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Rigorózní práce

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RIGORÓZNÍ PRÁCE

Further Exploration of Centralization and Strategic Delegation

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I do hereby declare that the whole thesis was elaborated on my own and that I used only the listed resources.

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ABSTRACT

The thesis provides with an insight into the problem of fiscal centralization and decentralization from the political economy perspective. It mainly focuses on the concept of strategic delegation. The strategic delegation describes a situation, when voters do not vote for a candidate according to their own preferences and purposely pretend biased preferences. The effect of the strategic delegation plays very important role because it can distort outcome in centralization so that the centralized decision-making fails to internalize policy externalities. In the thesis, voters' incentives to delegate strategically are explored in two decision-making settings; centralization and decentralization. The presented model concerns decision-making on public goods provision in two regions with positive externalities. The analysis includes different types of public goods; neutral goods, strategic substitutes and complements. Moreover, the model is extended by a bargaining game showing that voters can delegate a policy-maker strategically to improve her bargaining position .

ABSTRAKT

Rigorózní práce se zabývá problémem fiskální centralizace a decentralizace z pohledu politické ekonomie. Hlavním tématem je strategická delegace, která označuje situaci, kdy voliči nevolí politika podle svých vlastních preferencích, ale záměrně předstírají preference jiné. Strategická delegace je velice důležitá zejména v případě centralizovaného politického rozhodování, kdy může ovlivnit výsledek natolik, že externí efekty nebudou v centralizaci plně zahrnuty. Rigorózní práce zkoumá účinky strategické delegace v případě centralizace a decentralizace. Uvedený model popisuje politické rozhodování o poskytování veřejného statku ve dvou regionech, přičemž veřejný statek má pozitivní externí efekty. Analýza je provedena pro tři různé druhy veřejných statků – nezávislé statky, strategické substituty a komplementy. Model je navíc rozšířen o vyjednávání, kdy voliči mohou volit politika strategicky, aby vylepšili jeho vyjednávací pozici.

Contents

1. Introduction

Centralization and decentralization of political decision making turns out to be a very relevant topic with ongoing integration in Europe. In the course of economic and political integration, fiscal and political powers have been transferred from the national governments both to a supranational authority and to lower levels of government. However, we cannot certainly say what policy areas should be centralized or decentralized. The thesis aims to provide with an insight into this problem.

In the beginning, we explore arguments in favour and against centralization and decentralization. We discuss issues as heterogeneity, economies of scale, financing public goods provision, competition among regions, governance and finally, we provide an overview of empirical studies investigating performance of different tiers of government.

In the main part, the thesis provides a model of policy-decision making on public goods provision with strategic delegation built on the framework of Dur and Roelfsema (2005). The strategic delegation describes a situation, when voters do not vote for a candidate according to their own preferences and purposely pretend biased preferences. It is a brand-new topic in the public economics and its effect has not been yet fully resolved. In the model, the strategic delegation affects an outcome such that centralization fails to internalize policy externalities. The fact, that people do not vote sincerely, distorts the outcome in such a way that overspending or underspending occurs. Higher or lower spending is a consequence of a delegation of a public good lover or of a conservative politician, respectively.

We model a decision making on public goods provision in two regions with positive externalities. The strategic delegation is determined by different costs and also different types of public goods. We distinguish two types of costs - direct (tax costs) and indirect (decrease of utility), and three types of public goods - neutral goods, strategic substitutes and complements. In decentralization, strategic delegation will arise only in case of strategic substitutes, however, in centralization, people will have an incentive to delegate strategically in all three cases.

In the end, we present an extension of the original model. We fix total tax revenues and suppose that policy-makers bargain over the public good, which is modeled with Nash bargaining solution. Under some specific assumptions, voters will delegate a policy-maker as to create a threat for a foreign policy-maker and as to improve a bargaining position of the domestic politician. It is striking that the strategic delegation is reverse to that one in the original model for neutral public goods and substitutes, however, for complements it is identical.

The remainder of the thesis is organized as follows. Section 2 provides with a brief survey of literature. Section 3 explores pros and cons of centralization and decentralization. Section 4 outlines the framework of the model. Section 5 presents outcomes in social optimum, section 6 under decentralization and section 7 under centralization of political decision making. Section 8 proposes an extension of the model and finally, section 9 gives some concluding remarks.

2. Survey of literature

Centralization of political decision making is a very large topic for which there are numerous empirical studies and theoretical models concerning its advantages and disadvantages. Oates (1972) in his decentralization theorem suggests why centralization can lead to suboptimal policies. He states that "...in the absence of cost-savings from the centralized provision of a local public good and of interjurisdictional externalities, the level of welfare will always be at least as high (and typically higher) if Pareto-efficient levels of consumption are provided in each jurisdiction than if *any* single, uniform level of consumption is maintained across all jurisdictions" (Oates 1972, p. 54). The costs of centralization come from the policy uniformity when the diversity of preferences of agents in regions is neglected, whereas the benefits arise in economies of scale and internalization of externalities.

Ellingsen (1998) models the trade-off between the benefits and the costs of the centralization and specifies the equilibrium design of jurisdictions. He illustrates that the relative size of the regions and the distribution of preferences are key determinants of equilibrium. The work of Alesina and Spolaore (1997) is closely related, because they focus on the trade-off between economies of scale and regional heterogeneity. In addition, they explore the influence of democratization on the size of government. Above mentioned studies in the Oates' tradition explain the cost of centralization in policy domains where public goods can not be differentiated according to the preferences of jurisdictions. However, in many cases it is possible to decide centrally on differentiated levels of public goods in regions according to the diverse preferences.

Centralized provision of local public goods when regions can be provided with different amounts is studied by Persson and Tabellini (1994). They state that it causes a free-rider problem which enhances the incentives of each region to lobby for government spending. All agents in all regions have strong incentives to push for greater amount of public good, since they only pay a fraction of the costs. Nash equilibrium thus involves overprovision of all local public goods.

A unique approach is examined by Redoano and Scharf (2004). They compare policy centralization outcomes of public goods provision under alternative democratic choice procedures; direct democracy and representative democracy, and conclude that centralization is more likely to occur if the choice to centralize is made by elected policymakers rather than by a referendum. In this situation, centralized policy is close to the preferred level of the region that desires centralization the least. Schnellebach (2006) presents a similar conclusion in a slightly different setup. He shows that the existence of rent extraction by the delegate alone is sufficient for making cooperative centralization more feasible through representative democracy.

Lockwood (2005) explores other arguments in favour of decentralization, such as higher preference-matching and accountability of government. He evaluates contributions to the study of fiscal decentralization using the approach of political economy and presents formal models which provide insights into cases when decentralization may fail to deliver these benefits.

However, none of the above-mentioned studies takes into account possible effects of strategic delegation. This concept describes a situation where a voter with particular preferences elects a politician with different preferences from her own. It is a special case of strategic voting which occurs in more-rounds and more-proposals elections. Besley and Coate (1997) begin to analyze strategic delegation in the case of cooperative decisions. They develop an alternative model of representative democracy and conclude that all decisions by voters, candidates and policy-makers are derived from optimizing behaviour. Therefore, voters may have an incentive to elect a candidate with different preferences from their own if it coincides with their optimizing behaviour. In a later paper, Besley and Coate (2003) illustrate the trade-off between centralized and decentralized provision of local public goods in the case of spillover effects. They emphasize the importance of the decision-making mechanism in centralization, because voters may delegate policy making authority strategically. If the costs are shared through a common budget, voters have an incentive to delegate bargaining to public good lovers. Since in equilibrium all regions send public good lovers, the policy outcome is not effective and the overprovision of public goods may occur. Dur and Roelfsema (2005) extend this analysis by allowing for non-shareable costs in the centralized public goods provision and show that under certain conditions voters delegate conservatives instead of public good lovers. Consequently, underprovision of public goods will occur.

Jennings and Roelfsema (2004) apply this analysis to "conspicuous" public goods. Production of a conspicuous public good in one region has negative externalities in another region. In decentralized system, median voter elects a politician with lower preferences for a conspicuous public good. On the contrary, in case of centralization the delegated politician will have higher preferences. Roelfsema (2004) specifically considers the strategic delegation in the case of the environmental policy making. He argues that in a non-cooperative policy making setting voters may have an incentive to delegate politicians who care more for the environment than they do themselves. If voters anticipate cooperative policy making, they have an incentive to elect persons who care less for the environment. Roelfsema (2006) applies strategic delegation to central banking and shows that regional representatives in the committee responsible for monetary policy making are less conservative than average citizens. Therefore, they are more in favour of expansive monetary policy.

Another application of strategic delegation is provided by Brueckner (2001) who investigates the political economy effects of two different regimes of international capital taxation; tax competition and tax coordination. In the competitive tax regime, delegates choose tax rates on capital at the same time and independently of each other, so that they maximize their utility. In case of tax coordination they choose tax rates in order to maximize the sum of utilities. The policy makers then like the public good more than the median voters under competitive regime. Hence, delegation has a tax-increasing effect. On the contrary, in coordination regime, voters delegate conservatives and taxes are lower.

The papers above consider the cooperative bargaining and simple decision-making in centralized body. Segendorff (1998) computes another model of strategic delegation showing how the choice of a particular type of an agent can become a threat to another nations agent. To find a bargaining outcome, instead of maximum of the sum of utilities, he implements the theory of Nash bargaining solution using reservation utilities. The author distinguishes between two cases, weak and strong delegation games. Weak delegation means that the delegated agents have no influence on the breakdown allocation and principals' ideal allocations are implemented. Strong delegation gives each agent the authority to decide on the national breakdown allocation. Segendorff concludes that in the strong delegation game, the delegated agent with less taste for the public good will decrease the reservation level of utility of another nation's agent. Therefore the principal threatens the other country's agent by her choice. In case of weak delegation, both principals are better off than in a decentralized system. In the strong delegation game both principals delegate strategically and as a consequence the agreed allocation may provide less of a public good than under a decentralized system.

Graziosi (2006) uses a similar approach and also shows that gains of the internalization of economic externalities in centralization can be canceled due to the delegation of conservative representatives and consequently underprovision of the public good. However, he proposes two extensions. If the pre-play game in which countries choose whether or not to initiate political integration is introduced, any integration is prevented. If there is an ex post formal ratification procedure of already specified policies, the result of political integration will improve and consequently, social welfare will increase.

3. Centralization versus decentralization

In this section, we will try to specify pros and cons of centralization and decentralization from different points of view. We will consider heterogeneity, economies of scale, financing public goods provision, competition among regions and governance. In the end, we will provide a survey of empirical evidence about effects of centralization and decentralization.

Every multiple-level government has to deal with the question, which level of government should be responsible for particular taxing and spending decisions. In the European Union, the principle of subsidiarity states that the functions should be decentralized where possible, but there are not any clearly defined criteria for conditions under which centralization would be desirable. The main goal of the normative theory of fiscal federalism is to distinguish between functions and instruments which are best centralized and those which should be decided upon by decentralized levels of government. Generally, it states that the central government should have the basic responsibility for the macroeconomic stabilization and for income redistribution. In addition, it should provide certain "national" public goods that provide services to the entire population of the state. Local governments should provide goods and services whose consumption is limited to their regions (Stiglitz, 1988). This section aims to provide some factors which should be considered when deciding on whether or not to centralize political decision making.

In theory, the efficient level of public good provision is determined by the Samuelson's condition. It states that for efficient output of public good we must have:

$$\sum_{i=1}^{n} MRS_i = MRT$$

MRS is the marginal rate of substitution - the amount of the private good the consumer i, $i = 1, 2, ..., n$ is willing to give up in order to obtain additional unit of the public good. Therefore the sum of MRS_i is the amount of the private good all consumers are willing to give up. MRT denotes the marginal rate of transformation determined by production function. It is the amount of the private good which is necessary for the production of an additional unit of the public good, thus we can rewrite it as marginal cost of production MC. If the Samuelson's condition is satisfied, the loss of utility a consumer suffers from giving up some amount of her private good - individual marginal cost, must be equal to the utility gain from consumption of additional unit of public good - marginal benefit of public good consumption, MB. Hence, Samuelson's condition can be modified as

$$\sum_{i=1}^{n} MB_i = MC$$

Increase in the total utility from the consumption of the additional unit of the public good of the whole society must be equal to the marginal cost of production.

However, the reasoning above is applicable only for a perfect world, in which interests of all individuals are taken into account. In reality, we usually observe overprovision or underprovision in some policy areas. If we extend the analysis to political decision making we can reach different conclusions. Under the system of majority voting the interests of minorities can be neglected in centralization, especially when compensation is impossible or prohibitively costly. As Giertz (1981) argues, if a small group prefers some kind of public good and its production entails higher taxes for all citizens and the group cannot compensate majority, the production of the public good will be rejected by the majority. Even though the potential provision of the public good would bring the positive net utility (= increase in utility of the small group less the absolute decrease in utility caused by higher taxes) and thus would increase social welfare, it is not produced because of a large number of taxed non-beneficiaries. In this case, centralization is less effective than decentralization and the Samuelson's condition is not satisfied. If we allow for "trading with votes" as logrolling can be defined, which is in fact particular type of compensation, we can obtain a more efficient result. However, logrolling process is often very costly and unfeasible, because there are high transaction costs of trading with externalities. Therefore, in centralization, underspending can be observed.

Another argument explaining underspending comes from the lack of information of voters, who cannot precisely calculate benefits of particular public goods, but can see the costs accurately in form of higher taxes. Akai and Mikami (2006) come with another approach and show that minorities can be better-off in a centralized system and thus centralization may be more efficient. They argue that under a majority rule, a district majority can choose a very extreme policy and discriminate district minorities when the policy-making is decentralized. In some cases, this ignorance of interests of minorities can lead to lower efficiency. According to the law of large numbers, extreme preferences in some local districts can be balanced if these districts are integrated. Therefore, in centralization, more moderate policies can be chosen and minorities can be better served to some extent.

On the other hand, we can find arguments for overspending in centralization. Fiscal illusion serves as a counterargument against the one stressing the lack of voters' information about the benefits of public goods provision. Turnbul (1998) shows that citizens often do not correctly perceive the full burden of taxation, because the tax system is too complex and they even do not know to what extent they are taxed. As voters are consistently underestimating tax costs, they support higher governmental spending than they would if they had complete information.

Another argument for overspending comes from the common pool problem. When the policy-making is decentralized, then every local public good is evaluated according to its benefits and costs in each region. If provision of a local public good is centralized, then the common pool problem occurs. The costs in the particular region are much lower, since people only pay a fraction of the total costs. Consequently, as Weingast, Shepsle and Johanson (1981) argue, concentration of benefits and dispersion of costs imply that regional representatives lobby for projects which would not be even carried out under decentralization, and overspending occurs.

As we can see, the effect of centralization of public goods provision has not yet been fully resolved. Following sections will stress some advantages and disadvantages of centralization and show under what conditions it can be profitable to centralize.

3.1. Heterogeneity

Citizens usually differ in their preferences of public good, which are more likely to vary across different regions than within a region. If we assume that they vary across regions but not within a region, we will find that efficient levels of public goods in regions are not the same. In addition, there can be also cost differences. Figure 3.1 displays the utility losses which result from the centralized provision of public goods when costs are same in both regions and linear in public goods provision, however the demands are different. For MB^i as the sum of marginal benefits of all individuals in region i and MC as the marginal costs of producing public good, quantities Q_1 and Q_2 denote the efficient amounts of public good in region 1 and 2 in decentralization, respectively. In centralization, the optimal level satisfying Samuelson's condition will be Q_c. In case of region 1, the marginal cost will be much higher than total benefit, so the citizens will be forced to consume and pay more than they would like to. The loss is represented by the yellow triangle. On the contrary, individuals in region 2 are willing to pay and consume much more. Their consumer surplus will decrease by the red triangle. These losses seem to argue in favour of decentralization.

