# Distributive Politics and the Benefits of Decentralisation

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Abstract

This paper integrates the distributive politics literature with the literature on decentralization by incorporating inter-regional project externalities into a standard model of distributive policy. A key finding is that the degree of uniformity (or "universalism") of the provision of regional projects is endogenous, and depends on the strength of the externality. The welfare benefits of decentralization, and the performance of "constitutional rules" (such as majority voting) which may be used to choose between decentralization and centralization, are then discussed in this framework.

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## 1. Introduction

The di¤erent tax, expenditure and regulatory functions of government typically vary considerably in their degree of decentralization. For example, in the US, expenditure on education is highly decentralized, while expenditure on defense is almost entirely federal; property taxes are the main revenue-raising instrument at local level, whereas state and federal governments use income taxes. Moreover, countries di¤er in the degree to which functions are decentralized; for example, in contrast to the US, the only tax which is not centrally set in the UK is the local residential property tax.

Moreover, there is both an old and continuing debate over the desirable degree of decentralization. For example, there has been an ongoing debate about the appropriate sharing of tax and expenditure powers between Federal and State governments since the drafting of the US Constitution (Inman and Rubinfeld(1997)). In the European Union, the principle of subsidiarity, in introduced in the Maastricht Treaty, "remains vague and capable of con‡icting interpretations" (Begg et. al. (1993)).

To understand this empirical diversity, and also to address the normative questions, we must understand both the underlying costs and bene…ts of (de)centralization, and the political processes that lead to the choice of a particular level of decentralization being chosen.

The earlier literature on …scal federalism, and in particular Oates' seminal work (Oates(1972)) gave the following account of costs and bene…ts of decentralization. Sub-central governments may …nd it hard to coordinate to internalize inter-jurisdictional externalities, or to exploit economies of scale, in the provision of regional projects. On the other hand, the bene…t of decentralization is greater responsiveness in the choice of project to the preferences of regions and localities. Speci…cally, in Oates' work, the cost of centralization was assumed to be policy uniformity i.e. it was assumed that if a regional public good was provided centrally, it must be provided at the same level in every region. This leads to the conclusion (Oates' "decentralization theorem"), that the e¢cient level of decentralization of the provision of a public good (or indeed any other government activity) is at the point where the bene…ts from less policy uniformity no longer exceed the costs of less internalization of externalities.

While providing important insights, Oates' account su¤ers from two problems. First, typically, spending by central governments is not uniform across regions in per capita terms. For example, the formulae used to allocate US grants-in-aid depends not only on population, but also on income per capita, tax raising e¤ort, and several other factors (Boadway and Wildasin(1984)).

Second, the hypothesis of "policy uniformity" is not derived from any explicit model of government behaviour, and indeed, explicit public choice models tend to give a di¤erent account of what might happen with centralized provision of regional public goods. For example, the large literature on distributive politics (see e.g. Ferejohn, Fiorina and McKelvey (1987)) emphasizes the formation of minimum winning coalitions, rather than policy uniformity, in the provision of projects with region-speci…c bene…ts.

However, the distributive politics literature cannot be applied directly to re…ne Oates' argument, as it does not model the bene…ts of centralization that arise from the internalization of externalities. This paper attempts to integrate these two literatures, by formulating a model of distributive policy where (i) legislative behaviour is rigorously modelled, with the primitives being legislative rules, rather than outcomes; (ii) spillovers between regions generated by distributive policies gives some rationale for centralization.

The main insight of this paper is that there is an interaction between these two features; the strength of the spillovers a¤ects the degree of "universalism" or uniformity in distributive policy. When spillovers are strong (and positive), the outcome of legislative decision-making is closer to uniformity than it is when spillovers are small, or negative.

Absent externalities, the speci…c model we use is in many respects standard in the large theoretical literature with distributive politics. Speci…cally, every region has a discrete project which generates both intra-regional bene…ts and external bene…ts (or costs). All voters within a region are identical, but regions may vary both with respect to the costs and the bene…t of the project. Central government then comprises a legislature of delegates, each delegate representing a region, and elected from amongst the citizens of that region[1]. The legislature then decides on which projects are to be …nanced out of the proceeds of a uniform national tax.

Building on the important papers by Ferejohn, Fiorina, McKelvey(1987), and McKelvey(1986), we then propose some minimal legislative rules to ensure that behaviour in the legislature is determinate. First, legislators make proposals concerning subsets of regions whose projects are to be funded. These proposals are then ordered into an agenda, and are voted on sequentially, and the winning motion is then paired with the status quo.

This procedure has a unique equilibrium outcome, where a proposal to fund projects in a particular set $K$ of regions is proposed and approved, independently of how items are ordered on the agenda. The key …nding is the following. If externalities are negative, or only weakly positive, this set comprises a bare majority of regions[2] with the lowest costs as in the distributive politics literature (Ferejohn, Fiorina, McKelvey(1987)). If externalities are strongly positive, $K$ comprises more than a bare majority of regions, and may include all regions. So, the level of the externality helps determine the degree of uniformity in project provision.

The second contribution of the paper is a thorough investigation of the constitutional choice between centralization and decentralization, using this model as a vehicle. We study …rst the benchmark case, where unanimity is required for any change to the status quo, but side-payments between regions are possible. This case is a useful benchmark, in that the e¢cient alternative that maximises aggregate welfare (the sum of utilities) will be chosen. We also consider the alternatives of unanimity rule and majority rule without side-payments. Generally, the picture con…rms Oates' insights; centralization is chosen when externalities are strong and regions are relatively homogenous, and decentralization is chosen when the converse is true. But, there are some intriguing exceptions. For example, the relative bene…t to centralization is not everywhere increasing in the size of the externality. These exceptions result from the fact that the legislative outcome is endogenously determined, in part by the

[1] Another new feature is that of election of delegates to the national legislature. As all regions are homogenous, however, the delegate must have the preferences of any resident of that region. Besley and Coate(1998) consider the case where intra-regional preferences may di¤er.

[2] That is, $m = (n + 1)=2$ regions, where $n$ is the (odd) number of regions.

size of the externality.

There is already a body of work[3] which addresses (explicitly or implicitly[4]) the choice between centralization and decentralization, while taking a political economy approach to the modelling of government behavior (Alesina and Spolare(1997), Bolton and Roland(1997), Cremer and Palfrey(1996), Ellingsen(1997)). However, with the exception of Ellingsen, this literature follows Oates in assuming that centralized provision of a public good is uniform.

Finally, there is independent contribution of Besley and Coate(1998), seen only after the first draft of this paper was completed. Their paper also reexamines Oates' decentralization theorem from a political economy perspective. The focus of Besley and Coate's paper, however, is really quite different; they explicitly model the election of delegates to the national legislature in a citizen-candidate setting, and how this process interacts with the behaviour of the legislature. By contrast to this paper, theirs does not model all the rules of operation of the legislature explicitly. Rather, in the setting of a "one-shot" version of Baron and Ferejohn's model of legislative bargaining, they capture the degree of "universalism" in an ad hoc way by supposing that the agenda-setter places some (exogenous) weight on the utility of the other delegate when formulating his agenda.

The rest of the paper is laid out as follows. Section 2 exposits the model. Sections 3 and 4 analyse political equilibrium under centralization. Section 5 considers issues of constitutional design, and derives conditions under which centralization or decentralization is the more efficient. Section 6 considers the robustness of the results to various extensions of the model. Section 7 discusses some related literature in more detail than above, and concludes.

# 2. The Model

## 2.1. Preliminaries

There are an odd number $i = 1, \ldots n$ of regions or districts each populated by a number of identical individuals with a population size normalized to unity. In each district there is a discrete project $x_i \in \{0, 1\}$. Each project has a resource cost $c_i$, and generates benefit $b_i$ for residents of $i$, and also external benefits $e$ for residents of all regions $j \neq i$. There are two ways of interpreting this externality. The first is if there are three contiguous regions located in two-dimensional space, in which case the externality is "local" i.e. a project only impacts on neighboring regions, as shown in Figure 1.

[3] One should also note the work of Edwards and Keen(1996), and Seabright(1996)), where government is modelled as a Leviathan. The problem with such models of government behaviour, however, is that they are not based explicitly on the primitives of voters, legislative rules and the principal-agent relationship between voters and bureaucrats. There are also a number of papers which model government as welfare-maximizing (see e.g. Caillaud, Gilbert and Picard(1996), Gilbert and Picard(1996), Klibanoff and Poitevin(1996), Seabright(1996)). The challenge for these papers is to explain why decentralization might ever be welfare-superior to centralization; if central government can precommit, it can always replicate the decentralised outcome.

