditions cooperation may be sustained.

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[21] Axelrod (1984), p.14-15, cites a dramatic reduction of politicians' fluctuation ratios in US Senate and Congress during the last century. He argues that this increase in re-election probability, i.e. of exogenous δ, lets politicians discount future pay-offs less heavily thus facilitating cooperation among delegates. This model agrees with his conclusion showing that high probabilities of re-election go hand in hand with moderate political pressure resulting in low incentives to deviate from cooperation.

[22] For an analysis of this problem see e.g. Farrell and Maskin (1989).

V. Appendix

A.1 Pareto-optimal allocations with quasi-linear utility

$$
\begin{aligned}
&\underset{G,x_j}{Max}\; V_j(G)+x_j \quad \text{mit } V'>0,\; V''<0\\
&s.t.:\\
&V_i(G)+x_i \geq \bar{U}_i \quad \forall i \neq j\\
&\sum_{i=1}^{n} w_i \geq \sum_{i=1}^{n} x_i + G
\end{aligned}
$$

From the resulting Lagrange-program

$$\underset{G,x_j,\vec{x}_{i\neq j},\vec{l}_{i\neq j},m}{Max} L = V_j(G)+x_j+\sum_{i\neq j} l_i\left(V_i(G)+x_i-\bar{U}_i\right)+m\left(\sum_{i=1}^{n} w_i-\sum_{i=1}^{n} x_i-G\right)$$

follows that

$$\left.\begin{aligned}
&\frac{\partial L}{\partial x_j}=1-m=0 \Leftrightarrow m=1\\
&\frac{\partial L}{\partial x_i}=l_i-m=0
\end{aligned}\right\} \Rightarrow l_i=1 \quad \forall i\neq j$$

Consequently the Lagrange-program can be written as

$$\underset{G,\vec{x}_i}{Max}\sum_{i=1}^{n}\left(V_i(G)+x_i\right)-\sum_{i\neq j}\bar{U}_i+\sum_{i=1}^{n} w_i-\sum_{i=1}^{n} x_i-G$$

or

$$\underset{G}{Max}\sum_{i=1}^{n} V_i(G)-G+\sum_{i=1}^{n} w_i-\sum_{i\neq j}\bar{U}_j$$

For $a_i = a_{-i} = 1/2$ and $V_i(G)=b_i\Psi(G)$ this program yields the same results as the program in 2).

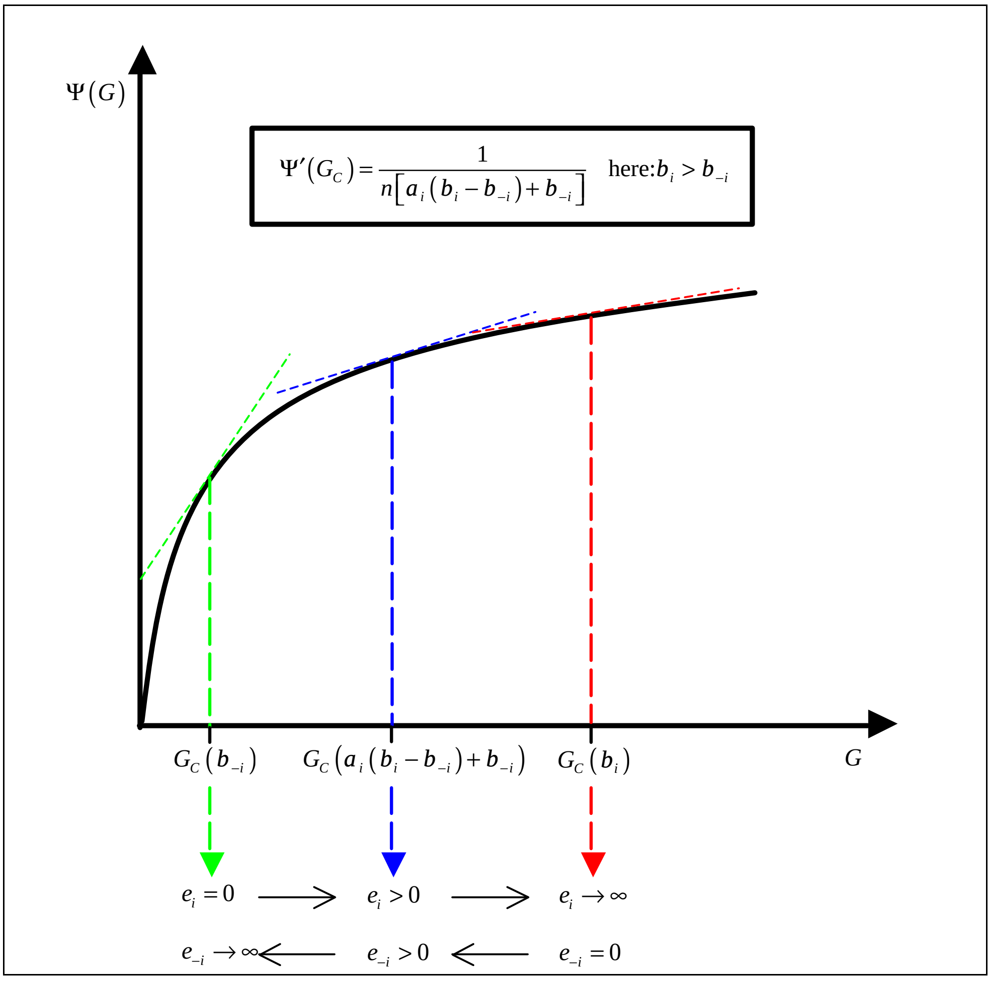
A.2 An increase in e_i induces an increase (a reduction) of G_C if $b_i > (<) b_{-i}$

