Kosher Pork*

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Abstract

Both conventional wisdom and leading academic research view pork barrel spending as antithetical to responsible policymaking in times of crisis. In this paper we present an alternative view. When agents are heterogeneous in their ideology and in their information about the economic situation, allocation of pork may enable passage of legislation appropriate to a "crisis" that might otherwise not pass. Pork "greases the legislative wheels" not by bribing legislators to accept legislation they view as harmful, but by conveying information about the necessity of policy change, where it may be impossible to convey such information in the absence of pork. Pork may be used for this function in situations where all legislators would agree to forgo pork under full information. Moreover, when government has high pre-existing fiscal obligations (say from debt service) pork will be observed when the public good is *most* valuable precisely because the public good is valuable and the informed agenda setter wants to convey this information.

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1 Introduction

Pork-barrel spending given to specific groups or districts at general expense is commonly seen as simply benefitting the recipients while hurting everyone else. The public associates pork with "politics as usual" as lawmakers satisfy their love of earmarks meant to benefit their constituents. This is to be distinguished from responsible policy making, in which legislators put their love of pork aside in times of "crisis" that is, when specific public goods have very high social value.

In a brilliant and justly influential paper Battaglini and Coate (2008) present a model formally capturing this difference in policy-making regimes. Depending on the social value of public goods and on the level of outstanding debt, which determines pre-existing claims on revenues, the economy may be in either of two regimes. In BAU ("business as usual"), the agenda setter distributes pork to members of the (minimum winning) coalition. In contrast, in RPM ("responsible policy making"), when the social value of public spending is high and/or debt is high, no pork is distributed to reflect the combination of high value of public good spending and low "discretionary" revenue.

RPM is not surprising when there is general agreement on the high social value of public goods, that is, on the existence of a "crisis". Similarly, general agreement on public goods expenditure in a time of acknowledged crisis is possible when legislators are homogeneous in their preferences over spending. This is the assumption of Battaglini and Coate (2008): legislators are identical in their preferences, specifically having identical valuation of public goods expenditures in different states of nature; and they are equally informed and hence in agreement about the state of nature. Politics is entirely distributive, that is, determines who receives pork when there is (general) agreement on politics as usual. The known alternation of who has the spending power, combined with the possibility of adopting policy measures with less than unanimous legislative consent, leads to pork-barrel spending in non-crisis times, but no pork in crisis when spending on public goods is highly valued.[1].

However, the assumption of identical legislators, though analytically convenient, is not realistic. Even considering a single economic policy, legislators differ in their beliefs about

[1]The central role of "minimum winning coalitions" in this line of research is sometimes contrasted with "universalism" in the provision of pork (see, for example, Weingast [1979]). We follow much of the literature in assuming MWCs in a legislative equilibrium and not addressing the phenomenon of super-majority coalitions.

what the economic situation is, as well as in what they think is optimal policy in specific situations. Of course, this point is more general in economics, since the "representative agent" assumption is an approximation. For many questions, this assumption, though not strictly true, can be justified because the basic results are not changed by adding the complication of heterogeneity. Is that true in studying the political economy of pork barrel spending in legislative politics? That is, does the assumption of representative legislators – legislators who are identical in their policy preferences and information – matter qualitatively for studying the role of pork barrel spending in the legislative process?

The purpose of this paper is to address this question. Our principal conclusion is that it matters quite a bit.[2] We argue that introducing heterogeneity of the sort discussed in the previous paragraph significantly changes the qualitative results of the Battaglini and Coate model using homogeneous legislators who agree on the value of public good spending versus pork. Our heterogeneous-agent results are complementary to the homogeneous-agent results of Battaglini and Coate, but as we shall see, dropping the standard representative-agent assumption makes a big difference.

More concretely, suppose the agenda setter believes there is a crisis and thinks special legislation is called for, but other lawmakers with different preferences and information, do not agree. Passage of the legislation the agenda setter favors may require deal-making, that is, the agenda setter giving other legislators something in exchange for their support. Usually this may be thought of as *bribing* legislators to gain their support. However, differences in opinion about the current state suggest another, perhaps less obvious, sort of interaction to gain support. If the agenda setter has superior information about the state, she may use policy choice to try and *inform* other legislators about the state. If she uses pork to do so, information transmission seems conceptually different from bribing other legislators where their beliefs about the state are unchanged.