[4] Bolton and Roland focus on the closely related issue of when regions might choose to secede from a federation. One of the main themes of Bolton and Roland's work is how policy might be designed by the federation (assuming uniformity), subject to the constraint that it is not in either region's interest to secede. In our paper, we abstract from these issues by (implicitly) assuming that secession is infinitely costly.

Figure 1 in here

The second is that the externality is "global", that is, the project affects all regions, whether neighboring or not. Also, the externality $e$ may be positive or negative, and may be interpreted as technological or pecuniary. This is a very stylized way of modelling externalities, but is analytically convenient. Some of the results of this paper extend to the case with $n > 3$ regions and local externalities (Lockwood(1998)).

The following notation will be useful. Let $x = (x_i)_{i \in N}$ be any vector of projects, and $X = \{0; 1\}^n$ be the feasible set of project vectors. If $F = \{i \in N \,|\, x_i = 1\}$ is the set of regions that have funded projects, let

$$x_i^F = \begin{cases} 1 & \text{if } i \in F \\ 0 & \text{otherwise} \end{cases}$$

and let $x^F = (x_i^F)_{i \in N}$. Also, let $f = \#F$.

All residents of region $i$ have identical preferences over $x^F$ and a numeraire good of the form

$$u_i = b_i x_i^F + y_i + (f - x_i^F)e \tag{1}$$

where $b_i$ is the benefit from the project for those in region $i$; and $y_i$ the level of consumption of a numeraire good. The term $(f - x_i^F)e$ indicates that region $i$ gets external benefit of $fe$ from $x^F$ if it does not have a project funded, and benefit of $(f - 1)e$ from $x^F$ if it has a project funded.

A resident of region $i$ has initial endowment of the numeraire of unity, and pays a lump-sum of $t_i$ either to regional or central government. So, the budget constraint for residents of region $i$ is $y_i = 1 - t_i$. Substituting this constraint into (1), and suppressing the constant of unity, we get

$$u_i = b_i x_i^F - t_i + (f - x_i^F)e \tag{2}$$

## 2.2. Decentralization

With decentralization, the cost of the project is funded by a lump-sum regional tax[5], so the regional budget constraint is $t_i = x_i c_i$. Consequently, the net benefit of the project to any resident is $b_i - c_i$.

We make the natural assumption that a decision about the project is made by majority voting over the alternatives $x_i \in \{0; 1\}$. So, as all agents in a region are identical, the outcome under decentralization is simply that the project in $i$ is funded if $b_i \geq c_i$. For future reference, note that the payoff to a resident of $i$ with decentralization can be written

$$u_i^d = \max\{b_i - c_i; 0\} + (d - x_i^D)e \tag{3}$$

where $D = \{i \,|\, b_i \geq c_i\}$ is the set of projects funded under decentralization, and $d = \#D$. Obviously, in the presence of externalities, the outcome with decentralization is not efficient.

[5] This tax could easily be made distortionary, by introducing a factor of production in elastic supply (e.g. labour), and supposing that the tax is levied on this factor.

### 2.3. Centralization

We assume that in this case, both the decision about which projects to fund, and the setting of a tax to fund them, are made by a legislature that comprised of delegates from all regions. This is the way that centralization is often defined, but there are of course, two alternative kinds of partial centralization; the first is centralized expenditure, where projects are decided upon by central government, but are funded by regions as in Section 2.2 above, and the second centralized funding, where projects are decided upon regionally, but funded though a national tax (these alternatives are discussed in Section 6.2 below).

Revenue is raised by a national lump-sum tax, $t$ i.e. a tax rate that is uniform across regions[6]. So, the national government budget constraint is

$$nt = \sum_{j \in C} c_j \tag{4}$$

where $C$ is the set of projects funded with centralization.

We make the reasonable assumption that the delegate from region $i$ must be drawn[7] from the (homogenous) population in that region, consistently with the citizen-candidate model (Besley and Coate(1997)). Combining this with (1) and (2), we see that the payoff to both any resident of region $i$ and its delegate from any $x^C$ is:

$$u_i^c = x_i^C b_i - \frac{1}{n} \sum_{j \in C} c_j + (c - x_i^C)e \tag{5}$$

where $c = \#C$: This indicates that with centralization, there are two spillovers at work; the first is the project spillover, captured by the term $(c - x_i^C)e$, and the second is the cost-sharing spillover, captured by the term $\frac{1}{n}\sum_{j \in C} c_j$: Thus a project in region $j$ benefits $i$ by net amount $e - c_j/n$.

The set $C$ of projects is determined by voting in a legislature, as described in Section 4 below. There, our modelling strategy is to take as given not the outcome, but the rules of operation of the legislature governing agenda-setting and voting. A key prior question is whether there exist alternatives $x \in X$ which are Condorcet winners, and it is to this issue that we now turn.

## 3. When Do Condorcet Winners Exist?

Our space of alternatives is multi-dimensional, and so one might conjecture that in general, no Condorcet winner (CW) will exist in $X$. In fact, in the special case of our model without externalities, it is well-known that under weak conditions, there is no[8] Condorcet winner

[6] This is obviously in contrast to expenditure decisions, which are allowed to be non-uniform. Empirically, taxes levied by central government are uniform in the sense that rates do not vary by region; one reason for this convention may be to protect minority regions from expropriation.

[7] Of course, if voters in a region had differing preferences over projects, then the choice of delegate would be non-trivial, and some explicit modelling of the procedure for the selection of a delegate would be appropriate. This issue is pursued in Besley and Coate(1998).

[8] Ferejohn, Fiorina, and McKelvey(1987) also prove a positive result, namely that there is an $x^* \in X^n$ which beats all $y \in X^n$ that beat the status quo, and moreover, that this CW is the proposal that funds

in $X$ (Ferejohn, Fiorina, and McKelvey(1987)). Our main finding in this section is that the Ferejohn-Fiorina-McKelvey result generalizes to the case of negative or weakly positive externalities, but that the case of strongly positive externalities is quite different, with a unique CW.

We begin by defining a CW formally. Let the majority voting preference relation $R$ over pairs $(x, y)$ in $X$ be defined by

$$xRy \iff \#\{i \mid u_i^c(x) > u_i^c(y)\} \geq \#\{i \mid u_i^c(y) > u_i^c(x)\} \tag{6}$$

Then, $xRy$ indicates that $x$ cannot be defeated by $y$ in a majority vote, if voters who are indifferent between $x, y$ abstain. Say[9] that $x \in Y$ is a Condorcet winner in $Y \subseteq X$ if there exists an $x$ such that $xRy$, all $y \in Y$.

We now make four assumptions. The first is very weak; it simply says that each region derives a greater benefit from its project than the benefit it generates for any other region;

A0: $b_i > e$, $i \in N$

Now w.l.o.g, order the regions by increasing cost. The second assumption is that no two regions have the same cost i.e.

A1: $c_1 < c_2 < \ldots < c_n.$

Next, define $M = \{1, \ldots m\}$, with $m = (n+1)/2$; so $M$ is the "minimum winning coalition" of regions with lowest costs. So, $x^M$ is the policy that funds projects in these regions only. Define the status quo to be a situation with no project in any region, described by $0 \in X$. Our final assumption says that all $i \in M$ strictly prefer $x^M$ to the status quo 0. Formally;

A2: $b_i - \frac{1}{n}\sum_{j \in M} c_j + (m-1)e > 0$, $i \in M$

The fourth assumption is only needed in a special case, and its role is further discussed in Example 1 below.

A3: Suppose that $c_{k+1}/n > e \geq c_k/n$ for some $k < m$. Let $K = \{1, \ldots k\}$ and $L \subset N$ with $l = \#L$. If $l > n + k - m$, then for some $S \subset L/K$ with $\#S = m - k$, all $i \in S$ prefer $x^K$ to $x^L$ i.e. $b_i + (l-1)e - \frac{1}{n}\sum_{i \in L} c_j < ke - \frac{1}{n}\sum_{i \in K} c_j$, $i \in S$.

Also, for neater statement of results, define a number $c_{n+1} = \infty$. Our result[10] on the existence of CWs is then the following.

**Proposition 1.** Assume that A0-A2 hold. (i) If $e < c_1/n$, then there exists no Condorcet winner in $X$. However, $x^M$ is the unique Condorcet winner in the set of those alternatives that are not beaten by the status quo, $Y = \{x \in X \mid xR0\}$. (ii) If $c_{k+1}/n > e \geq c_k/n$ for some $n \geq k \geq m$, then $x^K$, $K = \{1, 2, \ldots k\}$ is the unique Condorcet winner in $X$. (iii) If $c_{k+1}/n > e \geq c_k/n$ for some $1 \leq k < m$, and in addition A3 holds, then $x^K$, $K = \{1, 2, \ldots k\}$ is the unique Condorcet winner in $X$.

project in a bare majority of regions with the lowest costs. This result carries over to our model - see Proposition 1(i).