Perceived by region *i*'s politician equation 3) reads as

13) $$\Psi'(G_C) = \frac{1}{n\left[a_i(b_i - b_{-i}) + b_{-i}\right]} =: RHS$$

It follows that $\frac{\partial G_C}{\partial e_i} = \frac{\frac{\partial RHS}{\partial e_i}}{\Psi''(G_C)}$. With $\frac{\partial RHS}{\partial e_i} = \frac{-n\frac{\partial a_i}{\partial e_i}(b_i - b_{-i})}{\left[n\left(a_i(b_i - b_{-i}) + b_{-i}\right)\right]^2} \begin{Bmatrix} > \\ < \end{Bmatrix} 0 \Leftrightarrow b_i \begin{Bmatrix} < \\ > \end{Bmatrix} b_{-i}$ it follows that $\frac{\partial G_C}{\partial e_i} \begin{Bmatrix} > \\ < \end{Bmatrix} 0 \;\Leftrightarrow\; b_i \begin{Bmatrix} > \\ < \end{Bmatrix} b_{-i}$. See figure 2.

Figure 2 Central negotiations



A.3 Identical equilibrium efforts rise with preference heterogeneity

From 9) the first order condition for region *i*'s delegate can be written as

$$\left(b_i \Psi'(G_C) - \frac{1}{n}\right)\frac{\partial G_C}{\partial e_i} = \Gamma'(e_i).$$

Together with the results from A.2 this reads as

$$\left(\frac{b_i}{n\left[a_i(b_i - b_{-i}) + b_{-i}\right]} - \frac{1}{n}\right)\frac{\dfrac{-n\dfrac{\partial a_i}{\partial e_i}(b_i - b_{-i})}{\left[n\left(a_i(b_i - b_{-i}) + b_{-i}\right)\right]^2}}{\Psi''(G_C)} = \Gamma'(e_i)$$

$$\Leftrightarrow \frac{b_i - a_i(b_i - b_{-i}) - b_{-i}}{n\left[a_i(b_i - b_{-i}) + b_{-i}\right]}\frac{n\dfrac{\partial a_i}{\partial e_i}(b_i - b_{-i})}{\left\{n\left[a_i(b_i - b_{-i}) + b_{-i}\right]\right\}^2} = -\Psi''(G_C)\Gamma'(e_i)$$

$$\Leftrightarrow \frac{(1 - a_i)\dfrac{\partial a_i}{\partial e_i}(b_i - b_{-i})^2 n}{\left\{n\left[a_i(b_i - b_{-i}) + b_{-i}\right]\right\}^3} = -\Psi''(G_C)\Gamma'(e_i)$$

$$\Leftrightarrow (1 - a_i)\frac{\partial a_i}{\partial e_i} = -\Psi''(G_C)\Gamma'(e_i)\frac{\left\{n\left[a_i(b_i - b_{-i}) + b_{-i}\right]\right\}^3}{n(b_i - b_{-i})^2} \qquad i = 1,2$$