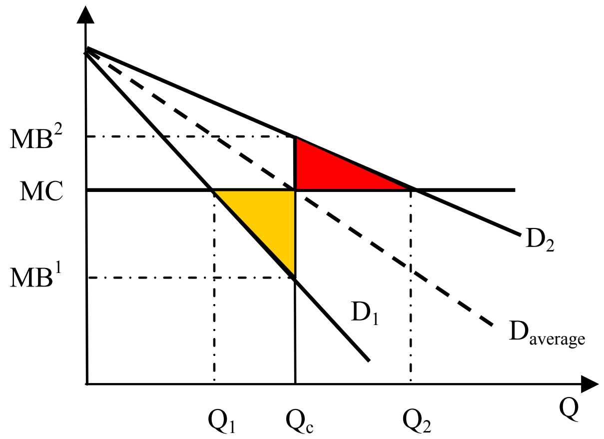

Figure 3.1.: Heterogenous preferences

However, this reasoning is applicable only for public goods, which are local and partially rivalrous between regions, although they can be pure public goods within each region. Consumption of these goods by people in one region reduces, but does not eliminate the benefits that the people in the other region receive from its consumption. In centralization, we will provide in total $2Q_c$ which would correspond to the intersection of the curve MC and the total demand curve $D_1 + D_2$ and each region will get exactly a half, Q_c, which is illustrated by the uniform policy. If the public good is entirely pure, non-rivalrous and non-excludable across regions in consumption, centralization will lead to the welfare improvement. Army of one region can defend also the other region and if regions formed integrated constituency, marginal cost of the defence in form of taxes would decrease for every citizen. The problem of heterogeneity persists, however people pay less.

But there is more to the story. We assumed the uniform level of output in centralization of public goods provision and differentiated levels in decentralization, because local governments are much closer to the people in their region and possess knowledge of local preferences and cost conditions that a central government is unlikely to have. However, in a setting with perfect information, it would be obviously possible for a central government to determine the set of differentiated local amounts that would maximize the overall social welfare. Nevertheless, the higher levels of public goods in some regions than in others can be constrained by some political pressure, which can require a certain degree of uniformity in centralization. However, Greco (2003) uses the perspective of information economics and argues that under asymmetric information, self-interested central governments can design optimal contracts to extract local information. Moreover, he shows that, empirically, central expenditures are very differentiated on a regional basis.

3.2. Economies of scale

In some cases it is more efficient to provide public services or goods at the centralized level. One of the arguments is based on the economies of scale. If the production function has increasing returns to scale, then the production of a greater amount will result in cheaper goods.

Figure 3.2 shows such production function on the left graph with costs C on the horizontal axis representing requisite money for production of a particular amount

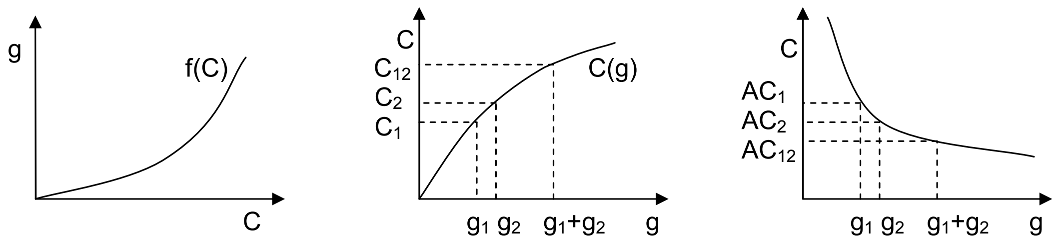

Figure 3.2.: Economies of Scale

and public good g on the vertical axis. The graph in the middle is just an inverse cost function and the right one illustrates decreasing average costs. If the regions produce public goods separately, they will both bear very high costs in comparison with the centralized production. Hence, $C_{12} = C(g_1 + g_2) < C(g_1) + C(g_2) = C_1 + C_2$ implying $AC_{12} < \min(AC_1, AC_2)$. For this reasoning, we assume that the production function is the only one and same in both regions. In this setting, centralization seems to be welfare superior for both regions, however we can get a problem of division of total output.

We can imagine a third party which would own a factory where the public good is produced and let's say it is a competitive industry, therefore plant owner earns zero profit. If the representative of one region comes to the factory with her input and she will be the first one to ask for production, she will make a contract with the producer and will get the same output as in decentralization. However, if the representative from the other region comes just after her, she will get more advantageous contract because her output of the public good will be higher. This situation stems from the common production and its economies of scale. In this case, the representative from the second region gains all the profit. The core of this idea would not change if we assumed the factory was situated in either region 1 or 2.

Figure 3.3 illustrates this situation. On the left graph we can see the situation of the first agent when she comes to the factory and provides x_1 for production and she makes the contract with the provider of getting output g_1. A few minutes later the second agent brings to the factory x_2, however, in this case the provider is aware of

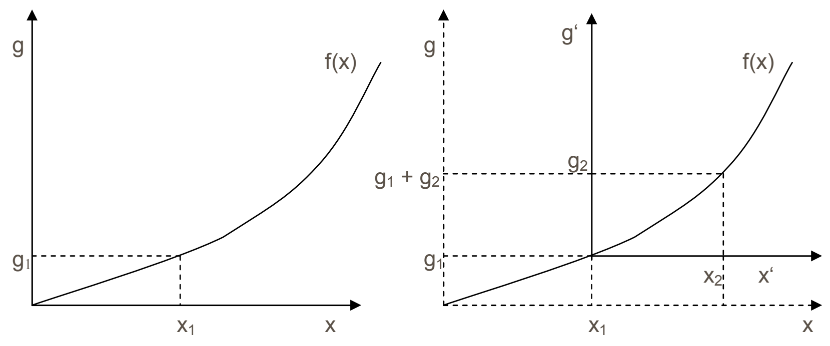

Figure 3.3.: Economies of Scale - third party

the first order of g_1. Therefore, he can now produce g_2, which is greater than the amount of the public good from the agent's decentralized production. Actually, we can imagine it as the down-left shift of the production curve as depicted in the right graph.

But, is there any incentive for the first agent to join production when he might not necessarily be better off? The answer can be affirmative under the assumption that in the beginning of the game nobody knows who will gain all the profit. In case of two regions, the probability that either representative will be the winner and will take it all is $p = \frac{1}{2}$. Even if the representatives are risk averse, they will always play this lottery, because they do not lose anything and their expected utility is higher.

However, when there is a perfect centralized production and no third party, nobody is the first or the second. Therefore, bargaining about division of output should take place. The stronger the representative's position is, the more public good she will get. Whatever the outcome, both representatives will always be better off. As a result, under the economies of scale centralization of public goods provision is welfare superior to decentralization.

3.3. Financing public goods provision

Governments need specific fiscal instruments to carry out their functions like the public goods provision. In centralization, except tax and debt instruments, an additional method of how to allocate finances among local governments is available - the intergovernmental grants. One local government may have larger tax revenues than its own expenditures and transfer the money to the other local government which would then cover its excessive expenditures in order to balance the budget.

The intergovernmental grants have three roles as Oates (1999) emphasizes: the internalization of spillover benefits to other regions, fiscal equalization across regions and an improved overall tax system.

Matching grants, under which the donor finances a specific share of the recipient's costs, are used for the local services and goods which generate some benefit to the residents of other regions. Policy-makers are therefore aware of the spillover benefits and take them into account in their decision-making on production of that particular service or good.

Intergovernmental equalizing grants can serve as a tool to transfer money from wealthy regions to the poor ones. It should allow poorer regions to compete more effectively with fiscally stronger regions. However, an opposite effect can occur. Regions with low wages and low costs are more attractive for investors and this investment can induce their economic growth. Therefore, fiscal equalization may actually harm the economy in the poor regions, because it may impede the flow of resources based on the cost differentials. Another problem can be a soft-budget constraint in the poorer region. The local government in this region realizes that it will always receive some financial help in case of financial problems. Thus with lack of caution it will support ineffective projects. As Qian and Roland (1998) find out, fiscal decentralization and independence of regions would harden the budget constraint and thus increase incentives of local government to use resources more effectively. Thus, decentralization serves as a commitment device to prevent from inefficient government spending.

The third role is to ensure a more equitable and efficient overall tax system. Centrally administered taxes will not cause the locational inefficiencies which are associated with varying tax rates across decentralized regions. Furthermore, central tax system can be more progressive. Chernick (1992) shows that the state and local systems of taxes are more regressive than the central one. Hodler and Schmidheiny (2005) and Schelker (2005) also find out that fiscal decentralization reduces the progression of the common tax system, and even verify it in empirical testing.

It can be argued in theory whether or not decentralization leads to a higher fiscal discipline. Using the reasoning above, intergovernmental grants should help to balance budgets in the centralized system, and therefore decentralization should lead to higher debts. However, as Schaltegger and Feld (2006) show, evidence favours the interpretation that fiscal decentralization strengthens fiscal discipline. It is supported by the fact that in order to ensure fiscal discipline, governments must be made to face the financial consequences of their decisions. If the local government is aware that it will not get any bailout in case of debt, it will pursue stricter fiscal policy. Neyapti (2003) empirically supports this argumentation and proves that the greater the fiscal decentralization, the lower the budget deficits. These empirical studies comply with the Leviathan model of government behavior, in which governments seek to maximize the budget size. According to this model, Brennan and Buchanan (1980) argue that decentralization can serve to diminish the monopoly power of government agents.

To sum up, intergovernmental grants build transfer dependencies and thus undermine fiscal discipline, however properly designed grants can enhance competition for the supply of public goods, financial harmonization and regional equity.

3.4. Competition among regions

Decentralization of policy decision making is often based on the argument of competition which should enhance efficiency. If competitors are absent, governments will behave as monopolies, which leads to a less efficient result. However, competition among jurisdictions can emerge only if a minimum freedom of factor movement is guaranteed; the higher is the mobility of the factor, the stronger is the competitive pressure.

Oates and Schwab (1988) develop a model showing that under particular conditions the competition is efficient. It forces the local government to use its resources in form of tax revenues to provide public goods as effectively as possible in order to attract citizens and firms to settle in their region. In case of no mobility constraints, they would move to the region offering such a combination of tax rate and public services which would bring them higher utility.

On the other hand, the competition among decentralized levels of governments may cause serious allocative distortions. In their effort to encourage economic development, governments tend to hold down tax rates. Low taxes mean low costs for business enterprises which should bring new jobs into the region and thus promote economic growth. Local governments compete for potential firms by cutting taxes and, as Oates (1999) argues, this can result in a "race to the bottom" with suboptimal supplies of public goods. However, labour is usually much more immobile than capital, thus under the pressure of competition governments lower the taxes on capital, but at the same time they are forced to tax labour more heavily. As a consequence, the "race to the bottom" does not occur in case of public goods.

There is another aspect which should be considered here. The tax policies are closely related to redistributional policies, simply, the lower the taxes, the less welfare spending is possible. Government expenditures consist of social transfers and public goods and social transfers are more responsive to changes in tax revenues. Therefore, with decreasing tax revenues, the amount of social transfers is more likely to decrease than the amount of public good. Schelker (2005) states that if regions set different pair of taxes and welfare spending, rich people will move into regions with low taxes and poor people will move into regions with the greater amount of welfare spending. This negative dynamics will lead to segregation and distortion of redistributive policies.

There is another tool which governments can use for attracting new business enterprises. Cumberland (1979) argues that governments can reduce local environmental standards to lower the costs of pollution control. It is costly not to pollute for firms and if they are allowed to pollute, their total costs of production will be lower. Consequently, firms' decisions about where to do their business are additionally influenced by the environmental regulation. Rational governments decrease the environmental standards until the marginal costs of pollution will be equal to the marginal benefits of inflow of newcomer firms. Inefficiency stems from the negative externalities of higher pollution in other regions, which are not compensated. Competition among regions thus can lead to deterioration of the environment. On the other hand, Glazer (1999) states that local governments raise environmental regulations above the optimal level to discourage polluting firms from entering their region. Millimet (2003) conducts an empirical research in this field and finds out that decentralization of environmental policy during the Reagan's presidency in the US lead to the increase in environmental standards.

Concisely, on one side there are some efficiency-enhancing effects of competition among regions, but on the other side there are allocative distortions caused by competition. Tax harmonization seems to be an appropriate remedy, in which revenues are shared among the regions. Governments do not have to worry about losing the business because of lower tax rates in other regions. Furthermore, the competition through environmental standards can be an argument for harmonization of environmental measures in a centralized system.

However, in case of tax and environmental harmonization, local governments can compete by other distorting means. Cai and Treisman (2004) show that local officials may offer firms protection from central tax collectors, bankruptcy courts or regulators. Authors even give examples from Russia, China and the US. As a result, interjurisdictional competition corrodes the state and leads to weaker central law enforcement and lower welfare.

As we can see, the arguments emphasizing both advantages and disadvantages of competition among jurisdictions can be found and in normative theory, it is still not clear of what net effects competition has. In real world, there are high mobility constraints, thus competition pressure is limited. Feld, Kirchgasser and Schaltegger (2003) investigate the data for Swiss cantons in order to show the effect of tax competition and they suggest that intensity of tax competition is not harmful for economic growth.

3.5. Governance

Local and centralized governments differ in their governance - the institutions by which authority is exercised and public resources managed. Governance involves mainly political accountability, rule of law and corruption. Mello and Barenstein (2001) try to specify the relation between decentralization and governance and they find out that governance in general can be enhanced through decentralization.

A particular level of government also influences the possibility of rent extraction by private parties. Fisman and Gatti (2005) deal with the relation between decentralization and government corruption. In theoretical framework, there was a disagreement of what relation to expect. Having examined this issue empirically, they find very strong consistent negative relation, therefore fiscal decentralization creates less possibilities of rent extraction by private parties. On the other hand, Triesman (2002) examines correlations between eight different measures of decentralization and various measures of corruption and did not find any positive association.

The term accountability is used in a broader sense and includes electoral rules and institutional mechanisms constraining the rent-seeking, such as taking bribes, favouring of some interest groups and political shirking. On the centralized level, government decides on general policies and voters cannot monitor if politicians work correctly and pursue their promises made during the period before elections. However, in decentralization, government is much closer to voters, thus they can observe particular things the government is doing.

Hindriks and Lockwood (2005) compare the accountability of decentralized and centralized governments. When they consider the competence of politicians in terms of high or low expected costs of public goods provision they conclude that in centralization, the probability of a bad politician to be reelected is higher. Therefore, centralization reduces accountability. When they take into account honesty, which can be described as a situation when honest politicians are motivated by voters' well-being, while dishonest politicians by their rents, they come to a conclusion that centralization can have two effects - it can increase the ability to recognize bad incumbent politicians, but at the same time it can decrease the incentive for better discipline of incumbent politicians or vice versa in different settings. Therefore, we cannot easily say that decentralization increases accountability of government.

As Bardhan and Mookherjee (2005) argue, empirical studies cannot provide any robust evidence on the relation between decentralization and governance because of large methodological problems including the difficulty with controlling unobserved cross-sectional heterogeneity and with measurement errors, problematic quality and comparability of data.

3.6. Empirical evidence

Across countries, we observe different institutional frameworks and very different levels of fiscal decentralization. Panizza (1999) attempts to identify empirical regularities explaining differences in the level of fiscal decentralization across countries. Using cross-sectional methods of analysis, he finds out that fiscal centralization is negatively correlated with the country size, income per capita, ethnic fractionalization and the level of democracy. The richer, the more democratic and the larger a country is, the more likely it is to be decentralized.

There are a few empirical studies that explore the relation between fiscal decentralization and economic growth, however these relations are not yet clear even in theory. Considering three main public functions, fiscal decentralization may provide higher economic efficiency in the *allocation* of resources, but centralization can pursue better *redistribution* of public resources and *macroeconomic stability.* It is not clear whether there is a direct effect of decentralization on economic growth, but it is more likely there are many indirect linkages. Decentralization influences already mentioned efficiency, redistribution and macroeconomic stability, but also local government competition and corruption, which then affect economic growth.

Martinez-Vasquez and McNab (2001) investigate the relation between revenue decentralization and inflation and find statistically significant negative correlation (in case of expenditure decentralization it was not significant). It is quite a striking result, because revenue decentralization does not hinder, but even promotes price stability. Having studied the impact of fiscal decentralization on economic growth, they did not find any significant direct relationship. Neither Feld, Kirchgasser and Schaltegger (2003) find any correlation in evidence from Switzerland.

Davoodi and Zou (1998), exploring this relationship with cross-country data from 1970 to 1989, show that there is a significant negative correlation for developing countries and none for developed countries. However using the recent data from 1997 to 2001 for 51 countries, Iimi (2005) empirically verifies that fiscal decentralization leads to higher economic growth; Akai and Sakata (2002) come to the same conclusion while estimating the latest data for the US. Thiessen (2001) suggests that there are limits for economic gains of decentralization and the relationship is non-linear. If decentralization is low and increases up to a certain medium level, it will promote economic growth. But after reaching the peak, the additional rise brings worse economic growth.

Shah (2005) studies the various effects of fiscal decentralization. In case of monetary policy, he found positive significant impact on the independence of central bank. Decentralization also positively affects the quality of fiscal policies and institutions, transparency and accountability of public sector. On the other hand, the negative impact was found in case of growth of government expenditures.