[9] Also, define $xPy \iff \#\{i \mid u_i^c(x) > u_i^c(y)\} > \#\{i \mid u_i^c(y) > u_i^c(x)\}$. Note that if the Condorcet winner $x$ is unique, then we must have $xPy$ for all $y \in Y$; that is, $x$ defeats all $y \neq x$ in a majority vote.

[10] This and all subsequent results are proved in the Appendix, when proof is required.

So, if externalities are negative or weakly positive ($e < c_1/n$), our result is a simple extension of Ferejohn, Fiorina, and McKelvey(1987). By contrast, however, if externalities are strongly positive and large enough ($e \geq c_m/n$), a CW exists. Moreover, this CW will typically involve funding projects in more than a bare majority of regions; indeed, if $e \geq c_n/n$, the CW funds projects in all regions (universalistic provision).

In the intermediate case, ($c_m/n > e \geq c_1/n$), the picture is more complicated. Under an additional assumption A3, we have a unique CW, but now projects are only funded in a minority of regions (and possibly only one!).

The intuition for these results is as follows. First, when externalities are negative or only weakly positive ($e < c_1/n$), then the proposal $x^M$ that gives projects to the minimum winning coalition with lowest costs cannot be a CW, as it is beaten - for example - by a proposal that only gives a project to the $k < m - 1$ lowest-cost regions. But, any such proposal imposes a net cost on a majority of regions, and so is then beaten by the status quo.

When externalities are strongly positive ($e \geq c_m/n$), this intransitivity is avoided, as even regions that do not get projects prefer $x^M$ to some proposal that gives projects to fewer regions: In the intermediate case, the reasoning is more subtle. In the standard case with $e = 0$, any proposal that funds projects in a minority of regions cannot be a CW, as it is defeated by the status quo. However, with intermediate externalities, all regions may prefer the funding of projects in a few very low-cost regions to the status quo.

This intuition can be clarified by considering the following example. This example also shows why A3 is required; in the intermediate case we may generally have no Condorcet winner, even relative to those alternatives that beat the status quo.

**Example 1.**

Assume $n = 3$, and $c_2/3 > e > c_1/3$. It is easy to show that there may be no Condorcet winner, even if we restrict our attention to the set of those alternatives that are not beaten by the status quo, $Y = \{x \in X \mid xR0\}$.

Not counting the status quo, there are seven subsets of $N$ and so seven possible alternatives in $X$. However, using assumption A0, $\{1,2\}$ is strictly preferred by 1 and 2 to $\{1,3\}$ and $\{2,3\}$. Also, $\{1\}$ is strictly preferred by 1 and 3 to $\{2\}$, and $\{1\}$ is strictly preferred by 1 and 2 to $\{3\}$. So, we only need consider $K = \{1\}, M = \{1,2\}$ and $N = \{1,2,3\}$. Now,

$$u_1^K = b_1 - \frac{c_1}{3} > 0 \text{ (by A0)}$$
$$u_i^K = e - \frac{c_1}{3} > 0; \ i = 2, 3$$

So, $x^K \in Y$ i.e. it beats the status quo. Also,

$$u_i^M = b_i + e - \frac{(c_1 + c_2)}{3} > 0; \ i = 1, 2 \text{ (by A2)}$$
$$u_3^M = 2e - \frac{(c_1 + c_2)}{3} < 0$$

Again, $x^M \in Y$. Also, note that $u_1^K - u_1^M = u_3^K - u_3^M = c_2/3 - e > 0$, so $x^K P x^M$.

Finally,

$$u_i^N = b_i + 2e - \frac{(c_1 + c_2 + c_3)}{3}; \ i = 1, 2, 3$$

Also, note that $u_1^M - u_1^N = u_2^M - u_2^N = c_3/3 - e > 0$, so $x^M P x^N$. Now assume that

$$b_2, b_3 > \left(e - \frac{c_1}{3}\right) - \left(2e - \frac{(c_1 + c_2 + c_3)}{3}\right) \tag{7}$$

Then, from (7), we see that

$$u_i^N = b_i + 2e - \frac{(c_1 + c_2 + c_3)}{3} > e - \frac{c_1}{3} = u_i^K > 0$$

So, we conclude that $x^N \in Y$ and that $x^N P x^K$. So, we have a cycle $x^K P x^M P x^N P x^K$, where each alternative in the cycle beats the status quo. We conclude that there exists no CW in $Y$, as claimed. ∥

The example also makes clear however, that the only way that this cycle can be avoided is by making either $b_2$ or $b_3$ less than $\left[e - \frac{c_1}{3}\right] - \left(2e - \frac{(c_1+c_2+c_3)}{3}\right)$. For then, two out of three delegates would then prefer $x^K$ to $x^N$, and the cycle would be broken, making $x^K$ the CW.

In fact, the role of A3 is that it makes exactly this restriction in the general case. To see this, note that in the example, $k = 1, m = 2$, and $n = 3$; so the only relevant set $L$ is $L = N$ ($l > n + k - m$ implies $l > 3 - 1 = 2$, implying $l = 3$). Also, if $S \subset L/K$ and $\#S = m - k$, then we must have $S \subset \{2, 3\}$ and $\#S = 1$ implying $S = \{2\}$ or $S = \{3\}$. So, A3 requires that

$$b_i + 2e - \frac{(c_1 + c_2 + c_3)}{3} < e - \frac{c_1}{3},\ i = 2 \text{ or } 3 \tag{8}$$

which of course is equivalent to the converse of (7) for $i = 2$ or $i = 3$. It remains to check that A3 is consistent with A2. It is easy to check that if (8) holds for $i = 2$, it would violate A2. But A2 does not place any restriction on $b_3$, so we can always choose $b_3$ so that (8) holds.

## 4. Legislative Rules and Endogenous Agenda Equilibrium

Proposition 1 above makes it clear that unrestricted majority voting over alternatives in $X$ in the legislature will lead to voting cycles unless externalities are positive and large enough ($e \geq c_1/n$). So, in order to ensure a determinate outcome in this case, we need to specify some minimal rules of procedure for the legislature. Rules of procedure specify how proposals get on the agenda, what amendments (if any) may be put against them, and when voting takes place.

It turns out that some quite unrestrictive rules lead to a unique equilibrium outcome. The key rule is that the status quo must be privileged, in the sense that any amended motion is only passed if it defeats the status quo in a final round of voting. This rule is one that is used in the US Congress (Ordeshook(1986)).

The order of events is as follows.

1. Proposals

Any delegate $i$ can propose any motion $a^i \in X$ as an alternative to the status quo.

2. Agenda Formation

All the motions made by the delegates are incorporated into an agenda. Motions proposed by delegates $i = 1, \ldots n$ are put on the agenda in a random order, with the final item on the agenda being the status quo. Formally, a permutation function $\pi : N \to N$ is selected randomly from $\Pi$, the set of all such functions, with probability[11] $p_\pi > 0$. Given $\pi$, an agenda is an $n + 1 -$ tuple $y = (y^1, y^2, y^j \ldots y^n, 0)$, where $y^i = a^{\pi(i)}$.

3. Voting

Voting on the agenda is as follows. The first and second motions $y^1, y^2$ are voted on, the winner is paired with $y^3$, and so on, until finally the winner after $n - 1$ rounds of pairwise voting (the amended motion) is paired with the status quo, 0; and there is a final vote for the amended motion against the status quo. [If the motion on the floor and the newest amendment get equal numbers of votes, the tie-breaking rule selects the motion on the floor.]

This procedure is rather general in two senses. First, we allow for endogenous formation of agendas. Second, the structure of the agenda is very general; the only restriction is that the items on the agenda are compared pairwise (the agenda is binary[12]), and the last item is the status quo.

Steps 1-3 above describe an extensive-form game played by the delegates. We suppose that delegates have Von-Neumann-Morgenstern preferences over risky outcomes, and we place the following weak restrictions on strategies: (i) indifferent voters abstain at all decision nodes in the voting subgame; (ii) weakly dominated strategies are not played in the voting subgame. Call any subgame-perfect equilibrium of the above game that satisfies (i) and (ii) an endogenous agenda equilibrium.

Building on results by Fiorina, Ferejohn, and McKelvey, we can show that given assumptions A0-A3, although the endogenous agenda equilibrium is not unique, there is a unique equilibrium outcome[13], independent of the ordering of the proposals $\pi$: Specifically, let

$$C = \begin{cases} M & \text{if } e < c_1/n \\ K = \{1, \ldots k\} & \text{if } c_{k+1}/n > e \geq c_k/n,\ k \in N \end{cases}$$

**Proposition 2.** If A0-A3 hold, in any endogenous agenda equilibrium, at least one $i \in C$ proposes the motion $x^C$. Consequently, whatever $\pi \in \Pi$, the unique endogenous agenda equilibrium outcome is $x^C$.