Due to symmetry of fist order conditions equilibrium efforts are identical with $e_i^* = e_{-i}^* = e^*$. From $a_i(e^*) = a_{-i}(e^*) = 1/2$ and $\left.\frac{\partial a_i}{\partial e_i}\right|_{e^*} = \left.\frac{\partial a_{-i}}{\partial e_{-i}}\right|_{e^*} = \frac{1}{4e^*}$ it follows that the following condition is satisfied in equilibrium

14) $$-\Psi''(G_C)\Gamma'(e^*)e^*\frac{(b_i + b_{-i})^3}{(b_i - b_{-i})^2} - \frac{1}{n^2} = 0$$

With $\Delta_b = b_1 - b_2 > 0$ and $\sum_{i=1}^{2} b_i = \bar{b}$ it follows that $\frac{\partial e^*}{\partial \Delta_b} = -\frac{\frac{\partial 14)}{\partial \Delta_b}}{\frac{\partial 14)}{\partial e^*}} > 0$.

A.4 Repeated game pay-offs

Cooperation

$$\Pi_{Co} = \Pr_{Co} R + \Pr_{Co}{}^{2} R + \Pr_{Co}{}^{3} R ... = R\sum_{t=1}^{\infty} \Pr_{Co}{}^{t} = R\frac{\Pr_{Co}}{1-\Pr_{Co}}$$

Deviation in first period

$$\Pi_{D,1} = \Pr_D R + \Pr_D \Pr_E R + \Pr_D \Pr_E{}^{2} R + ... = \Pr_D \left[R + \Pr_E R + \Pr_E{}^{2} R + ... \right]$$

$$= \Pr_D \left[R\sum_{t=0}^{\infty} \Pr_E{}^{t} \right] = R\frac{\Pr_D}{1-\Pr_E}$$

Deviation in period s

$$\Pi_{D,s} = \Pr_{Co} R + ... + \Pr_{Co}{}^{s-1} R + \Pr_{Co}{}^{s-1} \Pr_D R + \Pr_{Co}{}^{s-1} \Pr_D \Pr_E R + \Pr_{Co}{}^{s-1} \Pr_D \Pr_E{}^{2} R ...$$

$$= \sum_{t=1}^{s-1} \Pr_{Co}{}^{t} R + R \Pr_{Co}{}^{s-1} \Pr_D \sum_{t=0}^{\infty} \Pr_E{}^{t} = \sum_{t=0}^{s-1} \Pr_{Co}{}^{t} R - R + R \Pr_{Co}{}^{s-1} \Pr_D \sum_{t=0}^{\infty} \Pr_E{}^{t}$$

$$= R\left(\frac{1-\Pr_{Co}{}^{s}}{1-\Pr_{Co}} - 1 \right) + R\frac{\Pr_{Co}{}^{s-1} \Pr_D}{1-\Pr_E}$$

$$= R\left(\frac{\Pr_{Co} - \Pr_{Co}{}^{s}}{1-\Pr_{Co}} \right) + R\frac{\Pr_{Co}{}^{s-1} \Pr_D}{1-\Pr_E}$$

Deviation in period $s+1$

$$\Pi_{D,s+1} = R\left(\frac{\Pr_{Co} - \Pr_{Co}{}^{s+1}}{1-\Pr_{Co}} \right) + R\frac{\Pr_{Co}{}^{s} \Pr_D}{1-\Pr_E}$$