The informational role of pork when legislators are heterogeneous leads to a refinement of the BAU and RPM regimes. In BAU pork may go to all legislators ("complete BAU") or only some ("partial BAU"); in the latter case, the desire of the agenda setter to signal the state may lead to her getting no pork, with all pork going to coalition partners. This

[2] Baron and Diermeier (2001) consider a model of legislative bargaining where heterogeneity of legislators' preferences over policy plays a key role in explaining the composition and size of legislative coalitions (see the previous footnote). They assume agreement across legislators about the state of the world.

contrast with standard "divide-the-dollar" models of legislative bargaining, in which the agenda setter gets more pork than other coalition members.

More interestingly perhaps, we show that in situations of RPM under full information (such as large debt service obligations), asymmetric information will often lead to pork being given by the agenda setter to signal the state. Moreover, pork will be observed when the public good is *most* valuable, not when it is less valuable. That is, pork is not antithetical to "responsible policy making" but in fact crucial to policy being able to respond to a high valuation of the public good. Furthermore, this is not a pathological case but in fact appears to hold for parameter values describing actual economies.

We also argue that in the absence of pork (or some primarily distributive policy), analogous information transmission may not be possible. This result provides a comparison – and counterpoint – to Cukierman and Tommasi (1998a,1998b), in which the known ideological bias of the agenda setter, combined with asymmetric information, makes it impossible to adopt policy appropriate to the state of nature if it coincides with the agenda-setter's bias. The addition of pork to the policy menu may make it possible to adopt such policy in this situation.

The plan of the paper is as follows. In the next section we set out the basic model and the legislative process, as well as defining political equilibrium in the model. In section 3 we derive the political equilibrium under full information and characterize the various regimes. Section 4 presents the general characterization of an asymmetric information equilibrium and shows that when pork is restricted to be zero under asymmetric information there is no signaling of the state. In section 5, the conceptual heart of the paper, we demonstrate the informational role of pork both in BAU and in what would be RPM under full information. Section 6 presents conclusions.

2 Model

2.1 Set-up

Consider a legislature consisting of n districts, each with the following preferences over the consumption of private and public goods and leisure:

$$u\left(c^i, g\right) = c^i - \frac{h^{\frac{1}{\varepsilon}+1}}{\varepsilon+1} + \left(z + \alpha^i\right) v\left(g\right), \tag{1}$$

where g and c^i are the consumption of public and private goods, respectively and h is the supply of labor. $z + \alpha^i$ is a parameter that affects the marginal value of the public good to households and includes a term z that is identical across districts and another term α^i that is idiosyncratic to the specific district. $\alpha^i \in \{-\alpha, 0, \alpha\}$, with $\alpha > 0$, representing right-leaning, centrist and a left-leaning districts (where here "left" is defined as having a stronger preference towards the provision of public goods.) Let n^L n^C and n^R represent the number of districts of each type, with $n^L + n^C + n^R = n$. The households maximize utility over the following budget constraint:

$$c^i = (1 - \tau) h + s^i, \tag{2}$$

where τ are labor taxes, the pre-tax wage is equal to unity, and s^i are transfers from the central government (pork). The household's first order conditions give

$$h\left(\tau\right) = \left[\varepsilon\left(1 - \tau\right)\right]^{\varepsilon}, \tag{3}$$

which reflects the fact that distortionary taxes affect the supply of labor. (Though ε is literally the elasticity of labor supply, it primarily governs the extent to which taxes are distortionary, and could be interpreted more generally as the inefficiency inherent in the tax system.) Thus households' indirect utility over taxes, and private and public consumption is:

$$U\left(s^i, \tau, g; \alpha^i\right) = \frac{\varepsilon^{\varepsilon}\left[\left(1 - \tau\right)\right]^{\varepsilon+1}}{\varepsilon+1} + \left(z + \alpha^i\right) v\left(g\right) + s^i.$$