This result is essentially a generalization of Ferejohn, Fiorina, and McKelvey(1987), in a setting which allows for endogenous agenda formation, as in McKelvey(1986).

Proposition 2 has the following striking implications. First, the set of projects undertaken in equilibrium is independent of the local benefits $b_i$ of the projects (subject to A2 and A3 being satisfied). This makes precise the idea, expressed in Oates(1972), that centralization means that decisions are less responsive to regional preferences.

[11] These probabilities need not be equal.

[12] An agenda is binary if at every stage, voters vote between two alternatives, alternatives being subsets of the space of alternatives.

[13] Both the equilibrium and the equilibrium outcome are defined formally in the Appendix.

Second, the proportion of regions obtaining projects, $\lambda = c/n$ depends on the size of the spillover $e$; as shown in Figure 2.

Figure 2 in here.

When $e$ is positive and large enough, we clearly have universal provision of projects, whereas $e$ is small or negative, we have only provision to a majority. So, although formally, voting in the legislature is by majority vote (what Inman and Rubinfeld(1997a) call the "minimum winning coalition legislature"), the outcome may be similar to a legislature where there is implicit agreement to provide universal provision, as in Weingast(1979) and Niou and Ordeshook(1985). However, in our setting, this arises not though implicit cooperation, but through the fact that legislative rules allow for (partial) internalization of externalities.

Note finally that the proportion of projects funded, $\lambda$, is not monotonic in the size of the externality; when the spillover is of intermediate size, (i.e. in the range $[c_1/n, c_m/n)$), $\lambda$ actually falls. As remarked above, the intuition is that with intermediate externalities, all regions may prefer the funding of projects in a few very low-cost regions to the status quo, whereas when externalities are very low (or zero) the status quo can only be defeated by a "minimum winning coalition".

### 4.1. Centralization vs. Decentralization

Now that we have characterized the outcome of the political process with centralization, one way of thinking about the relative merits of centralization and decentralization is the following. By inspection of (3),(4), for a single region, the gain from decentralization can be written;

$$\begin{aligned} & u_i^d - u_i^c \\ = \; & [\max\{b_i - c_i, 0\} - x_i^C(b_i - c_i)] + [\frac{1}{n}\sum_{j \in C} c_j - x_i^C c_i] + [(d - x_i^D) - (c - x_i^C)] \end{aligned} \tag{9}$$

The three terms in (9) illustrate the gains from decentralization for each region in an illuminating way.

First, the term

$$\max\{b_i - c_i, 0\} - x_i^C(b_i - c_i) \geq 0$$

reflects the efficiency gain, due to additional responsiveness to regional project benefits, that comes with decentralized provision.

Second, the term

$$\frac{1}{n}\sum_{j \in C} c_j - x_i^C c_i$$

is the share of aggregate cost borne by $i$; minus the true economic cost of $i$'s project, under centralization. This term captures the distributional impact of moving to decentralised funding taking as given the set of projects that are funded.

The third term

$$(d - x_i^D) - (c - x_i^C)$$

measures additional spillovers accruing to $i$ that arise with decentralization. Decentralization is inefficient here in the sense that project externalities are not internalized at all. Centralization may be more efficient as project externalities are partially internalized.

So, we might expect decentralization to be preferred when $e$ is small and/or regions are heterogenous, and centralization to be preferred when $e$ is large and/or regions are homogenous. We now turn to a more detailed investigation of this question.

## 5. Constitutional Design

At some initial constitutional design stage, regions choose between centralization and decentralization. In practice, constitutional (re)design occurs through the political process, via what Buchanan calls constitutional rules. Depending on the nature of the constitution, reallocation of tax and spending powers may be decided upon by ordinary legislation in a national parliament, or may[14] require formal constitutional amendment, which may in turn, require referenda. In unitary states, such referenda may be only national, such as the referendum in the UK to decide on membership of the EU. However, in truly federal states, constitutional amendment always requires, in some way or other, approval of a (super)majority the constituent states or regions[15].

In this model, as all voters in a given region are identical, and all regions have identical populations, constitutional rules of this type reduce to a simple regional referendum: regions (or their delegates) vote on the status quo versus the alternative, and the status quo is selected unless a proportion[16] of at least $\alpha$ of regions prefer the alternative. We focus on two special cases; ordinary majority rule ($\alpha = 0.5$), and unanimity rule ($\alpha = 1$).

A second dimension of constitutional choice is whether regions can make side-payments to one another at the constitutional stage. Again, we focus on two polar cases. One is that they cannot, and the other is that costless and binding side-payments are possible. In this second case, because payoffs are linear in the numeraire good, with unanimity rule, the constitutional arrangement that maximises the sum of utilities (welfare) will be chosen.

This case is a useful benchmark, as distributional considerations are irrelevant with welfare maximization; the most efficient constitutional arrangement will be chosen. So, we will consider, in the following order; unanimity with side-payments, unanimity without side-payments, and majority rule.

Finally, to avoid tedious discussion of "non-generic" cases, we assume that;

A4: $d \neq m \neq n; \; b_i \neq c_i; \; i \in N$

i.e. that the set of projects funded under decentralization is never $m$ or $n$, and that no region is indifferent about their project. We can now move to an analysis of the three cases.

[14] Constitutional amendments are used routinely in Switzerland, and less frequently in the US, Canada and Australia, to reallocate tax and spending powers (Wheare(1963)).

[15] Constitutional amendments in Australia and Switzerland require majority approval of the population as a whole, and also majorities is all the regions (cantons), but in the US, approval of a supermajority (3/4) of the states is required (Wheare(1963)).

[16] In the event of a tie , we assume that the status quo is selected, which we take w.l.o.g. to be decentralization.

### 5.1. Unanimity Rule with Side-Payments

From (9), summing over all regions, we see that the efficiency gain from decentralization is

$$W^d - W^c = \sum_{i \in N} [\max\{b_i - c_i; 0\} - x_i^C(b_i - c_i)] + (n - 1)(d - c)e \qquad (10)$$

Note that in the aggregate, the distributional gains and losses in (9) from cost-pooling net out. So, (10) tells us that the efficiency gain from decentralization can be decomposed into two parts. The first term in (10) captures the fact that decentralization is always more responsive to regional preferences, and is always non-negative. The second term captures the degree to which decentralization internalizes the spillover more fully than centralization, and may be positive or negative.

We then have the following result;

**Proposition 3.** Assume that A0-A4 hold. If there are no spillovers ($e = 0$), then decentralization is more efficient ($W^d > W^c$): If spillovers are large enough ($e \geq c_n/n$); then centralization is more efficient ($W^d < W^c$):

One might conjecture from this result that the gain to centralization would be everywhere non-decreasing in $e$: In fact, this is not the case, and is related to the non-monotonicity of the number of projects in $e$ discussed above. The following example makes this point.

**Example 2**

The example has three regions. Assumptions A0-A3 are assumed to hold, and it is assumed that $D = \{1\}$: Also, suppose initially $e < c_1/3$, so $C = \{1; 2\}$: Then

$$W^c - W^d = b_2 - c_2 + 2e$$

As $D = \{1\}$; $b_2 - c_2 = -\varepsilon < 0$. Let $2e > \varepsilon$; then $W^c > W^d$ i.e. centralization is strictly more efficient. Now let $e$ increase to $e'$, with $c_1/3 \leq e < c_2/3$. Then, if A3 is satisfied, $C = \{1\}$, so now $W^c = W^d$: But $b_3$ can always be chosen to satisfy A3, as the discussion following Example 1 makes clear. So, in this example, $W^c - W^d$ is not everywhere non-decreasing in $e$:□

As remarked above, one might also conjecture that if regions are homogenous enough, centralization will be more efficient than decentralization (assuming $e \neq 0$). In fact, this is not always the case; a centralized government may not select the "right" projects even when regions are homogenous, as illustrated by the following example.

**Example 3**

The example has three regions. Assumptions A0-A3 are assumed to hold. Regions are homogenous in the sense that every region has the same project benefit ($b_i = b$), and (bearing in mind A1) $c_1 > c_3 - \varepsilon$ for some small $\varepsilon > 0$: Also, externalities are weakly positive;

$$\frac{c_1}{3} > e > 0$$

So, by Proposition 1, with centralization, projects are undertaken in region 1,2 i.e. $C = \{1; 2\}$. Also, assume that $b \geq c_3$. So, with decentralization, all projects are undertaken i.e. $D = \{1; 2; 3\}$: Now note that

$$W^d - W^c = (b_3 - c_3) + 2e > 0$$

so that decentralization is clearly more efficient, no matter how small $\varepsilon$. □

The reason for this inefficiency is that with centralization, there is a cost-pooling externality discussed above, which (in the absence of a strong positive project spillover) implies that the "minimum winning coalition" will form. A majority group of regions with can reduce their costs by cutting the number of members of that group with projects, as long as membership exceeds $m$; even though it may be inefficient to cut these projects.