The relation between government spending and fiscal decentralization is further explored in Fiva (2006), who emphasizes various possible impacts on two parts of public spending; social transfers and public goods. He uses data for 18 OECD countries and verifies this asymmetric impact of fiscal decentralization. Tax revenue decentralization is associated with less transfers, because the decentralized responsibility for redistribution induces each region to choose its policy in isolation and not to take into account positive effects in other regions. However, the expenditure decentralization is associated with increase in government consumption. This relation can be explained by greater efficiency of decentralized provision of public goods due to better preference matching, more competent and reliable government, which results in decrease of marginal costs and consequently, increase in demand for expenditures and higher government expenditures.

In the European Union, we can observe centralization and decentralization of different policy areas. According to Alesina et al (2005), there are different extents of trade-off between heterogenous preferences and positive externalities and economies of scales in various policy areas. It is efficient to centralize international trade policy and common market because of large economies of scale and low preference asymmetry. Areas such as competition policy, state aid control, monetary policy, fiscal policy (in form of Stability and Growth Pact) and tax policy entail high external effects, but the degree of preference heterogeneity is not clear. Therefore, we cannot easily make any conclusions about whether to centralize it or not. Currently, some of them are centralized at the EU level. Policy areas such as education, research, culture, industry, transport and others entail low external effects and have heterogenous preferences across countries, therefore it should be decided upon on either national or regional level. However, health, employment, social protection and mainly agricultural policy are centralized in the EU.

Stegarescu (2004) tests the hypothesis that economic integration in general, and the political unification in Europe in particular, foster the decentralization of the public sector. In case of OECD countries, his hypothesis is just partly supported by estimates, however in the European context, political integration proves to have contributed to fiscal decentralization. This is quite an interesting conclusion, because we would expect that in the course of economic and political integration, fiscal and political powers would be transferred from the national governments more often to a supranational authority than to lower levels of government.

4. Assumptions of model

In following sections, we present theoretical model considering the public goods provision in two different settings - under centralization and decentralization. We show that voters have incentives for strategic delegation of policy-makers and this will result in overprovision or underprovision of public goods.

Building on the framework of Dur and Roelfsema (2005) we construct the model. It concerns political decision-making on public goods provision in two regions and describes voters' incentives to delegate strategically.

Let us assume that regions are identical and denoted $i, i = 1, 2$. Individuals in each region differ in their preference λ for public goods, symmetrically distributed over the interval $\langle \underline{\lambda}, \overline{\lambda} \rangle$, in both regions identically. Symmetric distribution stands for the similarity of an individual with median preference and an individual with average preference, i.e. $\lambda^m = \frac{\underline{\lambda}+\overline{\lambda}}{2}$, λ^m denoting median preference.[1] The higher is an individual's λ , the stronger is her preference for public goods.

The region i produces a local public good g_i which entails utility for its citizens, however, its provision has also positive spillover effect on the utility of individuals in the region $-i$. The presence of the spillover effect is indicated by parameter $\kappa, \kappa \in \langle 0, 1 \rangle$. If $\kappa = 0$, spillover effect does not exist and individuals in region i do not get any utility from the provision of public good in region $-i$. The larger is the κ, the more the provision of g_i increases utility of individuals in $-i$. If $\kappa = 1$, individuals care equally for the public good g_i provided in their region as for the public good g_{-i}

[1] Let λ^j denotes an individual's preference in the given region and n is the number of individuals in the region, then $j = 1, 2, ..., n-1, n$. Symmetrical distribution of preferences over the interval $\langle \underline{\lambda}, \overline{\lambda} \rangle$ indicates that the set of individuals preferences $N^\lambda, \lambda^j \in N^\lambda$ is $N^\lambda = \lambda^1, \lambda^2, ..., \lambda^{n-1}, \lambda^n = \lambda^m + \alpha_1, \lambda^m + \alpha_2, ..., \lambda^m + \alpha_{\frac{n-1}{2}}, \lambda^m, \lambda^m - \alpha_{\frac{n-1}{2}}, ..., \lambda^m - \alpha_2, \lambda^m - \alpha_1$, where $\alpha_k \in \langle 0, \overline{\lambda} - \lambda^m \rangle, k = 1, 2, ..., \frac{n-1}{2}$. Average preference λ^a can be computed as $\lambda^a = \frac{\sum_{j=1}^{n} \lambda^j}{n} = \frac{n\lambda^m}{n} = \lambda^m \Rightarrow \lambda^m = \lambda^a = \frac{\underline{\lambda}+\overline{\lambda}}{2}$.

produced in the other region. This situation can be considered as the special case of global public goods.

The production of the public good is financed through non-distortionary income taxes. For simplicity we assume that the production of the public good has constant returns to scale, namely constant marginal costs, therefore tax costs are linear in the produced amount of public goods. To provide one unit of the public good, it is necessary to collect tax p from each individual in the region. Additionally, each unit of public goods produced in a region entails indirect utility cost c for each citizen in the region, and we suppose that also these costs are linear in public goods production. Since the regions are identical, $p_i = p_{-i} = p$ and $c_i = c_{-i} = c$.

There is a major difference between the tax cost p and the indirect cost c. In the centralized system, the tax cost can be shared among regions through a common central budget, but indirect cost cannot. This occurs when the cost c is closely related to the particular region and compensations are not feasible. How to interpret such type of the cost? It can be explained as some kind of negative externality associated only with the region where the production of public good is realized. We can imagine it as a decrease of a utility because some natural resource is damaged while producing the public good. As an example we can consider cutting down the trees to clear the area for building motor highway. It causes harm to citizens like a loss of lovely nature or reduction of oxygen which is not usually compensated by any transfer from the common centralized budget. Another way how to explain the indirect cost is in relation to health. The production of the public good can generate unhealthy conditions. Although we benefit from motor highway for number of years, as a consequence of air pollution, our health can get worse.

We already know the cost side in the utility function for region i which amounts to $t_i + cg_i$, where $t_i = pg_i$ in decentralization and $t_i = \frac{p}{2}(g_i + g_{-i})$ in centralization because tax costs are shared [2], but we have not considered yet how the individuals value the public goods, i.e. the utility function.

Dur and Roelfsema (2005) use the additively separable utility function which means

[2] Recall we assume that regions are identical, therefore $p_i = p_{-i} = p$ and $c_i = c_{-i} = c$.

that individuals value separately public good provided in their region and public good produced in the other region.

Definition 1 *The additively separable function* $U(g_i, g_{-i})$ *is the function satisfying* $\frac{\partial^2 U(g_i, g_{-i})}{\partial g_i \partial g_{-i}} = 0$ *for all* g_i, g_{-i}.

The utility function of an individual $j, j = 1, 2, ..., n$ in region i is given by

$$U_i^j = \lambda_i^j \Big(b(g_i) + \kappa b(g_{-i}) \Big) + y - t_i - c g_i$$

where y represents gross income per capita, hence $y - t_i$ is post tax income and also consumption of private goods of individual in region i. Marginal utility of private consumption is constant, therefore utility is linearly dependent on the private goods. The function $b(\cdot)$ is increasing and concave, $b(0) = 0$. The special feature of this utility function is such that the amount of g_{-i} does not influence the decision about provision of g_i in decentralization. Utility maximizing level of g_i is always the same for all g_{-i} as Figure 4.1 illustrates. This is a little bit extraordinary, on one hand, policy-maker in one region, who behaves like a social planner, does not care about the level of g_{-i} in the decentralized system, i.e. marginal utility is independent of g_{-i}. Thus, the goods should not be substitutes. On the other hand, there is some interdependence: the given amount of g_{-i} and $g_i = 0$ will bring the individual the same utility as the corresponding amount of g_i and $g_{-i} = 0$, i.e. total utility is dependent. The utility function thus treats g_i and g_{-i} as substitutes, but if they were substitutes, the local public goods must be very similar. How is it then possible that when maximizing utility we do not care about the other region's level of the public good which is very similar to our local public good? According to this utility function, the local public goods must be neutral goods that differ each from other. It can be for example reducing pollution in one region and building motor highways in the other.

Let us design an additively non-separable function, where g_i and g_{-i} are strategic substitutes.

Definition 2 *The additively non-separable function* $U(g_i, g_{-i})$ *is the function, for which* $\exists g_i, g_{-i}$ *such that* $\frac{\partial^2 U(g_i, g_{-i})}{\partial g_i \partial g_{-i}} \neq 0$.

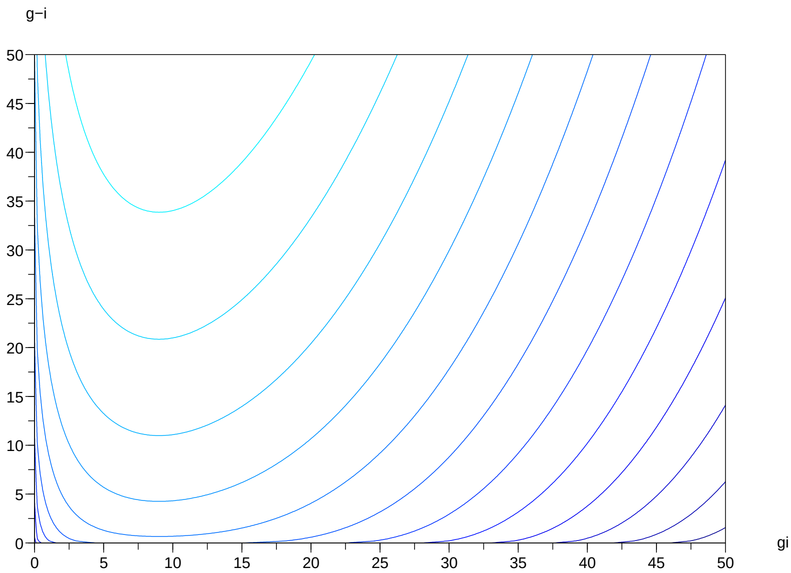

Figure 4.1.: Additive separable function ($\kappa = 0.3, \lambda = 0.6, p + c = 0.1$, $b(\cdot) = (\cdot)^{\frac{1}{2}}$)

Public goods are thus similar or of the same type. We can imagine inoculation as local public good provided in both regions, or regulation of air pollution in one region and emission limits imposed on cars in the other region. This function is given by:

$$U_i^j = \lambda_i^j \Big(b(g_i + \kappa g_{-i}) \Big) + y - t_i - cg_i$$

For an additively non-separable function, the utility maximizing level of g_i is dependent on the level of g_{-i}. Policy-maker deciding on a public good in one region takes into account the level of public good provided in the other region. As Figure 4.2 shows, with increasing g_{-i} the maximizing utility level of g_i decreases; this is the substitution effect. In the decentralized system, incentives for free-riding may arise, voters would like to push for higher production of foreign public good and lower production of the domestic public good.

We can examine an alternative specification of the utility function where local public goods are complements. It is a very special case, which is difficult to interpret, but it leads to interesting results. As an example, we can consider border protection. In such system like the Schengen is, the individuals utility of the border protection in each region depends on the minimal level of protection all regions set. The utility

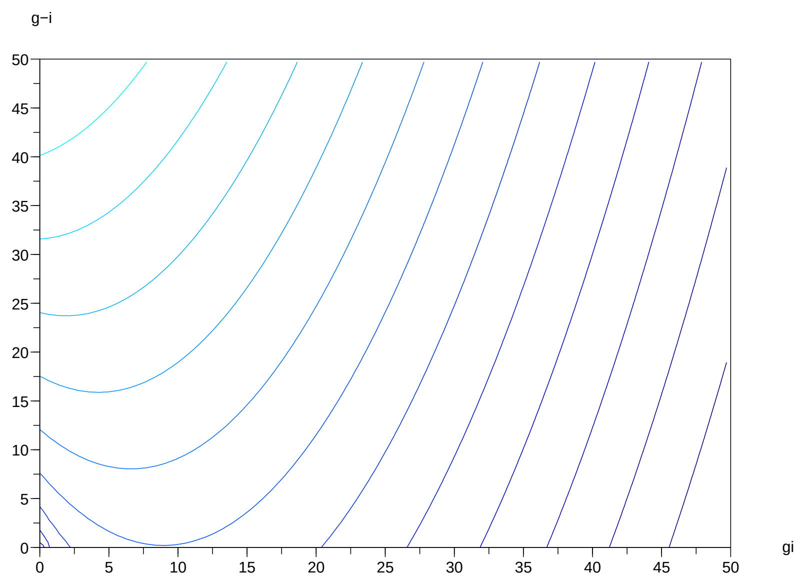

Figure 4.2.: Strategic substitutes ($\kappa = 0.3, \lambda = 0.6, p + c = 0.1,\ b(\cdot) = (\cdot)^{\frac{1}{2}}$)

function is given as:

$$U_i^j = \lambda_i^j b\Big(\min\{g_i, \kappa g_{-i}\}\Big) + y - t_i - cg_i$$

Utility maximizing level of g_i depends on g_{-i} as in the previous case. However now the optimum satisfies condition $g_i \leq \kappa g_{-i}$ and policy maker will set g_i^* according to the first-order condition for $g_i = \min\{g_i, \kappa g_{-i}\}$. For $\kappa = 1$ we have $g_i \leq g_{-i}$ and for $\kappa \in (0, 1)$ g_i will be always strictly smaller than g_{-i}. If there is no spillover effect, then $g_i = g_{-i} = 0$. The utility maximizing level of g_i increases in g_{-i} up to g_i^* then it stabilizes at the level g_i^* and for given $g_{-i} \leq \frac{1}{\kappa} g_i^*$ the utility is first increasing up to $g_i = \kappa g_{-i}$ and then decreasing in g_i. Figure 4.3 shows indifference curves for this case.

We look for interior solutions, therefore we assume that gross income y is always sufficiently high to cover the total tax cost which the provision of public goods entails whatever amount the policy makers will decide on.

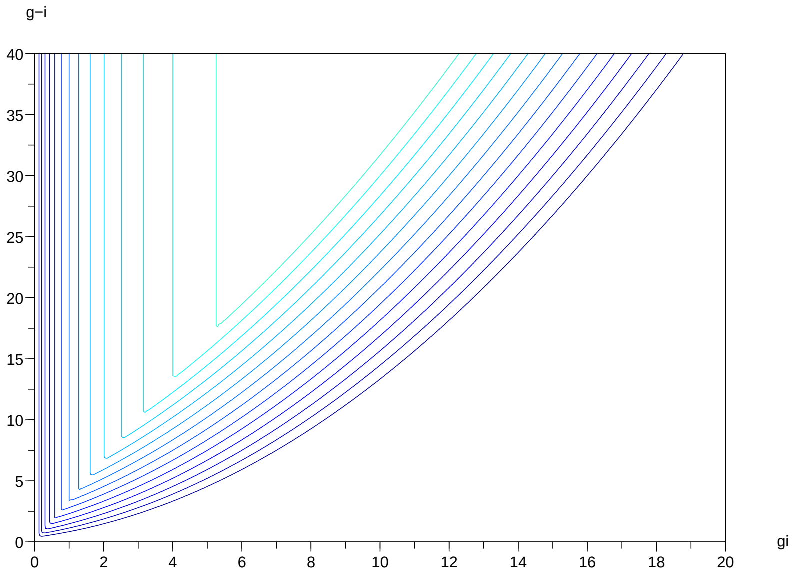

Figure 4.3.: Complements ($\kappa = 0.3, \lambda = 0.6, p + c = 0.1,\ b(\cdot) = (\cdot)^{\frac{1}{2}}$)

5. Social optimum

In this section, we will determine the socially optimal amounts of the local public goods in both regions. We apply the utilitarian measure that the social optimum is defined as the outcome which maximizes the sum of utilities of all individuals in both regions. For computing the social optimal levels, we use the proposition 3.

Proposition 1 *Let $U_i^j = \lambda_i^j b(g_i, g_{-i}, \kappa) + y - (p+c)g_i$ denote the utility function for an individual j, $j = 1, 2, ..., n$, in region $i, i = 1, 2$, for all alternative utility functions considered in the main text, V_i is the sum of utilities of all individuals in region i and $V = V_i + V_{-i}$. Let $\{g_i^*, g_{-i}^*\}$ denote the social optimal levels of public goods, which maximize V, then if individuals in region i are symmetrically distributed over the interval $\langle \underline{\lambda}, \overline{\lambda} \rangle$, in both regions identically, then $\{g_i^*, g_{-i}^*\} = \arg\max(U_i^m + U_{-i}^m)$, where U_i^m denotes the utility of the individual with median preferences in region i.*

For additive separable utility function, the social optimal levels of g_i and g_{-i} follow as solutions to the maximization problem:

$$\max_{g_i, g_{-i}} \lambda^m \Big(b(g_i) + \kappa b(g_{-i})\Big) + y - (p+c)g_i + \lambda^m \Big(b(g_{-i}) + \kappa b(g_i)\Big) + y - (p+c)g_{-i}$$

Social optimal amount of public good in region i consequently satisfies first-order condition:

$$\lambda^m (1+\kappa) b'(g_i) - (p+c) = 0$$

If we compare this outcome with decentralization, we find that $g_i^{SO} \geq g_i^D$. For $\kappa > 0$ we have $g_i^{SO} > g_i^D$. In other words, if there is any positive spillover effect, the social optimal amounts of public goods are higher than the utility maximized levels under the decentralized decision-making which is evidence of underprovision in the decentralized system. This relationship stems from the fact that the socially optimal level takes into account the existence of the positive externality while the decentralized optimal level does not.