The first term is the sum of household's utility from consumption *net* of s^i (that is, $(1 - \tau) h$) and disutility of labor h. Note that this is only a function of τ and is identical across all individuals. Denoting this utility from leisure and the consumption financed by labor income

as $\hat{u}(\tau)(\equiv \frac{\varepsilon^{\varepsilon}(1-\tau)^{\varepsilon+1}}{\varepsilon+1})$, we may write indirect utility as

$$U\left(s^i, \tau, g; \alpha^i, z\right) = \hat{u}(\tau) + \left(z + \alpha^i\right) v(g) + s^i \tag{4}$$

2.2 Information structure

The values of α^i are common knowledge, but only the agenda setter observes z. She attempts to obtain the support of $m-1$ other legislators, with m representing the size of the minimum winning coalition to pass a policy.[3] Otherwise, a default policy is enacted. Let $n^R < m$ and $n^L < m$ so that no partisan legislator can pass legislation without the support of centrists. Other legislators do not observe z but have expectations based on a prior distribution $z \in \{\underline{z}, \bar{z}\}$ with probabilities $\{1-p, p\}$ respectively. Let $z^e \equiv p\bar{z} + (1-p)\underline{z}$ be the expected value of z prior to the legislative round.

Underlying this assumption on asymmetric information, one may argue that the drafter of legislation gains additional information about the state of the economy in the process of drafting legislation. Committee chairmen, who tend to be agenda setters on legislation in the purview of their committee, have the ability and tendency to allocate more attention to the analysis of policies, and the changing environment, of a specific policy area.

2.3 Political equilibrium

We consider the case with three legislators, with $n^R = n^C = n^L = 1$ and $m = 2$.[4] Suppose that the agenda setter is "left-wing" in that $\alpha^{AS} = +\alpha$.[5] It should be apparent that it is "cheapest" for her to build a coalition with the centrist (C) legislator. She proposes a policy $\left\{g, \tau, s^C, s^\alpha\right\}$. A feasible policy satisfies

$$g + s^C + s^\alpha \leq 3\tau h = R(\tau) - X \tag{5}$$

[3]For ease of exposition, the agenda setter will be female, the independent legislator male. The former assumption is often consistent with marital experience.

[4]When there are more than three legislators, the basic arguments are the same, though the coalition will include both leftists and centrists.

[5]We do not model how the agenda setter is chosen. She could be randomly chosen, with our analysis focusing on the information transmission problems when the agenda setter has a partisan bias.

where X denotes prior obligations which must be met (for example, debt service) and, for ease of exposition, we have used $h(\tau) = [\varepsilon(1-\tau)]^{\varepsilon}$ to denote government revenue as a function of τ as simply

$$R(\tau) \equiv 3\tau\varepsilon^{\varepsilon}(1-\tau)^{\varepsilon}$$

If support is not obtained, a status quo policy of $g = g^q, s^C = s^\alpha = 0$ is implemented (with τ^q given implicitly by $R(\tau^q) = g^q + X$).[6] To summarize, the agenda setter wants to choose a feasible policy that maximizes $\hat{u}(\tau) + (z+\alpha)v(g) + s^\alpha$ while ensuring the participation of the centrist, whose alternative is the status quo.

2.4 Status quo policy

The status quo policy thus affects the possibility of agreement and hence may influence the equilibrium even when agreement is reached. Though assuming a status quo that is highly "inappropriate" for a crisis may in fact be descriptive of the problem the agenda setter faces in convincing other legislators of the need for action, one may argue that arbitrary assumptions about g^q and τ^q may bias our results. (Moreover, in our eventual extension to a dynamic framework, the natural assumption is that the status quo policy is that chosen in the previous period.) We therefore assume that status quo policy is that which would be chosen by a social planner who does not know the value of z. In other words, the status quo solves

$$\tau^q = \arg\max_{\tau} \{\hat{u}(\tau) + z^e v\{R(\tau) - X\}\}.$$

2.5 Preferred policy

It is also useful at this point to denote the most preferred policy of any legislator in the absence of pork, namely

$$\tau^*(\zeta, X) = \arg\max_{\tau} \{\hat{u}(\tau) + \zeta v[R(\tau) - X]\}, \tag{6}$$