However, as Proposition 3 indicates, this example relies on externalities being weakly positive; if the externality is strong enough, centralization is always more efficient, whether regions are homogenous or not.

### 5.2. Unanimity Rule

Proposition 3 above shows that when the spillover is zero, decentralization is strictly more efficient than centralization, but when it is large and positive, the reverse is the case. One might conjecture that there must be some way of choosing the remaining parameters (the $b_i$ and $c_i$) so that all agents can share in the relevant efficiency gain i.e. so that decentralization is unanimously preferred when the spillover is zero, and centralization is unanimously preferred when it is large and positive. Surprisingly, it turns out that only half of this conjecture is true.

Say that the regions are $\varepsilon-$homogenous if there exists a number $\varepsilon$ such that

$$\left|b_i - \bar{b}\right| < \varepsilon;\ |c_i - \bar{c}| < \varepsilon, \text{ all } i \in N.$$

where $\bar{b} = \frac{1}{n}\sum_{i\in N} b_i$, and $\bar{c} = \frac{1}{n}\sum_{i\in N} c_i$ are average benefits and costs. We assume that $\bar{b} \neq \bar{c}$ i.e. average net benefit from the project is not zero. Note that this definition of homogeneity is consistent with A1 above. We then have;

**Proposition 4.** Assume A0-A4 hold. If externalities are strongly positive ($e > c_n/n$), then, there exists an $\delta > 0$ such that if the regions are $\varepsilon-$homogenous, with $\delta > \varepsilon$; then $u_i^c > u_i^d$, $i \in N$. But, even if $e = 0$; then $u_i^c > u_i^d$, some $i$.

Note first the striking result that even if there are no spillovers, some region will strictly gain from centralization, so the choice of decentralization can never be unanimous. This is because the gain though cost-pooling will always benefit some high-cost region.

Second, we see that with sufficient homogeneity across regions, and strongly positive externalities, centralization is Pareto-preferred. Note, however, that (as Example 3 makes clear) strongly positive externalities are required; in fact the combination of strongly positive externalities, plus homogeneity, means that centralization chooses the efficient set of projects (i.e. $N$ projects in all regions).

### 5.3. Majority Rule

With majority rule, (de)centralization is selected if (of the regions that are not indifferent) a majority strictly prefer (de)centralization. In this case, it is possible to find conditions, on the distribution of costs only[17], sufficient for decentralization to be chosen when project

[17] Plus a weak lower bound on the median benefit.

externalities are zero, and for centralization to be chosen when externalities are large. Say that the costs are "$\varepsilon$-homogenous" if there exists a number $\varepsilon$ such that

$$|c_i - \bar{c}| < \varepsilon, \text{ all } i \in N.$$

where $\bar{c} = \frac{1}{n}\sum_{i \in N} c$. Also, let $\beta_m$ be the median benefit in the distribution of benefits across regions. We have;

**Proposition 5.** Assume A0-A4 hold. If $e = 0$, and costs are sufficiently heterogenous ($c_1 < \frac{1}{n}\sum_{j=1}^{m} c_j$) then majority rule selects decentralization. If $e \geq c_n/n$, $\beta_m > \bar{c} - (m-1)e$; and there is a $\delta > 0$ such if costs are $\varepsilon$-homogenous, with $\delta > \varepsilon$, then majority rule selects centralization.

For the case of large positive externalities, this result can be contrasted with Proposition 4: whereas we needed homogeneity in both costs and benefits to get a result about unanimous preference, we need only homogeneity in costs and a weak condition on the median benefit to get a result about majority preference.

## 6. Some Extensions

### 6.1. Vote Trading

It is often asserted that legislators have an opportunity for "vote trading", that is, an agreement between two or more legislators for mutual support, even though it requires each to vote contrary to his real preferences on some legislation (Ordeshook(1986)). A standard way of modelling vote-trading is to suppose that legislators can form coalitions to coordinate their strategies. Associated with any coalition S is a characteristic function i.e. a set of feasible utility vectors for that coalition. In our model (given the agenda-setting and voting procedure 1-3 described in Section 4 above), the set of feasible utility vectors for S is defined as the set that S can guarantee themselves by coordinating their agenda-setting and voting behavior. Then, given the characteristic function, the core of the voting game can be defined, and a point in the core (if the core is non-empty) is an equilibrium with vote-trading.

Here, the characteristic function $v(.)$ takes a very simple form. If some set S of voters has $\#S \geq m$, then this coalition S can propose and vote though any $x \in X$. So, in this case, the members of S can guarantee themselves any feasible payoff. Consequently, the characteristic function is

$$v(S) = \{(v_i)_{i \in S} \,|\, v_i \leq u_i = u_i^c(x),\ \text{some } x \in X,\ \text{all } i \in S\}$$

If on the other hand, $\#S < m$, then member i of S can guarantee only $\underline{u}_i = \min_{x \in X} u_i^c(x)$, so in this case

$$v(S) = \{(v_i)_{i \in S} \,|\, v_i \leq \underline{u}_i,\ \text{all } i \in S\}$$

Say that $x^*$ is an equilibrium with vote-trading if there does not exist a coalition S and a $w \in v(S)$ such that $w_i \geq u_i^c(x^*)$, $i \in S$, with at least one strict inequality. Note that the set of equilibrium payoffs with vote-trading comprises the (strong) core.

The above game is simple majority-rule voting game (Ordeshook(1986)). In such games it is well-known that the strong core comprises the set of payoffs from Condorcet winners. From this, it follows that $x^*$ is an equilibrium with vote-trading iff it is a Condorcet winner. So, we have;

**Proposition 6.** Assume that A0-A3 hold. If $c_{k+1}/n > e \geq c_k/n$ for some $k \in N$; then $x^K$; $K = \{1; 2; ..k\}$ is the unique equilibrium outcome with vote-trading. If $e < c_1/n$, then there exists no equilibrium with vote-trading.

So, in the event that externalities are sufficiently positive, there is an equilibrium with vote-trading. Otherwise, no equilibrium exists.

This proposition has a striking implication. If $e \geq c_1/n$; the outcome with vote-trading is exactly the same as with no coordination between legislators. Specifically, coordination does not allow legislators to incorporate the benefits of projects into the political decision-making process. So, Propositions 3,4,5 of the previous section, concerning the relative efficiency of (de)centralization, continue to hold.

### 6.2. Alternative Models of Legislative Behaviour

We have focussed on the legislative model of Fiorina, Ferejohn and McKelvey(1987), which can be characterized as a two-stage process; first, a (binary) agenda is formed, and then voting takes place. The other leading model of legislative behaviour is the Baron and Ferejohn(1989) model of legislative bargaining, which has been applied to public finance issues by Baron(1989), Besley and Coate(1998), and Persson (1998). There are two problems with using the Baron/Ferejohn model in this context. First, the infinite-horizon model is analytically complex when regions are heterogenous[18], and perhaps for this reason, Besley and Coate(1998) and Persson (1998) both use a "one-shot" version of the model, where each legislator is chosen with probability $1/n$ to make a proposal which is then voted on in a pairwise comparison with the status quo, after which the game ends. This is both restrictive and unrealistic, as it does not allow other legislators to make amendments to the initial proposal.

A second problem with the Baron/Ferejohn model is that it is possible that even when a Condorcet winner exists, alternatives other than the CW alternative will be chosen in equilibrium. The reason is that (in the "one-shot" closed-rule version of the Baron/Ferejohn model) the legislator who is selected to make a proposal then chooses her proposal to maximise her payoff, subject to the constraint that at least $m - 1$ other legislators also prefer that proposal to the status quo, and the solution to this constrained maximization problem need not be a CW. In particular, the proposer may wish to grant herself a project, even though a majority of other delegates may prefer the proposer not to have a project. The following example illustrates this point.

**Example 4**

The example has three regions. Assumptions A0-A2 are assumed to hold. Suppose that $c_2/3 \leq e < c_3/3$, so that the CW is $x^C = (1; 1; 0)$: Now suppose that 3 is chosen as proposer.

[18] Baron and Ferejohn(1989) make heavy use of the assumption of identical agents in characterising the (subgame-perfect) equilibrium of the model.