When local public goods are strategic substitutes, the socially optimal level of public good in region i satisfies following first-order condition:

$$\lambda^m b'(g_i + \kappa g_{-i}) + \kappa \lambda^m b'(g_{-i} + \kappa g_i) - (p + c) = 0$$

Since regions are identical, we know that they will provide same amounts of public good and we can rewrite the condition as $\lambda^m (1+\kappa) b'((1+\kappa)g) - (p+c) = 0$. If voters delegated a policy-maker in the decentralized system sincerely, the underprovision would be similar as for separable public goods. However, as we have observed, they delegate strategically conservative policy-maker with preferences $\lambda_i^d = (1-\kappa^2)\lambda_i^m$, so the underprovision in decentralization is more serious.

To obtain the social optimum for complements, we have to maximize function:

$$\lambda^m \Bigg(b\Big(\min\{g_i, \kappa g_{-i}\}\Big) + b\Big(\min\{g_{-i}, \kappa g_i\}\Big)\Bigg) + 2y - (p+c)(g_i + g_{-i})$$

This function is maximized if and only if $g_i = g_{-i} = g$. The optimal level of public good satisfies the first-order condition:

$$\lambda^m \kappa b'(\kappa g) - (p+c) = 0$$

For $\kappa > 0$ we have $g^{SO} > g^D$, so if there is any positive externality of production of public goods, it is efficient to centralize production.

Figure 5.1 illustrates the social optimum in the case of complements. The function depicts the sum of utilities for parameters g_i and g_{-i}; the redder is the surface, the higher is the utility we get from the corresponding combination of the parameters. The function uses parameters $\kappa = 0.3, \lambda = 0.6, p + c = 0.1, y = 0$, and $b(\cdot) = ()^{\frac{1}{2}}$, which give the social optimal amount g = 2.7. Hence, the sum of the utilities of median voters is maximal for g = 2.7.

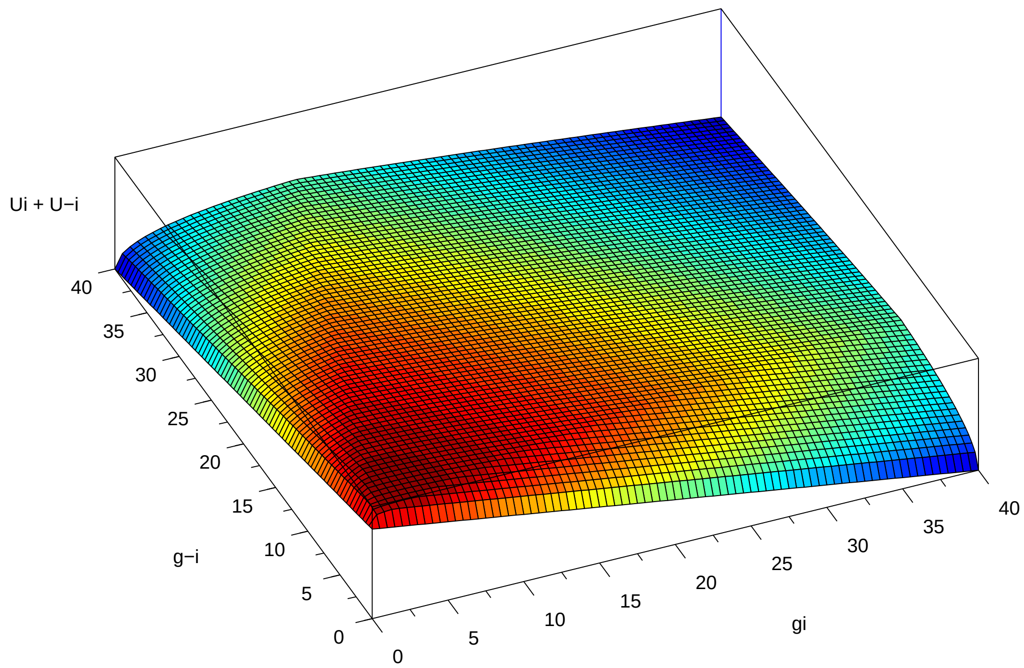

Figure 5.1.: Complements and social optimum

6. Decentralization of decision making

Under the decentralized decision-making, each region decides independently on its provision of local public good. The production of public good is financed through the local taxes, thus $t_i = pg_i$. In the first stage, voters in a region elect their policy-maker, who will decide on the level of the public good in the second stage. The elected policy-maker sets the level of g_i such that she maximizes her utility function. There is no additional incentive for re-election or a carrier promotion for policy-maker. The amount of production of local public good thus depends on the policy-maker's preference λ.

In this section, we will explore in more detail the decision-making about provision of local public goods in decentralized system for each type of the utility function.

6.1. Additively separable utility function

Proposition 2 *In the model, if the utility function is additively separable, in decentralization, voters will elect the policy-maker, whose preferences coincide with the preferences of the median voter.*[1]

The policy maker will choose the level of g_i to maximize her utility function:

$$U_i^m = \lambda_i^m \Big(b(g_i) + \kappa b(g_{-i}) \Big) + y - pg_i - cg_i$$

Optimal provision of public goods in region i is defined by the first-order condition:

$$\lambda_i^m b'(g_i^*) - (p + c) = 0$$

The amount of public good g_i under decentralized decision making does not depend on the spillover effect κ. In other words, the policy-maker does not take into account externalities in her decision.

[1] See proof as well as other proofs in appendix.

6.2. Utility function and strategic substitutes

If local public goods are strategic substitutes, voters have incentives to delegate policy-making to an agent with preferences different from their own. They intend to free ride on the production of the foreign public good.

Proposition 3 *Suppose the assumptions of our model are satisfied and local public goods are strategic substitutes. Then in decentralization, voters in region i will elect the policy-maker with preferences* $\lambda_i^d = (1-\kappa^2)\lambda_i^m$.

The delegated policy maker will select the amount of local public good to maximize her utility function $U_i^d = \lambda_i^d b(g_i + \kappa g_{-i}) + y - pg_i - cg_i$. The level of provided g_i^* will be consequently set as to satisfy the first-order condition:

$$\lambda_i^d b'(g_i + \kappa g_{-i}) - (p+c) = 0 \Rightarrow \lambda_i^m (1-\kappa^2) b'(g_i + \kappa g_{-i}) - (p+c) = 0$$

For any $\kappa > 0$, voters elect the policy maker who cares less for public goods than the median voter does. The higher is κ, the more conservative agent is voted for. If κ increases, we get higher utility from the given level of g_{-i} and we can lower the production of the local public good so that it satisfies first-order condition. According to the symmetry of the equilibrium, both regions will delegate conservatives, and, as a result, the underprovision of the local public goods will occur. For optimal levels of g_i and g_{-i} we have symmetric Nash equilibrium strategy profile $g_i^* = g_{-i}^* = g^*$ satisfying condition $\lambda_i^m(1-\kappa^2)b'((1+\kappa)g^*) - (p+c) = 0$.

If we denote g^{AS} as the amount of produced local public good in the region under decentralization when the utility function is additive separable and g^{SS} as the amount of provided local public good in the region under decentralization if local public goods are strategic substitutes, we find that for $\kappa \in (0,1)$ we have $g^{SS} < g^{AS}$, because $b'(g^{AS}) = (1-\kappa^2)b'\Big((1+\kappa)g^{SS}\Big) \Rightarrow b'(g^{AS}) < b'\Big((1+\kappa)g^{SS}\Big) \Rightarrow g_{AS} > (1+\kappa)g_{SS}$.

6.3. Utility function and complements

When local public goods are complements, the objective function of the elected policy maker is $U_i^d = \lambda_i^d b\Big(\min\{g_i, \kappa g_{-i}\}\Big) + y - (p+c)g_i$. The optimal amount of g_i will always comply with $g_i \leq \kappa g_{-i}$. Let g_i^* denote the amount of public good satisfying $\lambda_d^i b'(g_i^*) - (p + c) = 0$. If $\kappa g_{-i} < g_i^*$, the utility maximizing level of g_i will be set as $g_i = \kappa g_{-i}$. If $\kappa g_{-i} \geq g_i^*$, the policy maker will maximize her utility function by providing g_i^*. In this situation we get into the same case as with additive separable utility function and the level of g_i^* is independent on g_{-i}. If we followed the condition $g_i = \kappa g_{-i}$ also in this situation, we would provide too much local public good.

Anticipating that the delegate will either choose g_i^* according to her preference or set $g_i = \kappa g_{-i}$, voters will not have any incentive to behave strategically, so they will elect the policy-maker with median preferences. For provision of g_i^* we can use the same reasoning as for additive separable utility function [2] and the latter case means that policy-maker with any preferences will select always the same $g_i = \kappa g_{-i}$.

Independent decision making in two regions about production of local public goods can be illustrated as a non-cooperative game, in which the policy-maker adjusts the amount of public good produced in her region according to the level in the other region. The reaction curve of the policy-maker in region i is represented by the given first-order condition and it is best response function $BR(g_{-i})$. The Nash equilibrium of the game lies in the intersection of reaction curves and as Figure 6.1 shows, it satisfies $g_i^{NE} = g_{-i}^{NE} = 0$.

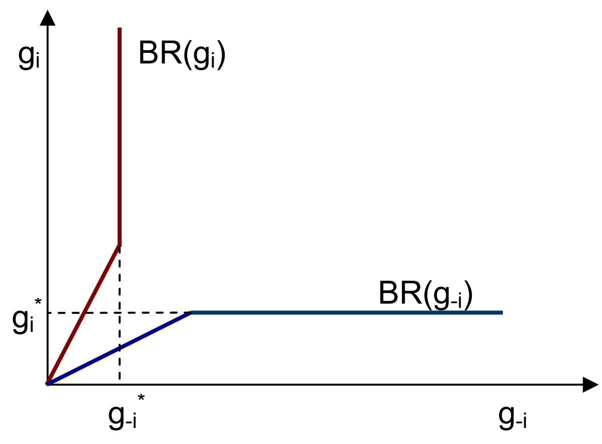

Figure 6.1.:

Reaction curves of decision making on provision of complements in decentralization.

[2] See proof of proposition 1 in appendix.

When local public goods are complements, neither region provides the local public good under decentralization. In comparison with two previous cases of utility functions, the voters will be now the worst off. This finding indicates that the centralization is desirable, especially when public goods are complements.

7. Centralization of decision making

We have illustrated the difference between the amounts of public good provided in the decentralized systems and the social optimal amounts. The welfare maximizing levels of public goods are at least as high as those produced in decentralization; for positive externalities, we even observe underprovision in decentralized systems. The remedy can be done by installing central body which will decide on local public goods provision in both regions. Central decision making has two stages. In the first stage, the voters in each region independently and simultaneously elect policy-maker from the regions' populations with preference $\lambda_i^d \in \langle \underline{\lambda}, \overline{\lambda} \rangle$; in the second stage, the elected policy-makers bargain over the amounts of public goods. We assume that bargaining is cooperative and delegates maximize the sum of their utilities. The central government controls common budget, through which the production of public goods is financed. Every individual in each region pays the tax cost $t_i = \frac{p}{2}(g_i + g_{-i})$.

If delegation is sincere and voters do not have any incentive for strategic voting, they will elect the agent with median preferences. In such case we will get into the social optimal situation and centralization will be pareto efficient. If there is positive spillover effect, the centralization will be always welfare improving under assumptions of our model. We have to recall that this argument holds only for identical regions and we do not consider the trade-off between heterogeneity of preferences and internalization of externalities. Contrary to the analysis in Oates (1972), our model disregards the cost side of centralization.

However, voters will not delegate an agent sincerely, because they have an incentive to misrepresent their policy preferences. To illustrate this, we use a non-cooperative example.

7.1. Non-cooperative example

In this example, we assume that a policy-maker with median preferences in region i has complete control over the central policy. She chooses different amounts of public goods than in the social optimum which represents the case with sincere delegation.

Given the additive separable utility, the objective function of policy maker from region i is $U_i^m = \lambda_i^m \Big(b(g_i) + \kappa b(g_{-i}) \Big) + y - \frac{p}{2}(g_i + g_{-i}) - cg_i$ and optimal levels of public goods satisfy first-order conditions $\lambda_i^m b'(g_i) - \frac{p}{2} - c = 0$, $\lambda_i^m \kappa b'(g_{-i}) - \frac{p}{2} = 0$. When we compare these levels to the social optimum where $\lambda^m (1+\kappa) b'(g_i) - (p+c) = 0$, we find that for $\kappa < \frac{p}{p+2c}$ the policy maker will push for higher production of domestic public good and lower production of foreign public good than in the social optimum. We can interpret it as follows: if the indirect costs are low enough or spillover effect is not so high, it is more profitable for policy maker who has complete control over the budget to produce more domestic public good than foreign public good. [1]

For strategic substitutes we have shown that the incentive to misrepresent preferences appears already in the case of decentralization. Let us now explore the case of complements. The delegate maximizes her utility function $U_i^m = \lambda_i^m b\Big(\min\{g_i, \kappa g_{-i}\} \Big) + y - \frac{p}{2}(g_i + g_{-i}) - cg_i$. The optimal levels of public goods will satisfy $g_i = \kappa g_{-i}$, which for $\kappa < 1$ differs from the social optimum where $g_i = g_{-i}$. The policy maker will therefore choose higher level of foreign public good for $\kappa < 1$ and she will get higher utility than under social optimum, $U_i^{m,CC} = \lambda_i^m b(\kappa g_{-i}) + y - \frac{p}{2}(1+\kappa) g_{-i} - c\kappa g_{-i} > U_i^{m,SO} = \lambda_i^m b(\kappa g_{-i}) + y - (p+c) g_{-i}$. [2] For $\kappa = 1$, she gets into the same case as in the social optimum.

We have proved that non-cooperating delegates have reasons for misrepresenting their preferences. Let us now move to cooperation in centralized decision-making.

[1] Let g_i^{SO} and g_i^{CC} denote levels of public good in social optimum and in the case the policy maker in region i has complete control over the common budget, respectively. From first-order conditions we have $\frac{b'(g_i^{SO})}{b'(g_i^{CC})} = \frac{2(p+c)}{(p+2c)(1+\kappa)}$ for domestic public good and $\frac{b'(g_{-i}^{SO})}{b'(g_{-i}^{CC})} = \frac{2(p+c)\kappa}{p(1+\kappa)}$ for foreign public good, which implies $g_i^{SO} < g_i^{CC} \Leftrightarrow \kappa < \frac{p}{p+2c}$ and $g_{-i}^{SO} > g_{-i}^{CC} \Leftrightarrow \kappa < \frac{p}{p+2c}$.

[2] If the policy maker in region i has complete control over the common budget, the level of public good in region i will satisfy FOC $\lambda_i^m b'(\kappa g_{-i})\kappa - \frac{p}{2}(1+\kappa) - c\kappa$. If we compare it with the FOC from the social optimum case we get $\frac{b'(\kappa g_{-i}^{SO})}{b'(\kappa g_{-i}^{CC})} = \frac{2(p+c)}{p(1+\kappa)+2c\kappa}$. As a result, $g_{-i}^{SO} < g_{-i}^{CC} \Leftrightarrow \kappa < 1$.