Difference

$$\Pi_{D,s+1} - \Pi_{D,s} = R\frac{\Pr_{Co}{}^{s} - \Pr_{Co}{}^{s+1}}{1-\Pr_{Co}} + R\frac{\Pr_D \left(\Pr_{Co}{}^{s} - \Pr_{Co}{}^{s-1} \right)}{1-\Pr_E}$$

$$= R\frac{\Pr_{Co} \left(\Pr_{Co}{}^{s-1} - \Pr_{Co}{}^{s} \right)}{1-\Pr_{Co}} + R\frac{\Pr_D \left(\Pr_{Co}{}^{s} - \Pr_{Co}{}^{s-1} \right)}{1-\Pr_E} = \left(\Pr_{Co}{}^{s-1} - \Pr_{Co}{}^{s} \right) \left(R\frac{\Pr_{Co}}{1-\Pr_{Co}} - R\frac{\Pr_D}{1-\Pr_E} \right)$$

$$= \underbrace{\left(\Pr_{Co}{}^{s-1} - \Pr_{Co}{}^{s} \right)}_{>0} \left(\Pi_{Co} - \Pi_D \right)$$

If deviation is not worthwhile in the first period $(\Pi_{Co} > \Pi_D)$, it is not worthwhile in any subsequent period. If deviation is worthwhile in the first period $(\Pi_{Co} < \Pi_D)$, it is not as worthwhile in subsequent periods.

A.5 Heterogeneity and cooperation

Assume $\Psi(G) = \ln G$, $\Gamma(e_i) = \frac{g\, e_i^2}{2}$ with $g > 0$

This yields $G_C = n\sum_{i=1}^{2} a_i b_i$, $e^* = \sqrt{\frac{(b_1 - b_2)^2}{4g\,(b_1 + b_2)}}$, $\Gamma(e^*) = \frac{(b_1 - b_2)^2}{8(b_1 + b_2)}$,

$$U_{Co} = b_1 \ln\left[\frac{n}{2}(b_1 + b_2)\right] - \frac{(b_1 + b_2)}{2} + w,$$

$$U_E = b_1 \ln\left[\frac{n}{2}(b_1 + b_2)\right] - \frac{(b_1 + b_2)}{2} + w - \Gamma(e^*),$$

$$U_D = b_1 \ln(n b_1) - b_1 + w$$

and thus $\Pr_{Co} = \frac{U_{Co} - \bar{U}_1 + a}{2a}$, $\Pr_D = \frac{U_D - \bar{U}_1 + a}{2a}$ as well as $\Pr_E = \frac{U_E - \bar{U}_1 + a}{2a}$.

With $w = n = 5000$, $a = 100$ and voters demanding utility associated with stage game equilibrium the following table shows values underlying the computation of *LHS* 12) for the affected politician.

Table 1 Selected values

b_1	b_2	Δ_b	Γ	$\bar{U}_1$	U_{Co}^1	U_D^1	U_E^1	$\Pr_{Co}^1$	$\Pr_D^1$	$\Pr_E^1$	*LHS* 12)
301	299	2	0,0	8981	8981	8981	8981	0,50	0,50	0,50	**0,99999**
321	279	42	0,4	9265	9265	9266	9265	0,50	0,51	0,50	**0,99656**
341	259	82	1,4	9548	9549	9552	9548	0,51	0,52	0,50	**0,98807**
361	239	122	3,1	9831	9834	9840	9831	0,52	0,54	0,50	**0,97686**
381	219	162	5,5	10113	10118	10128	10113	0,53	0,58	0,50	**0,96568**
401	199	202	8,5	10394	10403	10418	10394	0,54	0,62	0,50	**0,95736**
421	179	242	12,2	10675	10687	10709	10675	0,56	0,67	0,50	**0,95470**
441	159	282	16,6	10955	10971	11000	10955	0,58	0,73	0,50	**0,96045**
461	139	322	21,6	11234	11256	11293	11234	0,61	0,79	0,50	**0,97763**
481	119	362	27,3	11513	11540	11586	11513	0,64	0,87	0,50	**1,00999**
501	99	402	33,7	11791	11825	11881	11791	0,67	0,95	0,50	**1,06287**
521	79	442	40,7	12068	12109	12176	12068	0,70	1,00	0,50	**1,18636**
541	59	482	48,4	12345	12394	12472	12345	0,74	1,00	0,50	**1,43802**
561	39	522	56,8	12621	12678	12768	12621	0,78	1,00	0,50	**1,81307**
581	19	562	65,8	12897	12962	13065	12897	0,83	1,00	0,50	**2,42405**
599	1	598	74,5	13144	13218	13334	13144	0,87	1,00	0,50	**3,42170**

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