Let $F$ be the set of projects he decides to fund[19]. Let $b_3 > c_3/3$; then, he will always prefer to fund his own project than not, even though this makes the other two regions worse off, as $c_3/3 > e$. So, 3 chooses[20] between $F = \{3\}, \{1,3\}, \{2,3\}, \{1,2,3\}$, subject to the constraint that one other delegate must prefer $F$ to the status quo. It is easily checked that $F = \{1,2,3\}$ is the solution to this problem as long as $b_1, b_2 > c_3/3$ also.$\|$

In general, however it is possible to show that this divergence between the CW outcome and the Baron/Ferejohn equilibrium outcome is negligible when n is large. The reason is that a region not in C can only enforce its will on the others when that region's delegate is proposer, which occurs with probability $1/n$. In fact, we have:

**Proposition 7.** *Assume that $e \geq 0$ and $b_i \geq c_i/n$, $i \in N$. Then, in the equilibrium of the Baron/Ferejohn model, any $i \in C$ receives a project with probability 1,Moreover, if $e \geq c_m/n$ or $e < c_1/n$, and any $i \notin C$ receives a project with probability 1/n.*

This result says that for large n, the "one-shot" version of the Baron/Ferejohn model gives us an outcome that approximates (in terms of expected payoffs) the outcome of the model presented in Section 4 above, except for the parameter range $c_m/n > e \geq c_1/n$ - which itself becomes negligible as n becomes large. So, with this qualification, results 3,4,5 will carry over to this alternative model.

### 6.3. Partial Decentralization

We have compared two polar cases of the possible allocation of powers, full decentralization and full centralization. However, as mentioned above, there are two intermediate alternatives which are worthy of mention. The first, and the empirically more common case, is where expenditure decisions are decentralized, but are financed by a national tax. In this case, the perceived cost of a project for region i is $c_i/n$, so the project will be selected if $b_i \geq c_i/n$. So, in this case, the cost spillover, or "common pool" problem leads to overprovision of projects, and the outcome is always less efficient than with full decentralization.

The other case is where expenditure decisions are centralized, but are financed by regional taxes. In this case, there is no cost-sharing. Without externalities, all regions $j \neq i$ will be indifferent about i's project, and so the outcome under full decentralization, $x^D$, will be a Condorcet winner. Consequently, when $e = 0$, the outcome is equivalent to full decentralization. If $e > 0$, on the other hand, all $j \neq i$ strictly prefer $x_i = 1$, so the alternative where all projects are funded ($x = (1, ...1)$) is the unique Condorcet winner. This is of course the uniform outcome that some have associated with decentralization studied by Oates(1972). Under some conditions, this outcome may be more efficient than full centralization (see for example, Example 3). However, in general, the outcome is insensitive not only to regional benefits (as is full centralization), but also to regional costs (unlike

[19] In the original Baron/Ferejohn model, proposers can also make side-payments to regions. Howoever, Besley and Coate(1998) use a variant of the Baron/Ferejohn model similar to this one, where side-payments cannot be made.

[20] In the original Baron/Ferejohn model, proposers can also make side-payments to regions. Howoever, Besley and Coate(1998) use a variant of the Baron/Ferejohn model similar to this one, where sdie-payments cannot be made.

full centralization). Consequently, there can be no presumption that this form of partial centralization is generally more efficient than full centralization.

## 7. Conclusions and Related Literature

This paper has presented a model where the relative merits of centralization and decentralization, and the performance of various constitutional rules for choosing between the two, can be evaluated. One key feature of the paper is that (in the centralized case), we present a fully explicit model of a national legislature, where legislative rules, rather than behaviour, are taken as primitive. This model is a generalization of the well-known model of distributive policy to the case of inter-regional externalities. An important finding is that the uniformity of provision is endogenously determined by the strength of the externality. When externalities are large and positive, an outcome closer to universalistic provision, rather than just a bare majority of funded projects, will occur. Second, there is likely to be greater consensus on the merits of the equilibrium set of projects when externalities are large i.e. a Condorcet winners may emerge. Moreover, this characterization of the behaviour of the legislature is robust to the introduction of logrolling, and of different specifications of the legislative rules.

This model allows to investigate in detail both the relative efficiency of and decentralization, and of the performance of various constitutional rules for choosing between them. In general, our analysis confirms Oates' insights that decentralization is preferred when externalities are small and/or regions are heterogenous, and centralization to be preferred under the reverse conditions. However, there are some more intriguing findings, which emerge due to the interaction of the strength of the externality and legislative behaviour.

For example, while centralization may be welfare-superior to decentralization when externalities are very large, over some range an increase in the strength of the externality may make decentralization more attractive. Second, sufficient conditions for a majority of the population to prefer centralization (or decentralization) can be formulated only with reference to the heterogeneity of costs, not benefits.

Some related literature has already been mentioned in the introduction. Here, we discuss in more detail the two papers that are most closely related to this one. Ellingsen's paper does provide an explicit model of political decision-making with centralization. However, his model has only two types of agent, one of which is more numerous than the other, and direct, rather than representative, democracy. So, with centralization, the more numerous type is effectively a dictator. Moreover, expenditure is on a pure (national) public good, so the strength of inter-regional externalities cannot be varied. (Ellingsen does discuss informally an extension to the case where goods produced by the two jurisdictions are not perfect substitutes, but does not present any results.) However, his results in Section 3.2 of his paper (which are comparable to this paper as they assume homogenous regions) have some of the flavour of Propositions 3-5 above.

The work much the closest to this one is the independent work of Besley and Coate(1998), which addresses the same issue - the choice between centralized and decentralised provision of regional public goods - in a political economy model. However, this paper and theirs are really complementary in the way that they view centralization. First, Besley and

Coate(1998) focus on the role of strategic voting for delegates to the legislature. Specifically, in their model, populations in regions are heterogenous, and any citizen may stand a candidate for election. So, voting in a delegate with a strong preference for public spending is a precommitment mechanism that allows that region to capture more of the available tax revenue for its own projects. This is a source of inefficiency with centralized provision. We abstract from this important issue in our model, by assuming that the population within any region is homogenous.

The second key difference is that Besley and Coate do not model all the rules of operation of the legislature explicitly. Specifically, they assume that each of the two delegates to the legislature (there are only two regions in their model) is selected with equal probability to be agenda-setter, and then the agenda-setter maximises the sum of his own payoff and the weighted payoff of the other delegate, where the weight $\mu$ is exogenously fixed at some value between zero and one[21]. By contrast, in this paper, we study a model where all the rules of operation of the legislature are explicit (and quite general). This really makes a difference; one of the key insights of our model is that the degree to which policy is universalistic rather than majoritairian (i.e.e the proportion of regions that get projects) depends crucially on the level of the project externality; the higher this is, the closer provision is to universalistic. This suggests that the comparative static exercises of Besley and Coate, where the size of the externality and the weight $\mu$ are varied independently. may not be consistent with a "micro-founded" model of the legislature[22].

Perhaps because we do not model the possibility of strategic voting or delegates, (and because projects are discrete rather than continuous), our model is also more general in some other important respects, while remaining analytically tractable. We have an arbitrary number of regions (where Besley and Coate have two), and can obtain analytical results for the case where regions differ in both project benefits and costs (in Besley and Coate, the two regions have the same costs, and most analytical results are obtained only for the case where the two regions also have the same benefits).

[21] This weight is a proxy for the outcome of a dynamic model of legislative bargaining, where implicit cooperation is possible.

[22] This key difference is reflected also in the results. For example, Besley and Coate find that the gain from centralisation is monotonically increasing in the size of the project externality (Proposition 2(i)), whereas from Example 2 above, we do not.

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# Appendix

## A. Appendix

### A.1. Endogenous Agenda Equilibrium

Here, we define formally and characterise the endogenous agenda equilibrium. First, it is possible to obtain the following characterization of the voting subgame:

**Lemma 8.** Under restrictions (i) and (ii) in the text, the subgame-perfect equilibrium outcome of the voting subgame is unique, and equal to $y_1^*$, where $y_i^*$ is recursively defined as follows, with $y_{n+1}^* = 0$:

$$y_i^* = \begin{cases} y_i & \text{if } y_i R y_j^*, \ \forall j > i \\ y_{i+1}^* & \text{otherwise} \end{cases} \quad \text{for } i = 1, ..n-1 \tag{A.1}$$

**Proof of Lemma 8**

Given the restrictions on strategies stated in the Lemma, and the fact that at any node, there only two alternatives, it is easy to check that (given unique continuation payoffs), the unique equilibrium strategy for a non-indifferent voter is to vote sincerely i.e. for his most preferred alternative. Also, in the event of a tie, the tie-breaking rule gives a unique outcome. It now follows by a backward induction argument that there exists a unique SPE in this voting subgame. Moreover, the outcome must be described as in the Lemma, by backward induction. $\blacksquare$

In the voting literature, $y_i^*$ is known as the sophisticated equivalent of $y_i$. So, (A.1) says that if $y_i$ cannot be beaten by all the sophisticated equivalents of proposals further down the agenda (including the status quo), $y_i$ is its own sophisticated equivalent.