7.2. Neutral public goods

To determine the outcome and the preferences of the delegates we will use backward induction. Let us start in the second stage, in which two delegates bargain. The optimal amounts of neutral public goods under centralization are obtained from maximizing $\lambda_i^d\Big(b(g_i)+\kappa b(g_{-i})\Big)+\lambda_{-i}^d\Big(b(g_{-i})+\kappa b(g_i)\Big)+2y-(p+c)(g_i+g_{-i})$. We get first-order conditions:

$$(\lambda_i^d+\kappa\lambda_{-i}^d)b'(g_i)-p-c=0 \tag{7.1}$$

$$(\lambda_{-i}^d+\kappa\lambda_i^d)b'(g_{-i})-p-c=0 \tag{7.2}$$

The resulting g_i and g_{-i} depend on the preferences of the policy-makers. By applying the implicit function theorem we get the comparative statics showing how the g_i and g_{-i} change with changes of λ_i^d:

$$\frac{dg_i}{d\lambda_i^d}=-\frac{b'(g_i)}{(\lambda_i^d+\kappa\lambda_{-i}^d)b''(g_i)},\frac{dg_{-i}}{d\lambda_i^d}=-\frac{\kappa b'(g_{-i})}{(\lambda_{-i}^d+\kappa\lambda_i^d)b''(g_{-i})} \tag{7.3}$$

Using symmetry:

$$\Rightarrow\frac{dg_{-i}}{d\lambda_i^d}=\kappa\frac{dg_i}{d\lambda_i^d} \tag{7.4}$$

The stronger preferences the policy-maker has, the larger will be provision of both the domestic and the foreign public good. For $\kappa<1$, the increase in domestic public goods is larger than the increase in foreign public goods.

In the first stage, each voter elects the policy-maker according to her preference. The citizen j votes for the delegate λ_i^d so as to maximize U_i^j. In majority voting system, the elected delegate will be the one whom the citizen with median preferences votes for. The delegate is found by maximizing utility function of the median voter $U_i^m=\lambda_i^m\Big(b(g_i)+\kappa b(g_{-i})\Big)+y-\frac{p}{2}(g_i+g_{-i})-cg_i$. We obtain first-order condition:

$$\lambda_i^m\Big(b'(g_i)\frac{dg_i}{d\lambda_i^d}+\kappa b'(g_{-i})\frac{dg_{-i}}{d\lambda_i^d}\Big)-\frac{p}{2}\Big(\frac{dg_i}{d\lambda_i^d}+\frac{dg_{-i}}{d\lambda_i^d}\Big)-c\frac{dg_i}{d\lambda_i^d}=0 \tag{7.5}$$

Using (7.4) we get $\lambda_i^m\Big(b'(g_i)+\kappa^2b'(g_{-i})\Big)-\frac{p}{2}(1+\kappa)-c=0$. As regions are identical, we know that equilibrium will be symmetric and $g_i=g_{-i}=g$ and $\lambda_i^d=\lambda_{-i}^d=\lambda^d$, therefore $\lambda^m b'(g)(1+\kappa^2) - \frac{p}{2}(1+\kappa) - c = 0$. Substituting $(1+\kappa)\lambda^d b'(g) - p - c = 0$ yields:

$$\lambda^d = \Big[\frac{2(1+\kappa^2)(p+c)}{(1+\kappa)^2 p + (1+\kappa)2c}\Big]\lambda^m \tag{7.6}$$

Voters will delegate policy-maker with preference for public good λ^d. For $\kappa = 1$ or $\kappa = \frac{1}{2c+p}$, the sincere delegation occurs and $\lambda^d = \lambda^m$. For $\kappa > \frac{1}{2c+p}$, the elected policy maker is public good lover, for $\kappa < \frac{1}{2c+p}$ a conservative politician is appointed. Let us consider the different cost situations. If the indirect costs do not exist and all the costs are shared among regions, $c = 0$ and $\kappa < 1$, the delegate's preference for public good is always stronger, $\lambda^d > \lambda^m$. If all the costs are local, $p = 0$ and $0 < \kappa < 1$, voters elect the conservative policy-maker, $\lambda^d < \lambda^m$. Delegated policy-makers in both regions will be of the same type and will have similar preferences, therefore delegating public good lovers will result in overprovision and delegating conservatives will lead to underprovision of public goods.

7.3. Strategic substitutes

We can use the same procedure to determine the delegates preferences for public goods which are strategic substitutes. The bargaining outcome will satisfy the first-order condition:

$$\lambda_i^d b'(g_i + \kappa g_{-i}) + \kappa\lambda_{-i}^d b'(g_{-i} + \kappa g_i) - (p+c) = 0 \tag{7.7}$$

From this condition we get:

$$\frac{dg_{-i}}{d\lambda_i} = -\frac{\kappa dg_i}{d\lambda_i} \tag{7.8}$$

In the first stage of the game, the median voter maximizes his utility with respect to the preference of the policy maker and it results in the following first-order condition:

$$\lambda_i^m \Big[\Big(b'(g_i + \kappa g_{-i})\Big)\Big(\frac{dg_i}{d\lambda_i^d} + \kappa\frac{dg_{-i}}{d\lambda_i^d}\Big)\Big] - \Big(\frac{p}{2} + c\Big)\frac{dg_i}{d\lambda_i^d} - \frac{p}{2}\frac{dg_{-i}}{d\lambda_i^d} = 0 \tag{7.9}$$

Imposing the symmetry in equilibrium and implying (7.8) for the bargaining outcome, we obtain:

$$\lambda^d = \Big[\frac{2(1-\kappa^2)(p+c)}{(1-\kappa)^2 p + (1+\kappa)2c}\Big]\lambda^m \tag{7.10}$$

For $\kappa = \frac{p}{2c+p}$, the voters delegate sincerely, if $\kappa > \frac{p}{2c+p}$, then $\lambda^d > \lambda^m$, if $\kappa = \frac{p}{2c+p}$, then $\lambda^d < \lambda^m$. As in the previous case we found that for $c = 0$ and $\kappa < 1$ the voters delegate bargaining to the extreme public good lovers, $\lambda^d = 2\lambda^m$, and for $p = 0$ and $0 < \kappa < 1$ the policy maker has lower preference for public good.

7.4. Complements

Let us continue with the situation when two local public goods are complements, but the complementarity is different in each region. We keep using the region-specific complementarity where a foreign public good counts only κ-times of a domestic public good. This approach is justified since this complementarity is technically close to our definition of mutual spillovers for substitutes, but its interpretation is not as obvious as it is for the other types of complementarities.

The objective function of two policy-makers elected in both regions who bargain over the provision of public goods is:

$$U^d = \lambda_1^d b(\min\{g_1, \kappa g_2\}) + \lambda_2^d b(\min\{g_2, \kappa g_1\}) + 2y - (p + c)(g_1 + g_2) \tag{7.11}$$

We will solve the game by backward induction. In the second stage, we start by the fact for any fixed $g = g_1 + g_2$, there must be a unique $g_1^*(g)$. This allows us to split bargaining (in fact optimization of the joint utility function in (7.11)) into two steps: (i) recognizing function $g_1^*(g)$ and (ii) finding optimal g subject to $g_1^*(g)$. We find three candidate solutions.

In the first stage, we let voters elect the delegates. As usually, we use that $\lambda^d(\lambda_j)$ is monotonic in λ_j, so the median voter is decisive. Therefore, we can simplify the game into a non-cooperative game of two players, median voter in region 1 and median voter in region 2. In order to find a Nash equilibrium in pure strategies, we construct best responses of both players. We find an interesting equilibrium, and also provide constraints on function $b(\cdot)$ necessary for this equilibrium to sustain.

7.4.1. Delegates' optimum

We divide the optimization of (7.11) into two virtual steps. First, we let the delegates in the second stage jointly optimize on the constraint of a total amount fixed in the first period, namely $g_1 + g_2 = g$. Where is the optimum g_1?

By definition, $0 \leq g_1 \leq g$. The only problem is that complementarity violates monotonicity of the joint utility function. Therefore, we start by defining critical values in this interval in which the arguments within the minimum functions don't change, so the monotonicity is preserved. There are two critical values, therefore three intervals with three monotonic utility functions:

$$g_1^L = \frac{\kappa g}{1+\kappa} \qquad g_1^H = \frac{g}{1+\kappa}$$

1. When $g_1 \leq g_1^L$, we have $U^d = \lambda_1^d b(g_1) + \lambda_2^d b(\kappa g_1) + 2y - (p+c)g$. Obviously, this is maximized for the highest available g_1, i.e. $g_1 = g_1^L$.

2. When $g_1^L \leq g_1 \leq g_1^H$, we have $U^d = \lambda_1^d b(\kappa(g-g_1)) + \lambda_2^d b(\kappa g_1) + 2y - (p+c)g$. FOC gives us $\frac{\lambda_1^d}{\lambda_2^d} = \frac{b'(\kappa g_1)}{b'(\kappa g_2)}$. Because $b'(\cdot)$ is a monotonous strictly decreasing function ($b'' < 0$), we have $\lambda_1^d > \lambda_2^d \implies g_1 < g_2$. By analogy, $\lambda_1^d < \lambda_2^d \implies g_1 > g_2$. Public lover, as a result, gets relatively less than a conservative delegate.

3. When $g_1 \geq g_1^H$, we have $U^d = \lambda_1^d b(\kappa(g-g_1)) + \lambda_2^d b((g-g_1)) + 2y - (p+c)g$. Obviously, this is maximized for the lowest available g_1, i.e. $g_1 = g_1^H$.

In total, written in general form, we observe that the optimum is located on the interval $g_i \in \langle g_i^L, g_i^H \rangle = \langle \frac{\kappa g}{1+\kappa}, \frac{g}{1+\kappa} \rangle$. In other words, we can use only the middle interval, since $g_1 \geq \kappa g_2$ and symmetrically $g_2 \geq \kappa g_1$.

By rewriting $\frac{\kappa g}{1+\kappa} \leq \frac{g}{2} \leq \frac{g}{1+\kappa}$, we also observe that the symmetric (equal) solution always lies in this interval, as long as $0 < \kappa \leq 1$.

With this knowledge, we proceed to the second step, namely optimization on this interval. We write Lagrangian, where (7.11) is maximized with the two inequality constraints, $g_1 - \kappa g_2 \geq 0$, $g_2 - \kappa g_1 \geq 0$, and respective multipliers μ_1, μ_2.

$$\mathcal{L} = \lambda_1^d b(\kappa g_2) + \lambda_2^d b(\kappa g_1) + 2y - (p+c)(g_1+g_2) + \mu_1(g_1 - \kappa g_2) + \mu_2(g_2 - \kappa g_1) \quad (7.12)$$

The Kuhn-Tucker conditions with complementary slackness yield:

$$\frac{\partial \mathcal{L}}{\partial g_1} = \kappa\lambda_2^d b'(\kappa g_1) - (p+c) + \mu_1 - \mu_2\kappa \leq 0 \qquad g_1 \geq 0 \qquad \frac{\partial \mathcal{L}}{\partial g_1} g_1 = 0 \tag{7.13}$$

$$\frac{\partial \mathcal{L}}{\partial g_2} = \kappa\lambda_1^d b'(\kappa g_2) - (p+c) + \mu_2 - \mu_1\kappa \leq 0 \qquad g_1 \geq 0 \qquad \frac{\partial \mathcal{L}}{\partial g_2} g_2 = 0 \tag{7.14}$$

$$\frac{\partial \mathcal{L}}{\partial \mu_1} = g_1 - \kappa g_2 \geq 0 \qquad \mu_1 \geq 0 \qquad \frac{\partial \mathcal{L}}{\partial \mu_1} \mu_1 = 0 \tag{7.15}$$

$$\frac{\partial \mathcal{L}}{\partial \mu_2} = g_2 - \kappa g_1 \geq 0 \qquad \mu_2 \geq 0 \qquad \frac{\partial \mathcal{L}}{\partial \mu_2} \mu_2 = 0 \tag{7.16}$$

This gives us $2^4 = 16$ types of candidate solutions. We need to eliminate the inconsistent candidates. To do so, we examine four groups: (i) $g_1 = 0$, $g_2 = 0$, (ii) $g_1 > 0$, $g_2 = 0$, (iii) $g_1 = 0$, $g_2 > 0$ and (iv) $g_1 > 0$, $g_2 > 0$.

Group (ii) is inconsistent with $g_2 \geq \kappa g_1$. Also group (iii) can be eliminated due to inconsistency with $g_1 \geq \kappa g_2$. We also eliminate the perverse group (i), where the optimum is non-provision, by considering each of the sub-groups: (a) $\mu_1 = 0$, $\mu_2 = 0$, (b) $\mu_1 > 0$, $\mu_2 = 0$, (c) $\mu_1 = 0$, $\mu_2 > 0$ and (d) $\mu_1 > 0$, $\mu_2 > 0$.

Denote $\mathcal{X}_1 \equiv \kappa\lambda_1^d b'(\kappa 0) - (p+c)$ and $\mathcal{X}_2 \equiv \kappa\lambda_2^d b'(\kappa 0) - (p+c)$. In (a), by re-writing (7.13) and (7.14), we need $\mathcal{X}_1 \leq 0$ and $\mathcal{X}_2 \leq 0$. In (b), a necessary condition for the existence of the solution is $\mathcal{X}_1 \leq -\mu_1 < 0$ and $\mathcal{X}_2 \leq 0$. In (c), we need $\mathcal{X}_1 \leq 0$ and $\mathcal{X}_2 \leq -\mu_2 < 0$.

To show that none of the conditions above holds, we can simply impose a condition that even the extreme conservative prefers some public good:

$$\kappa\underline{\lambda} b'(\kappa 0) - (p+c) > 0 \Longleftrightarrow b'(0) > \frac{p+c}{\kappa\underline{\lambda}} \tag{7.17}$$

The final sub-group (d) of group (i) is a bit tricky. For the solution, we require $\mathcal{X}_1 \leq \mu_2\kappa - \mu_1$ and $\mathcal{X}_2 \leq \mu_1\kappa - \mu_2$. Anyway, we will see that the same condition (7.17) is sufficient to eliminate this sub-group.

First, we derive that $\underline{\mu} \equiv \min\{\mu_1\kappa - \mu_2, \mu_1\kappa - \mu_2\} \leq 0$. This is not difficult to see—the lower envelope of the two functions over the domain $\mu_1 \times \mu_2 \in \mathbb{R}^+ \times \mathbb{R}^+$ is always non-positive. For $\mu_1 < \mu_2$, we have $\underline{\mu} = \mu_1\kappa - \mu_2$. Yet, $\mu_1 < \mu_2$ implies $\mu_1\kappa - \mu_2 < \mu_1\kappa - \mu_2\kappa < 0$. For $\mu_1 \geq \mu_2$, we have $\underline{\mu} = \mu_2\kappa - \mu_1$. And, $\mu_2 \leq \mu_1$ implies $\mu_2 - \mu_1\kappa < \mu_2 - \mu_1 \leq 0$.

As $\underline{\mu} \leq 0$, we require that $\mathcal{X}_1 \leq 0 \wedge \mathcal{X}_2 \leq 0$. However, by (7.17), we have $\mathcal{X}_1 > 0$ and $\mathcal{X}_2 > 0$, so there is no solution in sub-group (d) of group (i) that would satisfy simultaneously Kuhn-Tucker conditions (7.13), (7.14), (7.15), and (7.16), as well as the condition of minimal interest in public good (7.17).

We are left only with group (iv), where $g_1 > 0$ and $g_2 > 0$, so conditions (7.13) and (7.14) are satisfied with equality. We can immediately focus on the candidate solution with $\mu_1 > 0$ and $\mu_2 > 0$ (both constraints are active), which is feasible only for perfect spillover ($g_1 = \frac{g_2}{\kappa} = \kappa g_2$). As we are interested only in incomplete spillovers ($\kappa < 1$), we disregard this case. As a result we have three types of solutions, one interior and two corner solutions.

Interior solution

Interior solution implies inactive constraints, i.e. $\mu_1 = \mu_2 = 0$. From (7.13) and (7.14), we get:

$$b'(\kappa g_1) = \frac{p+c}{\kappa \lambda_2^d} \qquad\qquad b'(\kappa g_2) = \frac{p+c}{\kappa \lambda_1^d} \tag{7.18}$$

We can interpret the result such that the preference of Delegate 1 determines the good in region 2, thereby the weakest link (minimum) in region 1. At the same time, region 1 bears only part of the costs, namely marginal costs are $\frac{p}{2}$. As a result, we will observe that individuals will have tendency to nominate public lovers and we end up in overprovision. This is however only up to some point, because a too extreme public lover will switch Interior solution into Lower corner solution, where marginal cost increases.