[6] Battaglini and Coate (and much of the literature) assume an alternative bargaining protocol in which the failure of the agenda setter to gain support for her proposal implies another round of bargaining in which another legislator is randomly chosen to make an offer. However, the equilibrium in their paper would not change if they used the protocol we use here given their assumptions on legislator homogeneity.

where we note that $\tau^*(\zeta, X)$ is increasing in both ζ and X.[7]. This equation may be solved for

$$\mu(\tau^*(\zeta, X)) = \zeta v_g [R(\tau^*(\zeta)) - X] \tag{7}$$

where $\mu(\tau^*(\zeta, X))$ is the marginal cost (per legislator) of raising a unit of tax revenues, defined as

$$\mu(\tau) \equiv -\frac{\hat{u}_\tau(\tau)}{R_\tau(\tau)} = \frac{1-\tau}{3(1-\tau-\varepsilon\tau)},$$

With this notation in hand, the status quo is simply

$$\tau^q = \tau^*(z^e, X). \tag{8}$$

For future exposition note that this implies that

$$\tau^*(\bar{z}, X) > \tau^q > \tau^*(\underline{z}, X) \tag{9}$$

3 Full Information

As a benchmark and to as an aid in understanding the possible informational role of pork, we begin with the case of full information.

3.1 Political equilibrium under full information

3.1.1 The agenda-setter's optimization problem

In a political equilibrium under full information, consider the problem of the agenda setter α, when the value of z is known to all. We illustrate with the case of the agenda setter when the state is known to be $\underline{z}$. (This will also be the relevant analysis in a separating equilibrium when $z = \underline{z}$.) The analysis when the state is known to be $\bar{z}$ is analogous, with $\bar{z}$

[7] $\tau^*(\zeta)$ solves the equation

$$v'(R(\tau^*(\zeta, X) - X)) \frac{1-\tau^*(\zeta, X) - \varepsilon\tau^*(\zeta, X)}{1-\tau^*(\zeta, X)} = \frac{1}{3\zeta}.$$

$\tau^*(\zeta, X)$ is increasing in ζ and in X.

replacing $\underline{z}$ in the relevant equations. The agenda setter proposes legislation that maximizes

$$\max_{g,\tau,\{s^i\}} \hat{u}(\tau) + (\underline{z} + \alpha) v(g) + s^{\alpha} \tag{10}$$

$$\hat{u}(\tau) + \underline{z} v(g) + s^{C} \geq \hat{u}(\tau^q) + \underline{z} v(g^q), \tag{11}$$

$$\hat{u}(\tau) + (\underline{z} + \alpha) v(g) + s^{\alpha} \geq \hat{u}(\tau^q) + (\underline{z} + \alpha) v(g^q), \tag{12}$$

$$g + s^{C} + s^{\alpha} \leq R(\tau) - X, \tag{13}$$

$$s^{C} \geq 0 \tag{14}$$

$$s^{\alpha} \geq 0 \tag{15}$$

(11) is the participation constraint of the centrist, while (12) is the "participation constraint" of the agenda setter, which will be useful in considering signaling under asymmetric information. It can be shown that under full information (12) is always slack and (11) is always binding in equilibrium. (14) and (15) are the non-negativity constraints which will be useful in characterizing whether the equilibrium is BAU or RPM.

Then the first order conditions of this problem are given by:

$$\left[\underline{z}\left(1 + \phi^{C}\right) + \alpha\right] v_g(g) = \lambda, \tag{16}$$

$$\left(1 + \phi^{C}\right) \mu(\tau) = \lambda, \tag{17}$$

$$1 + \varsigma^{\alpha} = \lambda, \tag{18}$$

$$\phi^{C} + \varsigma^{C} = \lambda, \tag{19}$$

where λ is the multiplier on (13); ϕ^C on the participation constraint of the the centrist; and ς^{α} and ς^{C}on the non-negativity constraints on pork for the agenda setter and the centrist, respectively.