Thus, conditional on $y$, this subgame generates a unique outcome, implying that a map from an agenda $y$ to the outcome, $y_1^* = z(y)$ can be constructed. Also, let $y(a, \pi)$ be the unique map from a vector of motions $a = (a_1, .a_n)$ to an agenda $y$ given a permutation $\pi$. So, the map from a vector of motions $a$ to an outcome is

$$y_1^* = z(y(a, \pi)) = \sigma(a, \pi)$$

Consequently, given this map, we may then write utility of agents over proposed agendas as

$$u_i(a_1, ..a_n, \pi) \equiv u_i^c(\sigma(a_1, ..a_n, \pi))$$

So, we can define

$$v_i(a_1, ..a_n) = \sum_{\pi \in \Pi} p_\pi u_i(a_1, ..a_n, \pi) \tag{A.2}$$

We can now formally define:

**Definition.** An endogenous agenda equilibrium is an n-tuple $(a_1^*, ...a_n^*)$, such that $v_i(a_i^*, ..a_{-i}^*) \geq v_i(a_i^0, ..a_{-i}^*)$, all $a_i^0 \in A$.

**Definition.** An $x^* \in X$ is an outcome of an endogenous agenda equilibrium conditional on $\pi$ if $x^* = \sigma(a_1^*, ...a_n^*, \pi)$, where $(a_1^*, ...a_n^*)$ is an endogenous agenda equilibrium.

## A.2. Proofs of Propositions

### Proof of Proposition 1

(i) For any $K \subset N$, define $v(K)$ as

$$v(K) = ke - \frac{1}{n}\sum_{j \in K} c_j$$

Also, define

$$w(j) = ej - \frac{1}{n}\sum_{i=1}^{j} c_i$$

So, $v(K) \leq w(k)$, with equality iff $K = \{1, \ldots k\}$. Consequently, if

$$\frac{c_{j+1}}{n} > e \geq \frac{c_j}{n} \iff w(j) \geq w(l),\ l \neq j$$

with $w(j) > w(l)$ unless $e = c_j/n$; in which case $w(j) = w(j-1)$. Also, note that if $l > k > j$, or $l < k < j$; then $w(k) > w(l)$: These two properties say that $w(l)$ is quasi-concave in $l$ with a maximizer of $j$ (which is unique unless $e = c_j/n$; in which case $j - 1$ is also a maximizer). Finally, note that if $e < c_1/n$, $w(j) < 0$, all $j \in N$:

Now let $K, L \subset N$ be two sets, with $K = \{1, \ldots k\}$ so it comprises the $k$ lowest-cost regions, and $L$ arbitrary. Let $A = K \cap L$, $B = K \cup L$. Using the above results, we see that following a switch from $x^L$ to $x^K$, we have the following gains for all $i \in (N/L) \cup K = S$;

$$\begin{aligned} u_i^c(x^K) - u_i^c(x^L) &= v(K) - v(L) \geq w(k) - w(l),\ i \in N/B \qquad (A.3) \\ u_i^c(x^K) - u_i^c(x^L) &= [b_i - e + v(K)] - v(L) > w(k) - w(l);\ i \in K/A \\ u_i^c(x^K) - u_i^c(x^L) &= [b_i - e + v(K)] - [b_i - e + v(L)] \geq w(k) - w(l),\ i \in A \end{aligned}$$

(ii) Now let $c_{k+1}/n > e \geq c_k/n$; $k \geq m$. We will show that $x^K P x^L$, implying that $x^K$ is the unique CW. Note first that as $k \geq m$, then $\#S = s \geq m$. Then,we see from (A.3) that

$$u_i^c(x^K) - u_i^c(x^L) \geq w(k) - w(l),\ i \in S \qquad (A.4)$$

Now from the properties of $w(.)$; if $e > c_k/n$, and/or $l \neq j - 1$; then $w(k) > w(l)$. Consequently, from (A.8), $u_i^c(x^K) > u_i^c(x^L)$; $i \in S$ and consequently $x^K P y$, all $y \in X^n$.

If $e > c_k/n$, and $l = j - 1$, then there are two cases. First, if $L \neq \{1, \ldots j-1\}$, $v(L) > w(l)$, implying that

$$v(K) - v(L) > w(k) - w(l)$$

Consequently, all the inequalities in (A.3) hold strictly, and so again $u_i^c(x^K) > u_i^c(x^L)$; $i \in S$ and consequently $x^K P y$, all $y \in X$. Finally, if $L = \{1, \ldots j-1\}$, then it is easy to check that all delegates are indifferent between $x^K$ and $x^L$ except for $j$, who strictly prefers $x^K$. Again, $x^K P y$, all $y \in X$:

(iii) Now let $c_{k+1}/n > e \geq c_k/n$; $k < m$. Again, we show that $x^K P x^L$. If $s \geq m$, then the argument is as above. However, as $k < m$, it is now possible that $s < m$. This can occur iff $l > n + k - m$.

So, it is sufficient to show that $x^K P x^L$ for all $L \subset N$ with $l > n + k - m$. In turn, to show that $x^K P x^L$ in this case, it is certainly sufficient to show that $m - k$ of delegates $i \in N/S$ strictly prefer $x^K$ to $x^L$; for then, $m - k + s \geq m$ delegates overall strictly prefer $x^K$ to $x^L$. Now,

$$u_i^c(x^K) - u_i^c(x^L) = -(b_i - e) + v(K) - v(L); \ i \in N/S$$

So, A4 implies directly that $u_i^c(x^K) > u_i^c(x^L)$ for $m - k$ delegates in $N/S$, as required.

(iv) Now consider the case with $e < c_1/n$. We first show that $x^M$ is a Condorcet winner in $Y = \{x \in X \mid xR0\}$. First, $0 \in Y$ by definition, and by assumption A1, $x^M R0$.

Next, assuming $x^L \neq 0$, if $x^L R0$, it must be the case that $\#L = l \geq m$. First we show that delegates $i \in N/L$ always prefer 0 to $x^L$. To see this, note that following a switch from 0 to $x^L$, regions $i \in N/L$ have a net gain of at most $w(l) < 0$ in external benefit. So, regions $i \in N/L$ always lose from the switch. Now if $\#L < m$, delegates $i \in N/L$ are in the majority, implying $0Px^L$.

So, let $L \subseteq N$ be such that $\#L = l \geq m$. It is then sufficient to show that $x^M$ is preferred to any $x^L$. But, from the argument in (ii),

$$u_i^c(x^M) - u_i^c(x^L) \geq w(m) - w(l), \ i \in S$$

Now, from the properties of $w(.)$, $w(m) > w(l)$. So, all $i \in S$ prefer $x^M$ to $x^L$; and as $\#S \geq m$, it follows that $x^M R x^L$.

Finally, we need to show that there does not exist a Condorcet winner overall. To do this, in view of (ii), we only need show that (a) $x^M$ is not a CW in $X$; (b) no $z \in X/Y$ is a CW in $X$.

The proof of (a) is simple. Let $x^{\{1\}}$, $i \in M$, be the proposal which only funds the project in 1. Then obviously, the delegate from region 1 prefers $x^{\{1\}}$. Moreover, as $w(1) > w(m)$, all $i \in N/M$ also prefer $x^{\{1\}}$. As these delegates constitute a majority, so $x^{\{1\}} R x^M$, implying that $x^M$ is not a CW in $X$.

Also, (b) follows immediately from the fact that if $z \in X/Y$, $z$ is beaten by the status quo 0. ■

## Proof of Proposition 2

Note from (9) that if an agenda $y$ contains $x^C$, then the sophisticated equivalent of $y_1$ must be $x^C$: this is because from Proposition 1, $x^C$ beats both the status quo and anything that beats the status quo (See Ferejohn, Fiorina, and McKelvey(1987)). So, $x^C = z(y)$, and the map from a vector of proposals $a = (a_1, ..a_n)$ to an outcome is $x_1^* = \sigma(a; \pi) = x^C$ iff $a$ contains $x^C$.