Upper corner solution (H)

Consider $\mu_1 = 0$ and $\mu_2 > 0$. From (7.15) and (7.16), we have $g_2 = \kappa g_1$. Putting into (7.13) and (7.14) and eliminating μ_2, we get:

$$\kappa \lambda_1^d b'(\kappa^2 g_1) + \lambda_2^d b'(\kappa g_1) = \frac{(p+c)(\kappa+1)}{\kappa} \tag{7.19}$$

Lower corner solution (L)

Consider finally $\mu_1 > 0$ and $\mu_2 = 0$. This is a symmetric problem to the previous case, only $g_1 = \kappa g_2$ and the solution writes:

$$\lambda_1^d b'(g_1) + \kappa\lambda_2^d b'(\kappa g_1) = \frac{(p+c)(\kappa+1)}{\kappa} \tag{7.20}$$

7.4.2. Voters' optimum

Voters optimize under expectation of either of solutions. Since their preference for the delegate is monotonic in λ_j, it will again be upon the median voter in region 1 and median voter in region 2, which delegates are nominated. In this game of two players, we get equilibrium by deriving best responses, namely $\lambda_1^{d*}(\lambda_2^d)$ and $\lambda_2^{d*}(\lambda_1^d)$. However, we have to be cautious, since best responses may yield different types of solutions.

To solve this problem, we start with median voter in region 1. We divide his strategy set into three subsets corresponding to each type of solution. In each subset, we find a (conditional) best response, which is the best response when strategies are restricted only to be drawn from the subset. We denote them $\lambda_1^L(\lambda_2^d)$, $\lambda_1^I(\lambda_2^d)$, and $\lambda_1^H(\lambda_2^d)$. Finally, we compare payoffs for each conditional best responses, and select "the best of the best", namely the genuine best response.

But how can we divide the space $\lambda_1 \times \lambda_2$ into strategy subsets relevant for each solution? Below, we will see that there exist two functions (boundaries) $\lambda_1^{bH}(\lambda_2)$ and $\lambda_1^{bL}(\lambda_2)$. If $\lambda_1 \leq \lambda_1^{bH}(\lambda_2)$, we have Upper corner solution. This is a case when Interior solution violates the upper bound, namely provides too much g_1 comparing to g_2, so we have to have $g_1 = \frac{g_2}{\kappa}$. For $\lambda_1^{bH}(\lambda_2) < \lambda_1 < \lambda_1^{bL}(\lambda_2)$, we have Interior solution. And if $\lambda_1^{bL}(\lambda_2) \leq \lambda_1$, we are in Lower corner solution. Here, Interior solution would violated the lower bound, namely provided too little g_1 comparing to g_2, so we have to have $g_1 = \kappa g_2$.

We know that Interior solution applies if and only if $g_1 \in \langle \kappa g_2, \frac{g_2}{\kappa} \rangle$. Can we make some inference about which $(\lambda_1^d, \lambda_2^d)$ lead to the solution with this property?

It is sufficient to use (7.18) and derive:

$$\frac{\lambda_1^d}{\lambda_2^d} = \frac{b'(\kappa g_1)}{b'(\kappa g_2)}$$

We put the upper and lower bounds of g_1 into this equality a use monotonicity of $b'(\cdot) > 0$:

$$\frac{b'(\kappa^2 g_2)}{b'(\kappa g_2)} \geq \frac{\lambda_1^d}{\lambda_2^d} \geq \frac{b'(g_2)}{b'(\kappa g_2)}, \tag{7.21}$$

Due to $b'(\cdot) > 0$, we also derive that:

$$\frac{b'(g_2)}{b'(\kappa g_2)} < 1 < \frac{b'(\kappa^2 g_2)}{b'(\kappa g_2)} \tag{7.22}$$

All of that gives us (albeit not explicit) boundary functions:

$$\lambda_1^{bH}(\lambda_2^d) = \lambda_2^d \frac{b'(g_2)}{b'(\kappa g_2)} < \lambda_2^d < \lambda_2^d \frac{b'(\kappa^2 g_2)}{b'(\kappa g_2)} = \lambda_1^{bL}(\lambda_2^d) \tag{7.23}$$

Conditional best response for Interior solutions

Median voter in region 1 maximizes $U_1^m = \lambda_1^m b(\kappa g_2) + y - \frac{p}{2}(g_1 + g_2) - cg_1$:

$$\frac{\partial U_1^j}{\partial \lambda_1^d} = (\lambda_1^j b'(\kappa g_2)\kappa - \frac{p}{2})\frac{dg_2}{d\lambda_1^d} = 0$$

We use implicit function theorem in (7.18) and derive that

$$\frac{dg_2}{d\lambda_1^d} = -\frac{p + c}{\kappa^2(\lambda_1^d)^2 b''(\kappa g_1)} > 0.$$

Therefore, we need $\lambda_1^m b'(\kappa g_2)\kappa - \frac{p}{2} = 0$, which in combination with the second term in (7.18) results into

$$\lambda_1^d = \frac{2(p + c)}{p}\lambda_1^m. \tag{7.24}$$

Now, consider implications of symmetry in preferences. Due to symmetry, we have $\lambda^m - \underline{\lambda} = \overline{\lambda} - \lambda^m$, where $\underline{\lambda} > 0$. This gives that $2\lambda^m = \overline{\lambda} + \underline{\lambda} > \overline{\lambda}$. As a result, $\lambda_1^d = \frac{2(p+c)}{p}\lambda_1^m > 2\lambda^m > \overline{\lambda}$. Therefore, conditional best response in Interior solution is constant and writes

$$\lambda_1^{I*}(\lambda_2^d) = \overline{\lambda}. \tag{7.25}$$

In other words, more than majority of voters tend to delegate the extreme public lover if they can count on the existence of the Interior solution.

Conditional best response for Upper corner solutions

Median voter in region 1 maximizes $U_1^m = \lambda_1^m b\left(g_1\right) + y - \frac{p}{2}(g_1 + g_2) - cg_1$ on the upper boundary $g_1 = \frac{g_2}{\kappa}$:

$$\frac{\partial U_1^j}{\partial \lambda_1^d} = \frac{dg_1}{d\lambda_1^d}\left[\lambda_1^m b'(\kappa^2 g_1) - \left(\frac{p}{2} + c\right)\right] - \frac{p}{2}\frac{dg_2}{d\lambda_1^d} = 0$$

By applying the implicit theorem on (7.19) and on the upper boundary $g_2 = \kappa g_1$, we have

$$\frac{dg_1}{d\lambda_1^d} = -\frac{b'(\kappa^2 g_1)}{\kappa^2 \; b''(\kappa^2 g_1) + \lambda_2^d b''(\kappa g_1)} > 0,$$

and

$$\frac{dg_2}{d\lambda_1^d} = \kappa \frac{dg_1}{d\lambda_1^d}.$$

As a result, we write the conditional best response implicitly by a system of two equations, where g_1 from the first equation is used to get function $\lambda_1^H(\lambda_2^d)$ in the second equation, replication (7.19):

$$\lambda_1^m b'(g_1) - \frac{p}{2}(1+\kappa) - c = 0 \tag{7.26}$$

$$\kappa\lambda_1^H(\lambda_2^d) b'(\kappa^2 g_1) + \lambda_2^d b'(\kappa g_1) = \frac{(p+c)(\kappa+1)}{\kappa} \tag{7.27}$$

Of course, the conditional best response in Upper corner solution is limited by $\underline{\lambda} \leq \lambda_1^H(\lambda_2^d)$ and $\lambda_1^H(\lambda_2^d) \leq \lambda_1^{bH}$, so we have to write:

$$\lambda_1^{H*}(\lambda_2^d) = \max\{\min[\lambda_1^H(\lambda_2^d), \lambda_1^{bH}(\lambda_2^d)], \underline{\lambda}\} \tag{7.28}$$

Conditional best response for Lower corner solutions

Median voter in region 1 again maximizes $U_1^j = \lambda_1^j b(g_1) + y - \frac{p}{2}(g_1 + g_2) - cg_1$, but now on the lower boundary $g_1 = \kappa g_2$:

$$\frac{\partial U_1^j}{\partial \lambda_1^d} = \frac{dg_1}{d\lambda_1^d}\left[\lambda_1^j b'(g_1) - \left(\frac{p}{2} + c\right)\right] - \frac{p}{2}\frac{dg_2}{d\lambda_1^d} = 0$$

Applying the implicit theorem on (7.20) and on the restriction $g_1 = \kappa g_2$, we get

$$\frac{dg_1}{d\lambda_1^d} = -\frac{b'(g_1)}{\lambda_1^d b''(g_1) + \lambda_2^d \kappa^2 b''(\kappa g_1)} > 0,$$

and

$$\frac{dg_2}{d\lambda_1^d} = \frac{1}{\kappa}\frac{dg_1}{d\lambda_1^d}.$$

All in all, we use this and (7.20) to get the implicit expression of the conditional best response:

$$\lambda_1^m b'(g_1) - \frac{p}{2}\left(1 + \frac{1}{\kappa}\right) - c = 0 \tag{7.29}$$

$$\lambda_1^L(\lambda_2^d) b'(g_1) + \kappa \lambda_2^d b'(\kappa g_1) = \frac{(p+c)(\kappa+1)}{\kappa} \tag{7.30}$$

Of course, the conditional best response for Lower corner solutions is limited by $\lambda_1^L \leq \overline{\lambda}$ and $\lambda_1^{bL} \leq \lambda_1^L$, so we finally write:

$$\lambda_1^{L*}(\lambda_2^d) = \min\{\max[\lambda_1^L(\lambda_2^d), \lambda_1^{bL}(\lambda_2^d)], \overline{\lambda}\} \tag{7.31}$$

Finally, conditional best responses for median voter in Region 2 are symmetric. For Upper corner solutions:

$$\lambda_2^m b'(g_2) - \frac{p}{2}\left(1 + \frac{1}{\kappa}\right) - c = 0 \tag{7.32}$$

$$\kappa \lambda_1 b'(\kappa g_2) + \lambda_2^H(\lambda_1^d) b'(g_2) = \frac{(p+c)(\kappa+1)}{\kappa} \tag{7.33}$$

For Lower corner solutions:

$$\lambda_2^m b'(g_2) - \frac{p}{2}(1+\kappa) - c = 0 \tag{7.34}$$

$$\lambda_1 b'(\kappa g_2) + \kappa \lambda_2^L(\lambda_1^d) b'(\kappa^2 g_2) = \frac{(p+c)(\kappa+1)}{\kappa} \tag{7.35}$$

7.4.3. Equilibrium with public lovers

Without explicit derivation of $\lambda_1^H(\lambda_2^d)$, $\lambda_1^L(\lambda_2^d)$, $\lambda_2^H(\lambda_1^d)$, and $\lambda_2^L(\lambda_1^d)$, it is extremely difficult to compare payoffs in all conditional best responses and thereby determine the true best response. Instead, we find sufficient conditions for certain intuitive equilibrium to exist.

In pure strategies, we know that the only symmetric solution is $\lambda_1^d = \lambda_2^d = \overline{\lambda}$. This is because symmetric solutions are always in the strategy subset corresponding to Interior solutions, as (7.23) shows.

For $(\overline{\lambda}, \overline{\lambda})$ to be a Nash equilibrium, we need to prove that $\lambda_1^*(\overline{\lambda}) = \overline{\lambda}$ (the other best response is symmetric). We employ a special strategy—instead of calculating best responses for all types of solutions, we find condition under which strategy subsets for Upper corner solution and Lower corner solution become unfeasible due to domain of $\overline{\lambda}$, i.e. $\lambda \in \left[\underline{\lambda}, \overline{\lambda}\right]$.

Eliminating Upper and Lower corner subsets

When $\lambda_2^d = \overline{\lambda}$, we know that Lower corner subset is out of feasible set of preferences, since by (7.23), we have $\lambda_1^{bL} > \overline{\lambda}$.

We will do exactly the same thing with Upper corner subset. In other words, we derive when the strategy subset corresponding to this solution materializes out of feasible set of preferences, namely $\lambda_1^{bH}(\overline{\lambda}) < \underline{\lambda}$. As explained above, this will be sufficient (but not necessary) condition for $(\lambda_1^d, \lambda_2^d) = (\overline{\lambda}, \overline{\lambda})$ to be the Nash equilibrium.

We seek critical condition under which $\lambda_1^{bH}(\overline{\lambda}) = \underline{\lambda}$. The boundary function λ_1^{bH} is defined for situation when the Interior solution in (7.18) gives allocation of g_1 which is just on the upper boundary of the interval $\langle \kappa g_2, \frac{g_2}{\kappa} \rangle$, namely $\kappa g_1 = \frac{g_2}{\kappa}$. We use that in Interior solution, a change in λ_1 does not affect g_1, only g_2, so we can define $\overline{g_1}$ for $\lambda_2^d = \underline{\lambda}$:

$$b'(\kappa\overline{g_1}) = \frac{p+c}{\kappa\overline{\lambda}} \tag{7.36}$$

Again, we use that in Interior solution,

$$\frac{\lambda_1^d}{\lambda_2^d} = \frac{b'(\kappa g_1)}{b'(\kappa g_2)}$$

to derive that for $\lambda_2^d = \underline{\lambda}$

$$\lambda_1^{bH}(\overline{\lambda}) = \overline{\lambda}\frac{b'(\kappa\overline{g_1})}{b'(\kappa^2\overline{g_1})}. \tag{7.37}$$

By using implicit definition of $\overline{g_1}$ in (7.36), we find equivalence:

$$\lambda_1^{bH}(\overline{\lambda}) < \underline{\lambda} \iff \overline{\lambda}\frac{p+c}{\kappa\overline{\lambda}}\frac{1}{b'(\kappa^2\overline{g_1})} < \underline{\lambda} \iff b'(\kappa^2\overline{g_1}) > \frac{p+c}{\kappa\underline{\lambda}} \tag{7.38}$$

That is the condition we have been seeking. We can write it explicitly, using inverse function $b'^{-1}(\cdot)$, of course under assumption that it exists:

$$\kappa\overline{g_1} = b'^{-1}\left(\frac{p+c}{\kappa\overline{\lambda}}\right) \iff b'\left[\kappa b'^{-1}\left(\frac{p+c}{\kappa\overline{\lambda}}\right)\right] > \frac{p+c}{\kappa\underline{\lambda}} \tag{7.39}$$

We can use the previous version in (7.38) and relation of upper boundary in (7.37) to discuss what the condition intuitively requires:

$$\lambda_1^{bH}(\overline{\lambda}) < \underline{\lambda} \iff b'(\kappa^2\overline{g_1}) > \frac{p+c}{\kappa\underline{\lambda}} \iff \frac{b'(\kappa^2\overline{g_1})}{b'(\kappa\overline{g_1})} > \frac{\overline{\lambda}}{\underline{\lambda}} \tag{7.40}$$

In other words, the condition requires that (i) either the population is sufficiently homogenous ($\underline{\lambda}$ being close enough to $\overline{\lambda}$), or (ii) demand for public good $b(\cdot)$ sufficiently elastic. The latter requirement is based on the fact that marginal utility $b'(\cdot)$ is monotonic (decreasing) and positive. High elasticity implies sufficiently responsive (steep) marginal utility; in other words sufficiently low $b''(\cdot)$.

Interpretation

For the equilibrium with strong public-good loving delegation, we need to impose two additional conditions, (7.17) and (7.38):

1. $b'(0) > \frac{p+c}{\underline{\lambda}\kappa}$

2. $b'\left[\kappa b'^{-1}\left(\frac{p+c}{\kappa\overline{\lambda}}\right)\right] > \frac{p+c}{\kappa\underline{\lambda}}$

In this equilibrium, voters in region 1 know that by increasing λ_1^d, they increase g_2, thereby the domestic weakest link and the domestic public good consumption. Costs increase, but more for the region 2 than the region 1. Voters thus free ride on the fact that the weakest link is determined in the *other* region, which has to pay non-shareable costs c. There is the paradox of this technology with complementarities: Voter increases domestic consumption by increasing production in the other region, for which she pays a disproportionately lower share.

This picture would change if voters could decrease λ_1^d below a sufficiently low level; then, the cooperative legislators would have to decrease both g_2 and g_1 to maintain upper bound condition $g_1 \leq \frac{g_2}{\kappa}$. Lower g_1 would reduce costs substantially, so there might be a new local extreme (Upper corner solution), given by function $\lambda_1^H(\lambda_2^d)$.

To avoid complications of comparing utility of $\lambda_1^d = \overline{\lambda}$ and $\lambda_1^d = \lambda_1^H$, we simply imposed condition that the "sufficiently low level" of λ_1^d is prohibitively low in terms of feasible preferences. Below that level, no politician is on offer, so the voters cannot use Upper corner solution, and the feasible responses of median voter in Region 1 to $\lambda_2^d = \overline{\lambda}$ belong among Interior solutions, thus $\lambda_1^d = \overline{\lambda}$.

To summarize: If even conservatives demand non-negative amounts of public good, if demand for public good is rather elastic and population sufficiently homogeneous, we found that cooperative centralization in case of complements with spillovers leads to strategic delegation of extreme public good lovers.