3.1.2 Types of full-information equilibrium

We have different possible types of equilibrium, depending on parameter values α, $\bar{z}$, and $\underline{z}$. We assumed that that status quo policy is that which would be chosen by a social planner

given the expected value of z, i.e. $\tau^q = \tau^*(z^e, X)$. This means the bounds in (9) must hold, so that there are three cases to consider, namely

$A)$ $\tau^*(\bar{z}+\alpha, X) > \tau^*(\bar{z}, X) > \tau^q > \tau^*(\underline{z}+\alpha, X) > \tau^*(\underline{z}, X)$

$B)$ $\tau^*(\bar{z}+\alpha, X) > \tau^*(\bar{z}, X) > \tau^*(\underline{z}+\alpha, X) > \tau^q > \tau^*(\underline{z}, X)$

$C)$ $\tau^*(\bar{z}+\alpha, X) > \tau^*(\underline{z}+\alpha, X) > \tau^*(\bar{z}, X) > \tau^q > \tau^*(\underline{z}, X)$

In case A there is no conflict of interest between the left-wing agenda setter and the centrist because the difference between $\bar{z}$ and $\underline{z}$ is large and dominates: when $z = \bar{z}$ both want taxes (and government expenditures) higher than in the status quo and when $z = \underline{z}$ both want taxes (and government expenditures) lower than in the status quo. Under asymmetric information, the direction of the tax change would reveal the state, and pork plays no interesting role.

Key to case B is that the difference between $\bar{z}$ and $\underline{z}$ is still large enough to dominate ideology. $\alpha < \bar{z} - \underline{z}$, so that the difference in preferred policy between the states exceeds the ideological difference between the agenda setter and the centrist. It may be possible to signal even without pork.

The interesting case is case C, which differs from case B in that here $\alpha > \bar{z} - \underline{z}$. That is, the ideological difference between the agenda setter and the centrist exceeds the difference in preferred policy between states ("ideology dominates policy"). It is interesting because pork may enable signaling the state (and hence be "kosher"), while only a pooling equilibrium is possible when no pork is available.[8]

The parameter values such that case C obtains, similarly puts limits on the ranking of marginal cost of taxation (equivalent for all legislators) and the marginal benefit of public goods in the status quo (which differs across legislators). For example, when $z = \underline{z}$, the following ranking must obtain:

$$\underline{z} v_g\left(R\left(\tau^q\right) - X\right) < \mu\left(\tau^q\right) < \left(\underline{z} + \alpha\right) v_g\left(R\left(\tau^q\right) - X\right), \tag{20}$$

It is crucial to note that these relative magnitudes are *fixed* by the assumption that $\alpha > \bar{z} - \underline{z}$,

[8] Case C is the Cukierman and Tommasi (1998) environment. There the ideological bias of (for example) a left-wing policymaker implied she wanted to change policy in her desired direction even if there was no change in the state of the world. She has no way of signaling that the changed state of the world calls for a leftward policy shift, so that she is unable to enact socially optimal policy. This is exactly the problem here where no pork is availale.

but the absolute magnitudes are not and will determine the nature of the equilibrium. The absolute magnitudes will depend on the parameters X and ε, which therefore determine the nature of the equilibrium. This full-information characteristic parallels Battaglini and Coate (2008) when X represents preexisting debt-service which determines whether the economy is in BAU and RPM.

Two reference magnitudes are critical. The first is 1, which is the marginal value of a unit of pork. When $\underline{z}v_g\left(R\left(\tau^q\right)-X\right)>1$ then for the centrist (and hence for the left-wing agenda setter as well) the value of an additional unit of public goods in the status quo allocation exceeds that of an additional unit of pork. The value of $\mu\left(\tau^q\right)$ relative to 1 determines the relative magnitudes of the marginal cost taxation and the marginal value of pork under the status quo policy. When $\mu\left(\tau^q\right)>1$, *no* pork will be provided in the full-information political equilibrium and we are in RPM. When $\mu\left(\tau^q\right)<1$, pork *may* be provided in equilibrium. The second critical value is $\frac{1}{2}$, which is the value of a unit of pork if split equally between coalition members. Its importance will be clear shortly – it will be important in whether both legislators get pork in equilibrium ("complete" BAU) or only one ("partial" BAU).