(iii) We now claim that in any endogenous agenda equilibrium, $(a_1^*, ...a_n^*)$ must contain $x^C$. For suppose not: then the outcome must be some $x' \in Y = \{x \in X \mid xR0\}$. But for some $i \in M$, $u_i(x^C) > u_i(x')$ [otherwise, $i \in C$, $u_i(x^C) < u_i(x')$, all $i \in M$, which contradicts the definition of $x^C$ as a CW in $Y$]. So, by proposing $x^C$, some $i \in C$ can do strictly better than $u_i(x')$. ■

## Proof of Proposition 3

(i) When $e = 0$, $c = m$ so from A4, $c \neq d$. Then, as $c \neq d$, we have

$$\sum_{i \in N} [\max\{b_i - c_i, 0\} - x_i^C(b_i - c_i)] > 0$$

so (i) follows immediately from (10).

(ii) To prove (ii), note that we can write

$$W^c = \sum_{i \in C} (b_i - e + ne - c_i)$$
$$W^d = \sum_{i \in D} (b_i - e + ne - c_i)$$

Now, for $e \geq c_n/n$, $C = N$, so

$$W^c - W^d = \sum_{i \in N/D} (b_i - e + ne - c_i)$$

where $N/D$ is non-empty from A4. As $e \geq c_n/n$, and from A0; $b_i - e + ne - c_i > 0$ all $i \in N$, so $W^c > W^d$ as claimed. $\blacksquare$

**Proof of Proposition 4**

(i) First, if $e = 0$; all $i$ not in $C$ strictly prefer decentralization, as they no longer pay a share of other regions' costs, and only undertake their own project if the benefit is non-negative.

So, we focus on $i \in C$: From Proposition 1; $C = M$ as $e = 0$, so $i \in C/D = M/D$ only get a project with centralization. So, by A2, all $i \in M/D$ strictly prefer centralization: So, the only way in which decentralization could be Pareto-preferred is if $M/D = \emptyset$, i.e. if $M \subset D$. But then

$$\begin{aligned} u^d_m &= b_m - c_m \\ &< b_m - \frac{1}{m}\sum_{j=1}^{m} c_j \\ &< b_m - \frac{1}{n}\sum_{j=1}^{n} c_j \\ &= u^c_m \end{aligned}$$

i.e. the agent with the median cost strictly prefers centralization.

(ii) As $D = \{i \in N \mid b_i \geq c_i\}$, then for $\varepsilon$ small enough, recalling $\bar{b} \neq \bar{c}$ we see

$$D = \begin{cases} N & \text{if } \bar{b} > \bar{c} \\ \emptyset & \text{if } \bar{b} < \bar{c} \end{cases}$$

So, for $\varepsilon$ small enough,

$$u^d_i = \begin{cases} b_i - c_i + (n-1)e & \text{if } \bar{b} > \bar{c} \\ 0 & \text{if } \bar{b} < \bar{c} \end{cases}$$

Also, as $c_i \to \bar{c}$, $e > \bar{c}/n$ implies $e > c_n/n$ for $\varepsilon$ small enough. So, from Proposition 1, $e > \bar{c}/n$ implies $C = N$: So, for $\varepsilon$ small enough

$$u^c_i = b_i - c_i + (n-1)e$$

Now, by A4, $d \neq n$ so we are in the case where $\bar{b} < \bar{c}$. So, to show $u_i^c > u_i^d$, $i \in N$, we only need show that $b_i - c_i + (n-1)e > 0$. Now note that for $\varepsilon$ small enough,

$$A_i = b_i - \frac{1}{n}\sum_{j \in M} c_j + (m-1)e \tag{A.5}$$

$$< b_i - \frac{m}{n}c_i + (m-1)e + \varepsilon \tag{A.6}$$

$$= b_i - c_i + (n-1)e - (n-m)\left(e - \frac{c_i}{n}\right) + \varepsilon \tag{A.7}$$

Also, from A2, we must have $A_i > 0$. So, from (A.5), for $\varepsilon < (n-m)(e - \frac{c_i}{n})$; we have

$$b_i - c_i + (n-1)e > 0$$

as required. ∎

Proof of Proposition 5

(i) When $e = 0$, clearly all $i$ not in $C$ strictly prefer decentralization, as $\max\{b_i - c_i; 0\} > -\frac{1}{n}\sum_{j \in C} c_j$. As $\#C = m$, it suffices to find only one $i \in C$ who strictly prefers decentralization also, and we are done. Now note that by definition, $1 \in C$. So, combining this fact with $c_1 < \frac{1}{n}\sum_{j=1}^{m} c_j$ we see

$$u_1^d \geq b_1 - c_1 > u_1^c = b_i - \frac{1}{n}\sum_{j=1}^{m} c_j$$

So, 1 is the required region.

(ii) If $e \geq c_n/n$, then

$$u_i^c = b_i - \bar{c} + (n-1)e$$
$$u_i^d = \max\{b_i - c_i; 0\} + (d - x_i^D)e$$

By A4, $d \neq n \neq m$. Assume first that $n > dm$. Now, as $|c_i - \bar{c}| < \varepsilon$, if we choose $\varepsilon < e(n-d)$; then

$$\begin{aligned} u_i^c &> b_i - c_i + (n-1)e - \varepsilon \\ &> b_i - c_i + (d-1)e \\ &= u_i^d \end{aligned}$$

for all $i \in D$. So, a majority strictly prefer $C$.

Now suppose that $d < m$. Then for all $i \in D$; we can show that $u_i^c > u_i^d$ as before. Also, by definition of $\beta_m$ we can find $m - d$ members of $N/D$ with $b_i \geq \beta_m$. Let the set of such members be $S$.

$$\begin{aligned} u_i^c &> b_i - \bar{c} + (n-1)e - \varepsilon \\ &= b_i - \bar{c} + (n-1-d)e + de - \varepsilon \\ &\geq b_i - \bar{c} + (m-1)e + de - \varepsilon \\ &\geq \beta_m - \bar{c} + (m-1)e + de - \varepsilon, \; i \in S \end{aligned}$$

But by assumption, $\beta_m - \bar{c} + (m-1)e > 0$. So, for $\varepsilon$ small enough, $u_i^c > u_i^d = de$, $i \in S$. But then overall, a strict majority of regions prefer centralization. ■

## Proof of Proposition 7

By assumptions $b_i \geq c_i/n$ and $e \geq 0$, if any $i$ is agenda-setter, he will always prefer to give a project to his own region. Let $A_i$ be the set of "coalition members" that $i$ chooses when he is selected as proposer i.e. every $j \in A_i$ prefers $i'$s proposal to the status quo. Let $S = A_i \cup \{i\}$. Then $A_i$ must solve problem P, which is

$$\max_{A_i \subset N} b_i - \frac{1}{n}\sum_{j \in S} c_j + (\#S - 1)e$$

$$\text{s.t. } x_j^S b_j - \frac{1}{n}\sum_{j \in S} c_j + (\#S - x_j^S)e \geq 0, \; j \in A_i \tag{A.8}$$

$$\#S \geq m - 1 \tag{A.9}$$

There are then three cases.

(i) $e < c_1/n$. Here, $i$ can induce any $j$ to vote for $x^S$ only by offering $j$ a project, as without a project $j$ always prefers the status quo $(-\frac{1}{n}\sum_{j \in S} c_j + \#Se < 0$, all $S \subset N)$. So, $i$ will offer exactly $m-1$ other regions projects, and clearly these will be the ones with the lowest cost i.e. $A_i = \{1, \ldots m-1\}$. By A2, $\{1, \ldots m-1\}$ is feasible in P, and by the above argument, it clearly solves P.

(ii) $c_k/n \leq e < c_{k+1}/n$, $k < m$. In this case, ignoring the constraints (A.8),(A.9), $i$ would prefer to set $A_i = K = \{1, \ldots k\}$ (or $K = \{i\}$ if $i \in K$). Let $h > k$ be the largest integer such that

$$-\frac{1}{n}\sum_{j \in K \cup \{h\}} c_j + (k+1)e \geq 0$$

If $i \in H = \{1, \ldots h\}$, then if $i$ offers projects to regions in $K$, as well as a project in its own region, then every region gets a non-negative payoff from $x^S$, $S = K \cup \{i\}$, and thus $A_i = K$ is feasible in P. If $i > h$, $A_i = K$ is not feasible in P (i.e. externalities are not strong enough to induce regions who do not get projects to vote for $x^S$, $S = K \cup \{i\}$) and so $i$ must offer projects to the minimum winning coalition i.e. set $A_i = \{1, \ldots m-1\}$.

(iii) $c_k/n \leq e < c_{k+1}/n$, $k \geq m$. Here, $S = K \cup \{i\}$, by the previous argument.

By the above arguments, it is clear that whatever $e$, projects in $C$ are funded with probability one. Moreover, if $c_1/n \leq e$ or $c_m/n \leq e$, projects not in $C$ are funded with probability $1/n$ only. ■