8. Extension

In this section, we will provide an extension of our original model. In the presented model, we assumed that delegated policy-makers decide on a public goods provision such that they maximize sum of their utilities. However, this cooperative outcome is not always feasible. In this case, we deal with a slightly different problem, we assume that policy-makers bargain over the given amount of public good. This amount is determined by total tax revenues TR available. Each unit of a public good costs p, therefore we can provide exactly $g = \frac{TR}{p}$. We model bargaining process as a Nash bargaining solution (see Nash, 1950). We aim to show that delegation can change significantly, because voters will have incentive to improve bargaining position of a policy-maker.

8.1. Nash bargaining solution – theory

In the setup of cooperative games the players are allowed to communicate before choosing their strategies and playing the game. They can agree but also disagree about a joint strategy in centralization. The game proceeds the similar way as in the previous model. In centralization, voters in each region independently elect policy-makers from regions' population with preference $\lambda_i^d \in \langle \underline{\lambda}, \overline{\lambda} \rangle$; in the second stage, the elected policy-makers bargain over a provision of public good. However, their bargaining can fail and we can move into the third stage, in which the delegates set levels of public good in their regions independently. A threat point represents a constraint for bargaining to be successful. This threat point or the break down allocation for the policy-maker is exogenous and it is the utility that the delegate can get in the case of a decentralized decision-making. The policy-makers would not be satisfied with an allocation which would bring them less utility than the allocation in decentralization.

Let $g^0 = (g_1^0, g_2^0)$ be the allocation that is implemented if no agreement is reached and let g^{max} be a maximal amount of public good the policy-maker can gain in bargaining game.

Definition 3 *For any* $g^0 \in \langle 0, g^{max} \rangle$ *and any* $\lambda_1, \lambda_2 \in \langle 0, 1 \rangle$*, the agreement zone* $A(\lambda, g^0)$*, is the set of allocations that Pareto dominates the allocation* g^0*,*

$$A(\lambda_1, \lambda_2, g^D) = \{g_1 \in \langle 0, g^{max} \rangle, g_2 \in \langle 0, g^{max} \rangle | g_1 \succeq g_1^0 \wedge g_2 \succeq g_2^0\}.$$

The *agreement zone* includes all possible allocations for which an agreement can be reached. Nash bargaining solution picks out the allocation that is desired.

Definition 4 *The Nash bargaining solution (NBS) is*

$$y^{NB}(\lambda_1, \lambda_2, g^0) = \arg\max N(g, \lambda_1, \lambda_2, g^0)$$

where $g \in A(\lambda_1, \lambda_2, g^0)$ *and*

$$N(g, \lambda_1, \lambda_2, g^0) = (U_1^d(g, \lambda_1) - U_1^d(g^0, \lambda_1))(U_2^d(g, \lambda_2) - U_2^d(g^0, \lambda_2)).$$

8.2. General maximization problem

In the general case, the Nash bargaining solution (NBS) takes very complex and problematical form. To find NBS, we would have to solve following maximization problem:

$$[g_1, g_2] = \arg\max \left(U_1^d(\lambda_1, g_1, g_2) - U_1^0(\lambda_1, g_1^0, g_2^0)\right)\left(U_2^d(\lambda_2, g_1, g_2) - U_2^0(\lambda_2, g_1^0, g_2^0)\right)$$

such that $U_1^d(\lambda_1, g_1, g_2) \geq U_1^0(\lambda_1, g_1^0, g_2^0)$ and $U_2^d(\lambda_2, g_1, g_2) \geq U_2^0(\lambda_2, g_1^0, g_2^0)$

$U_i^d(\lambda_i, g_i, g_{-i}) = \lambda_i u(g_i, g_{-i}) + y - \frac{p}{2}(g_i + g_{-i}) - cg_i$ and $U_i^0 = \lambda_i u(g_i^D, g_{-i}^D) + y - (p+c)g_i$ for $i = 1, 2$, where $u(g_i, g_{-i})$ represents utility gain in all potential cases - neutral goods, strategic substitutes and complements.

Difficulties of computing solution stem from the insufficient specification of function $b(\cdot)$. (Recall function $u(g_i, g_{-i}) = b(g_i) + \kappa b(g_{-i})$ for neutral public goods,

$u(g_i, g_{-i}) = b(g_i + \kappa g_{-i})$ for strategic substitutes and $u(g_i, g_{-i}) = b\big(\min(g_i, \kappa g_{-i})\big)$ for complements.) Solution in this complex form would not bring any apparent insights into the problem.

However, we can get over this obstacle to some extent without further specification of $b(\cdot)$ when we fix a total amount of public good available. In this case, policy-makers would bargain over one pie representing the overall quantity of public good. Hence, modified maximization problem is

$$g_1 = \arg\max \big(\lambda_1 u(g_1, g - g_1) - \frac{p}{2}g - cg_1 - \gamma\big)\big(\lambda_2 u(g_1, g - g_1) - \frac{p}{2}g - c(g - g_1) - \gamma\big),$$

γ denoting constant term $\gamma = \lambda_i u(g_i^D, g_{-i}^D) - (p + c)g_i$. We aim to find solution on the agreement zone shown in Figure 8.1.

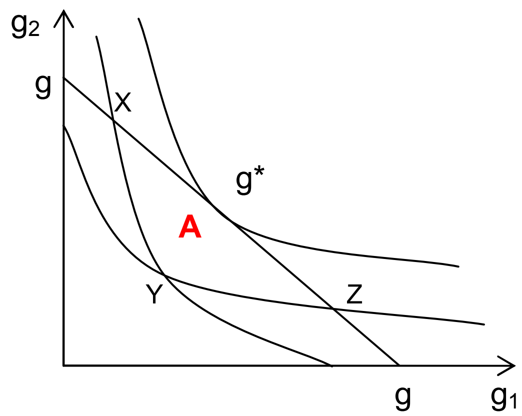

Figure 8.1.: Contract zone

The Figure 8.1 illustrates the maximization problem. It shows the budget constraint representing all possible divisions of total amount of public good g, which is the straight line gg. The curve passing through points XY corresponds to the break down situation for the policy-maker in the region 1, who will only accept agreement above this curve. The curve passing through points YZ characterizes the break down situation for the delegate in the region 2. Therefore, the agreement zone **A** is the area limited by curves crossing XYZ. As we fully divide the total amount g available, we are looking for point g^*, where a contour of maximized function is touching the budget constraint. In following sections, we will solve this problem for specific utility functions.

8.3. Neutral public goods

Firstly, we will try to compute a solution for neutral public goods. The maximization problem thus takes form:

$$g_1 = \arg\max \big(\lambda_1(b(g_1)+\kappa b(g-g_1))-\frac{p}{2}g-cg_1-\gamma\big)\big(\lambda_2(\kappa b(g_1)+b(g-g_1))-\frac{p}{2}g-c(g-g_1)-\gamma\big)$$

$$g_1 = \arg\max \big(\lambda_1(b(g_1) + \kappa b(g - g_1)) - cg_1 - \varepsilon\big)\big(\lambda_2(\kappa b(g_1) + b(g - g_1)) + cg_1 - \theta\big)$$

where constants $\varepsilon = \frac{p}{2}g + \gamma$ and $\theta = \frac{p}{2}g + cg + \gamma$. Hence, we derive the first order condition and substitute $g_2 = g - g_1$:

$$\begin{aligned} & b'(g_1)[\lambda_1\lambda_2(b(g_2)(1 + \kappa^2) + 2\kappa b(g_1)) - \lambda_1(cg_2 + \varepsilon) - \kappa\lambda_2(cg_1 + \varepsilon)]+ \\ & + b'(g_2)[-\lambda_1\lambda_2(2\kappa b(g_2) + b(g_1)(1 + \kappa^2)) + \kappa\lambda_1(cg_2 + \varepsilon) + \lambda_2(cg_1 + \varepsilon)]+ \\ & + c[\lambda_1(b(g_1) + \kappa b(g_2)) - \lambda_2(b(g_2) + \kappa b(g_1)) - cg_1 + cg_2] = 0 \end{aligned} \quad (8.1)$$

Let us explore this complex condition in a greater detail.

Zero indirect costs

Firstly, assume that there are no indirect costs, $c = 0$. The only costs that citizens pay for a public goods provision are direct and $\frac{p}{2}(g_1+g_2) = \frac{p}{2}g$. Voters in both regions pay always the same taxes, whatever division of output comes from an agreement between policy-makers. Therefore, they want to get as much public good, as possible.

From (8.1) we derive:

$$\frac{b'(g_1)}{b'(g_2)} = \frac{\lambda_1\lambda_2(2\kappa b(g_2) + b(g_1)(1 + \kappa^2)) - (\frac{p}{2}g + \gamma)(\lambda_2 + \kappa\lambda_1)}{\lambda_1\lambda_2(b(g_2)(1 + \kappa^2) + 2\kappa b(g_1)) - (\frac{p}{2}g + \gamma)(\lambda_1 + \kappa\lambda_2)}$$

Let us consider case when $g_1 > g_2$. From concavity of $b(\cdot)$, we have $b'(g_1) \leq b'(g_2)$.

$$\Rightarrow \lambda_1\lambda_2(1 - \kappa^2)(b(g_1) - b(g_2)) - \big(\frac{p}{2}g + \gamma\big)(1 - \kappa)(\lambda_2 - \lambda_1) \leq 0$$

Hence, for $\kappa \in \langle 0, 1)$ we must have $\lambda_2 > \lambda_1$. Similarly, $g_2 > g_1$ implies $\lambda_1 > \lambda_2$ and $g_2 = g_1 \Rightarrow \lambda_1 = \lambda_2$. The policy-maker with lower preferences for public good will always get higher amount of public good, because she must obtain additional units to increase her utility up to a level of the other policy-maker. Delegation of conservative policy-maker serves as a threat for the other delegate, who must then give up more units of public good to reach an agreement.

Using comparative statics, we get $\frac{dg_i}{d\lambda_i} < 0$ and $\frac{dg_{-i}}{d\lambda_i} > 0$. With increasing preferences of domestic delegate an amount of domestic public good is decreasing and an amount of foreign public good is increasing.

When we look back, we find that this conclusion is different from the one in the original model. As we can see in (7.3), the stronger preferences the policy-maker has, the larger is the provision of public good in both, domestic and foreign region. For $c = 0$ and $\kappa \in \langle 0, 1)$, (7.6) implies that voters would delegate public good lover $\lambda^d = \frac{2(1+\kappa^2)}{(1+\kappa)^2}\lambda^m$. However, in case of bargaining for a given amount of public good, it would not pay off to voters to delegate public good lover and they will rather vote for a conservative politician. As they always pay the same taxes pg, they want to get as much as possible, thus they elect the extreme conservative with preferences $\underline{\lambda}$. The equilibrium is symmetric, therefore both regions will delegate extreme conservative policy-makers.

Positive indirect costs

In case of positive indirect costs, $c > 0$, we do not obtain such an obvious result, moreover we get to mathematical difficulties because of non-specified parameters c, p, κ and function $b(\cdot)$. Therefore, we will not consider this case in next sections and we will give just an intuition behind.

When voters have to pay both, direct and indirect costs, we cannot generally say, whether voters would like to get greater amount of domestic public good or of foreign public good. It depends on the extent of spillover effect and the size of indirect costs. If the spillover effect is large, voters will have an incentive to free ride and would like to get more foreign public good, however, if it is small, they will ask for more domestic public good. Size of indirect costs affect voters' incentives similarly.

8.4. Strategic substitutes

If public goods are strategic substitutes, we come to very similar conclusions as for neutral public goods. We aim to solve following maximization problem:

$$g_1 = \arg\max \big(\lambda_1 b(g_1 + \kappa(g - g_1)) - cg_1 - \varepsilon\big)\big(\lambda_2 b(g - g_1 + \kappa g_1) + cg_1 - \theta\big)$$

First order condition:

$$\begin{aligned} b'(g_1 + \kappa g_2)[\lambda_1\lambda_2 b(g_2 + \kappa g_1)(1-\kappa) - \lambda_1(1-\kappa)(\frac{p}{2}g + cg_2 + \gamma)] + \\ + b'(g_2 + \kappa g_1)[-\lambda_1\lambda_2 b(g_1 + \kappa g_2)(1-\kappa) + \lambda_2(1-\kappa)(\frac{p}{2}g + cg_1 + \gamma)] + \\ + c[\lambda_1 b(g_1 + \kappa g_2) - \lambda_2 b(g_2 + \kappa g_1) - cg_1 + cg_2] = 0 \end{aligned} \tag{8.2}$$

If $c = 0$, from (8.2) we have :

$$\frac{b'(g_1 + \kappa g_2)}{b'(g_2 + \kappa g_1)} = \frac{\lambda_1\lambda_2 b(g_1 + \kappa g_2) - (\frac{p}{2}g + \gamma)\lambda_2}{\lambda_1\lambda_2 b(g_2 + \kappa g_1) - (\frac{p}{2}g + \gamma)\lambda_1}$$

Hence, if $g_1 > g_2$, then $\lambda_2 > \lambda_1$, for $g_1 < g_2$ we have $\lambda_2 < \lambda_1$ and $g_1 = g_2$ implies $\lambda_1 = \lambda_2 \Rightarrow \frac{dg_i}{d\lambda_i} < 0$ and $\frac{dg_{-i}}{d\lambda_i} > 0$ as for neutral public goods. Policy-maker with higher preferences for public good will get lower amount of domestic public good and visa versa. Therefore, voters will delegate extreme conservative to get as much public good as possible.

8.5. Complements

Finally, let us consider a situation when public goods are complements. The break down allocation is zero in this case, because no public good is produced in decentralization. Hence, we need to solve problem:

$$g_1 = \arg\max \big(\lambda_1 b(\min\{g_1, \kappa g_2\}) + y - \frac{p}{2}g - cg_1\big)\big(\lambda_2 b(\min\{g_2, \kappa g_1\}) + y - \frac{p}{2}g - cg_2\big)$$

For $g_1 + g_2 = g$, we get two boundary points $g_1^L = \frac{\kappa g}{1+\kappa}$ and $g_1^H = \frac{g}{1+\kappa}$, therefore we can distinguish three possible intervals.

Lower subset

We assume that $g_1 \in \langle 0, \frac{\kappa g}{1+\kappa})$. We obtain simpler form of maximization problem:

$$g_1 = \arg\max \big(\lambda_1 b(g_1) + y - \frac{p}{2}g - cg_1\big)\big(\lambda_2 b(\kappa g_1) + y - \frac{p}{2}g - c(g - g_1)\big)$$

First order condition:

$$\lambda_1 b'(g_1)\big(\lambda_2 b(\kappa g_1) + y - \frac{p}{2}g - cg_2\big) + \lambda_2 \kappa b'(\kappa g_1)\big(\lambda_1 b(g_1) + y - \frac{p}{2}g - cg_1\big) + \\ + c\big(\lambda_1 b(g_1) - cg_1 - (\lambda_2 b(\kappa g_1) - cg_2)\big) = 0 \quad (8.3)$$

However, for $c = 0$ (8.3) cannot be satisfied. First derivation is always positive. For any λ_1, λ_2, g_1 will never be in interval $\langle 0, \frac{\kappa g}{1+\kappa})$. Thus, we disregard case when the amount of g_1 is low in comparison with the amount of g_2.

Upper subset

Now, let us suppose $g_1 \in (\frac{g}{1+\kappa}, g\rangle$. The maximization problem is then:

$$g_1 = \arg\max \big(\lambda_1 b(\kappa(g - g_1)) + y - \frac{p}{2}g - cg_1\big)\big(\lambda_2 b(g - g_1) + y - \frac{p}{2}g - c(g - g_1)\big)$$

First order condition:

$$-\lambda_1 \kappa b'(\kappa g_2)\big(\lambda_2 b(g_2) + y - \frac{p}{2}g - cg_2\big) - \lambda_2 b'(g_2)\big(\lambda_1 b(\kappa g_2) + y - \frac{p}{2}g - cg_1\big) + \\ + c\big(\lambda_1 b(g_1) - cg_1 - (\lambda_2 b(\kappa g_1) - cg_2)\big) = 0 \quad (8.4)$$

Hence, for $c = 0$, hence (8.4) cannot be satisfied. First derivation is always negative. Therefore, g_1 will never be in interval $(\frac{g}{1+\kappa}, g\rangle$. We cannot have such a situation, that g_1 is relatively much higher than g_2.

Interior subset

Let us explore the last case, when $g_1 \in \langle \frac{\kappa g}{1+\kappa}, \frac{g}{1+\kappa}\rangle$. For $\kappa = 1$ it is unique $g_1 = \frac{g}{2}$, however for $\kappa = 0$, $g_1 \in \langle 0, g\rangle$. With increasing κ, the interval is getting narrower.

As indicated by examination of previous two cases, it is clear, that solution will lie in this interval. Product of utilities is increasing in g_1 in lower interval and decreasing in upper interval. However, we have to eliminate corner solutions g_1^L and g_1^H. According to the analysis in the original model, we impose restriction either on population to be more homogenous across regions ($\underline{\lambda}$ being close to $\overline{\lambda}$), or on demand for public good to be sufficiently elastic.

Then we do not need to impose any constraints ($\mu_1 = \mu_2 = 0$) and we can solve the following maximization problem:

$$g_1 = \arg\max \big(\lambda_1 b(\kappa g_1) + y - \frac{p}{2}g - cg_1\big)\big(\lambda_2 b(\kappa(g - g_1)) + y - \frac{p}{2}g - c(g - g_1)\big)$$

First order condition:

$$\lambda_1 \kappa b'(\kappa g_1)\big(\lambda_2 b(g_2) + y - \frac{p}{2}g - cg_2\big) - \lambda_2 \kappa b'(\kappa g_2)\big(\lambda_1 b(\kappa g_2) + y - \frac{p}{2}g - cg_1\big) + \\ + c\big(\lambda_1 b(g_1) - cg_1 - (\lambda_2 b(\kappa g_1) - cg_2)\big) = 0 \quad (8.5)$$

Assume c=0, hence:

$$\frac{b'(\kappa g_1)}{b'(\kappa g_2)} = \frac{\lambda_2\big(\lambda_1 b(\kappa g_2) + y - \frac{p}{2}g - cg_1\big)}{\lambda_1\big(\lambda_2 b(g_2) + y - \frac{p}{2}g - cg_2\big)}$$

Let us suppose $g_1 > g_2$. From concavity of $b(\cdot)$, we have $b'(\kappa g_1) \leq b'(\kappa g_2)$.

$$\Rightarrow \lambda_1\lambda_2(b(\kappa g_1) - b(\kappa g_2)) \leq (y - \frac{p}{2}g)(\lambda_1 - \lambda_2)$$

We assume that y is gross income and $\frac{p}{2}g$ is tax paid out of this income, therefore y must be high enough to cover this tax and $(y - \frac{p}{2}g) > 0$. Hence, for $\kappa \in \langle 0, 1\rangle$ we have $\lambda_1 > \lambda_2$. Similarly, $g_2 > g_1$ implies $\lambda_2 > \lambda_1$ and $g_2 = g_1 \Rightarrow \lambda_1 = \lambda_2$.

When public goods are complements and voters pay only direct costs, which are same across regions, they cannot create a threat for other policy-maker when voting for conservative delegate. They instead vote for extreme public good lover. If the policy-maker is conservative, he gets less public good than the other policy-maker, however the maximum amount, that the extreme public good lover can get, is only $\frac{g}{1+\kappa}$. If the spillover effect is higher, the division of total amount of the public good will be more equalized. For $\kappa = 1$, voters cannot influence the outcome by strategic delegation, however the lower is κ, the larger effect the strategic delegation has on the division of the public good.

9. Conclusion

The thesis has provided with an insight into the problem of fiscal centralization and decentralization from the political economy perspective. It has mainly focused on the central concept of strategic delegation. The effect of the strategic delegation plays very important role because it can distort outcome in centralization so that the centralized decision-making fails to internalize policy externalities.

In the first part, we have discussed conditions under which centralization of decision-making is superior to decentralization and what kind of benefits it can bring. We have given the most prevailing arguments found in literature in the fields as heterogeneity, economies of scale, financing public goods provision, competition among regions and governance. The last section has emphasized some empirical findings about the performance of economies under the centralized and the decentralized decision-making.

The major part of the thesis has presented the model of policy decision-making on public goods provision with strategic delegation, which has been built on the framework of Dur and Roelfsema (2005). In the model, we have dealt with the policy decision-making in two identical regions with positive externalities and have made distinction between two types of costs of public goods provision, direct and indirect. However, it is questionable if the indirect costs are relevant for this analysis and if they do not occur only for a minority of public goods. In our analysis, each region has produced one public good, but this is quite far from reality because governments usually provide with more public goods. Moreover, we have assumed that the spillover effect is same for both regions, although different public goods usually entails different positive externalities.

Though the assumptions of the model have been simplified very much, we have come to interesting conclusions. We have distinguished three possible cases of different types of public goods - neutral goods, strategic substitutes and complement goods.

For each case, we have computed the outcome in the setting of centralization and decentralization. In the end, we have presented the extension of the model and tried to specified strategic delegation effect in case of fixed tax revenues. The overall results are presented in following tables.

Table 9.1.: Neutral goods

Setting/Delegation	$c = 0,\, p > 0$	$c > 0,\, p = 0$	$c > 0,\, p > 0$
Decentralization	λ^m	λ^m	λ^m
Centralization	$\lambda^m \frac{2(1+\kappa^2)}{(1+\kappa)^2} \geq \lambda^m$	$\lambda^m \frac{1+\kappa^2}{1+\kappa} \leq \lambda^m$	$\lambda^m \frac{2(1+\kappa^2)(p+c)}{(1+\kappa)^2 p+(1+\kappa)2c}$
Nash bargaining	$\underline{\lambda}$	–	–

If public goods are neutral, people vote sincerely in decentralization and also for specific parameters κ, p and c discussed in the section above in centralization. When voters have to bear only shareable costs in centralization, they delegate public good lovers and overspending occurs, but in case of positive indirect costs and zero direct costs they have an incentive to delegate conservative politician leading to underprovision. However, if the total tax revenues are given and policy-makers only decide about the division of public good, then voters would like to elect extreme conservative even when they pay only direct costs. This type of politician has better bargaining position and can obtain more public goods.

Table 9.2.: Strategic substitutes

Setting/Delegation	$c = 0,\, p > 0$	$c > 0,\, p = 0$	$c > 0,\, p > 0$
Decentralization	$\lambda^m(1-\kappa^2) \leq \lambda^m$	$\lambda^m(1-\kappa^2) \leq \lambda^m$	$\lambda^m(1-\kappa^2) \leq \lambda^m$
Centralization	$\overline{\lambda},\, \kappa \neq 0$	$\lambda^m \frac{1-\kappa^2}{1+\kappa} \leq \lambda^m$	$\lambda^m \frac{2(1-\kappa^2)(p+c)}{(1-\kappa)^2 p+(1+\kappa)2c} \leq \lambda^m$
Nash bargaining	$\underline{\lambda}$	–	–

For strategic substitutes, people vote sincerely only in the case that no positive externality exists and for specific relation of parameters κ, p and c discussed in the section above in centralization. For any positive spillover effect citizens always vote for conservative politician in decentralization. When there are only shareable costs, citizens choose extreme public good loving policy-maker in centralization. For positive indirect costs and zero direct costs, they will choose conservative. If we use the Nash bargaining approach, the delegation will change extremely and voters elect extreme conservative, although they bear only shareable costs.

Table 9.3.: Complements

Setting/Delegation	$c = 0$, $p > 0$	$c > 0$, $p = 0$	$c > 0$, $p > 0$
Decentralization	λ^m	λ^m	λ^m
Centralization	$\overline{\lambda}$	$\overline{\lambda}$	$\overline{\lambda}$
Nash bargaining	$\overline{\lambda}$	–	–

When public goods are complements, they will not be produced in decentralization. Whatever policy-maker's preference, the outcome will always be zero. Therefore, centralization is very desirable. For specification of an outcome in centralization, we had to impose another restrictions. If population in regions is more homogenous, which means that $\underline{\lambda}$ is close to $\overline{\lambda}$, or if the elasticity of demand for public goods is high enough, voters will always delegate extreme public good lover. This fact will not even change with Nash bargaining, because voters cannot improve bargaining position of a policy-maker.

The main innovation of the model is incorporating complements into the analysis and also extension of the Nash bargaining solution. However, in the model's extension, we have not specified how policy-makers decide about the optimal level of taxes determining the total amount of public goods available. If we included this decision-making into the extended analysis, we would get different strategic delegation effects.

There are still some other problems which have not been yet resolved. Because of general specification of assumptions we could not solve all the cases precisely, therefore we should find such an specification which would enable us to make deeper conclusions. Furthermore, to bring the model closer to reality, there is a lot of options how to extend it. We can consider heterogenous regions, more public goods, various spillover effects, non-linear production of public goods or different form of taxation. Moreover, not all voters are able to delegate strategically, therefore we can for example distinguish between intelligent voters, who delegate strategically, and non-intelligent voters voting sincerely.

According to our analysis, the strategic delegation leads to inefficient outcomes; overprovision or underprovision of public goods. Therefore, important question arises. Is it possible to eliminate strategic delegation by some means and get to optimal levels of public good? All these issues remain open and they would require further economic research.

Appendix A.

Proofs

Proof of Proposition 1 If individuals in region $i, i = 1, 2$, are symmetrically distributed over interval $\langle \underline{\lambda}, \overline{\lambda} \rangle$, in both regions identically, we have:

$$V_i = \int_{\underline{\lambda}}^{\overline{\lambda}} [\lambda_i^j b(g_i, g_{-i}, \kappa) + y - (p+c)g_i] d\lambda_i^j$$

$$\begin{aligned}
V &= V_i + V_{-i} \\
&= \int_{\underline{\lambda}}^{\overline{\lambda}} [\lambda_i^j b(g_i, g_{-i}, \kappa) + y - (p+c)g_i] d\lambda_i^j + \int_{\underline{\lambda}}^{\overline{\lambda}} [\lambda_i^j b(g_{-i}, g_i, \kappa) + y - (p+c)g_{-i}] d\lambda_i^j \\
&= \int_{\underline{\lambda}}^{\overline{\lambda}} [\lambda_i^j b(g_i, g_{-i}, \kappa) + y - (p+c)g_i + \lambda_i^j b(g_{-i}, g_i, \kappa) + y - (p+c)g_{-i}] d\lambda_i^j \\
&= \int_{\underline{\lambda}}^{\overline{\lambda}} [\lambda_i^j \Big(b(g_i, g_{-i}, \kappa) + b(g_{-i}, g_i, \kappa) \Big) + 2y - (p+c)(g_i + g_{-i})] d\lambda_i^j \\
&= \Big[\frac{(\lambda_i^j)^2}{2} \Big(b(g_i, g_{-i}, \kappa) + b(g_{-i}, g_i, \kappa) \Big) + \Big(2y - (p+c)(g_i + g_{-i}) \Big) \lambda_i^j \Big]_{\underline{\lambda}}^{\overline{\lambda}} \\
&= (\overline{\lambda}^2 - \underline{\lambda}^2) \frac{1}{2} \Big(b(g_i, g_{-i}, \kappa) + b(g_{-i}, g_i, \kappa) \Big) + (\overline{\lambda} - \underline{\lambda}) \Big(2y - (p+c)(g_i + g_{-i}) \Big) \\
&= (\overline{\lambda} - \underline{\lambda}) \Big[(\overline{\lambda} + \underline{\lambda}) \frac{1}{2} \Big(b(g_i, g_{-i}, \kappa) + b(g_{-i}, g_i, \kappa) \Big) + \Big(2y - (p+c)(g_i + g_{-i}) \Big) \Big]
\end{aligned}$$

Using $\lambda^m = \frac{\overline{\lambda} + \underline{\lambda}}{2}$ we get:

$$V = (\overline{\lambda} - \underline{\lambda}) \Big[\lambda^m \Big(b(g_i, g_{-i}, \kappa) + b(g_{-i}, g_i, \kappa) \Big) + \Big(2y - (p+c)(g_i + g_{-i}) \Big) \Big] = (\overline{\lambda} - \underline{\lambda})(U_i^m + U_{-i}^m)$$

$$\Rightarrow \Big\{ g_i^*, g_{-i}^* \Big\} = \arg\max V = \arg\max \Big[U_i^m + U_{-i}^m \Big] \qquad \blacksquare$$

Proof of Proposition 2 We use backward induction of two stage game. In the second stage, the elected policy-maker will maximize her utility $U_i^d = \lambda_i^d \Big(b(g_i) +$

$\kappa b(g_{-i})\Big) + y - (p+c)g_i$ which gives the first-order condition $\lambda_i^d b'(g_i) - (p+c) = 0$. In the first stage, the voter j selects the policy-maker representing her preference so that she maximizes her utility function with respect to λ_i^d:

$$\frac{\partial U_i^j}{\partial \lambda_i^d} = \lambda_i^j \Big[b'(g_i)\frac{dg_i}{d\lambda_i^d} + \kappa b'(g_i)\frac{dg_{-i}}{d\lambda_i^d} \Big] - \frac{dg_i}{d\lambda_i^d}(p+c) = 0$$

$\lambda_i^d b'(g_i) - (p+c) = 0 \Rightarrow \frac{dg_{-i}}{d\lambda di} = 0 \rightarrow$ amount of g_{-i} is not influenced by $\lambda_i^d \Rightarrow \lambda_i^j b'(g_i) - (p+c) = \lambda_i^d b'(g_i) - (p+c) \Rightarrow \lambda_i^j = \lambda_i^d$. All the citizens will vote sincerely according to their preferences. Under the majority voting system and with our assumption of symmetrical distribution of preferences there is the only one candidate who can get the most votes and it is the policy maker with median preference. The elected policy-maker will have consequently median preference for public goods $\rightarrow \lambda_i^d = \lambda_i^m$.
■

Proof of Proposition 3 We use backward induction of two stage game. In the second stage, the elected policy maker will maximize her utility $U_i^d = \lambda_i^d b(g_i + \kappa g_{-i}) + y - (p+c)g_i$ which gives the first-order condition $\lambda_i^d b'(g_i + \kappa g_{-i}) - (p+c) = 0$. In the first stage, the voter j selects the policy-maker representing her preference so that she maximizes her utility function with respect to λ_i^d:

$$\frac{\partial U_i^j}{\partial \lambda_i^d} = \lambda_i^j \Big[b'(g_i + \kappa g_{-i})\frac{dg_i}{d\lambda_i^d} + \kappa b'(g_i + \kappa g_{-i})\frac{dg_{-i}}{d\lambda_i^d} \Big] - \frac{dg_i}{d\lambda_i^d}(p+c) = 0$$

Using $\lambda_i^d b'(g_i + \kappa g_{-i}) - (p+c) = 0$, $i = 1, 2$ and assuming ω is a constant we get:

$$\lambda_1^d b'(g_1 + \kappa g_2) - (p+c) = 0 \qquad \lambda_2^d b'(g_2 + \kappa g_1) - (p+c) = 0$$

$$\Rightarrow g_2 = \omega - \kappa g_1 \Rightarrow \lambda_1^d b'(g_1 + \kappa\omega - \kappa^2 g_1) \Rightarrow \frac{dg_1}{d\lambda_1^d} = -\frac{b'(g_1 + \kappa g_2)}{\lambda_1^d b''(g_1 + \kappa g_2)(1-\kappa^2)}$$

$$\Rightarrow g_1 = \frac{1}{\kappa}\omega - \frac{1}{\kappa}g_2 \Rightarrow \lambda_1^d b'(\frac{1}{\kappa}\omega - \frac{g_2}{\kappa} + \kappa g_2) - (p+c) = 0 \Rightarrow \frac{dg_2}{d\lambda_1^d} = \frac{\kappa b'(g_1 + \kappa g_2)}{\lambda_1^d b''(g_1 + \kappa g_2)(1-\kappa^2)}$$

$$\Rightarrow \frac{dg_{-i}}{d\lambda_i^d} = -\kappa \frac{dg_i}{d\lambda_i^d}$$

$$\Rightarrow \frac{\partial U_i^j}{\partial \lambda_i^d} = \lambda_i^j b'(g_i + \kappa g_{-i})(1-\kappa^2) - (p+c) = 0$$

$$\Rightarrow \lambda_i^j b'(g_i + \kappa g_{-i})(1-\kappa^2) - (p+c) = \lambda_i^d b'(g_i + \kappa g_{-i}) - (p+c) \Rightarrow \lambda_i^j(1-\kappa^2) = \lambda_i^d$$

The citizen $j, j = 1, 2, ..., n$, votes strategically for the delegate with preference $\lambda_i^d = (1-\kappa^2)\lambda_i^j$. Under the majority voting system and with our assumption of symmetrical distribution of preferences the voters in region i will elect candidate with preference $\lambda_i^d = (1-\kappa^2)\lambda_i^m$. ■

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