The importance of the values 1 and $\frac{1}{2}$ may be illustrated as follows. Consider first the following ranking (consistent with a high X)

$$1<\underline{z}v_g\left(R\left(\tau^q\right)-X\right)<\mu\left(\tau^q\right)<\left(\underline{z}+\alpha\right)v_g\left(R\left(\tau^q\right)-X\right). \tag{21}$$

It should be clear that under this ranking, the only possible legislative outcome is the status quo τ^q. On the margin, the agenda setter would like to increase taxes to finance the public good. The marginal value of the public good is higher from her perspective than the marginal cost of taxation, and both are higher than the marginal value of pork–even if the entire unit of pork were allocated only to her district. However, convincing the centrist to increase taxes requires either an increase in the public good or an increase in pork for the centrist (as (11) shows). But both the marginal value of pork and the marginal value of the public good are lower than the marginal cost of taxes, from the perspective of the centrist. Thus no combination of public goods and pork can convince the centrist to acquiesce to an increase in taxation. Thus, the equilibrium under (21) is RPM (no-one gets pork), with $\tau=\tau^q$. The same argument holds if

$$\underline{z}v_g\left(R\left(\tau^q\right)-X\right)<1<\mu\left(\tau^q\right)<\left(\underline{z}+\alpha\right)v_g\left(R\left(\tau^q\right)-X\right).$$

In contrast, consider the case in which

$$\underline{z}v_g\left(R\left(\tau^q\right)-X\right)<\mu\left(\tau^q\right)<1<\left(\underline{z}+\alpha\right)v_g\left(R\left(\tau^q\right)-X\right). \tag{22}$$

Under this ranking, the equilibrium will involve both a change in expenditures and taxation *and* pork to the centrist. Pork *may* also be provided to the agenda setter. To see why, notice again that the agenda setter would like to increase taxes, as the marginal value of the public good and pork are both greater than the marginal cost of raising revenues, from her perspective. The difficulty is that the centrist would not support an increase taxes if all new revenues are allocated to the public good. The marginal value of the public good is lower than the marginal cost of taxation, from his perspective. However, the marginal value of pork is larger than the marginal cost of raising a dollar of revenues. Thus, agreement on a policy change may be possible.

Specifically, if the agenda setter increased taxes on the margin to raise one unit of revenues and allocated a fraction ∂g to public goods and the remaining $1-\partial g$ for pork to bribe the centrist. Then ∂g must satisfy

$$\underline{z}v_g\left(g^q\right)\partial g+1-\partial g-\mu\left(\tau^q\right)\geq 0$$

to gain the support of the centrist. As the agenda setter would like to give the minimal amount of pork required to obtain the centrist's support, we have

$$\partial g=\frac{1-\mu\left(\tau^q\right)}{1-\underline{z}v_g\left(g^q\right)}.$$

Note that this equation reaffirms the ranking in (22). If $\mu\left(\tau^q\right)>1>\underline{z}v_g\left(g^q\right)$ then $\partial g<0$, implying that the centrist requires more than one unit of pork to support a unit increase in taxes, making political agreement impossible. Similarly, if $\mu\left(\tau^q\right)>\underline{z}v_g\left(g^q\right)>1$ then $\partial g>1$, indicating that the centrist would demand an increase of more than one unit in the public good to support an unit increase in taxes, making political agreement impossible again.

Let us now consider the utility of the agenda setter under this scheme. Her utility would

change by

$$\begin{aligned}\partial U &= (\underline{z}+\alpha)\, v_g(g^q)\, \partial g - \mu(\tau^q) \\ &= (\underline{z}+\alpha)\, v_g(g^q)\, \frac{1-\mu(\tau^q)}{1-\underline{z} v_g(g^q)} - \mu(\tau^q),\end{aligned}$$

thus political agreement is possible if

$$\frac{(\underline{z}+\alpha)\, v_g(g^q)}{1-\underline{z} v_g(g^q)} > \frac{\mu(\tau^q)}{1-\mu(\tau^q)}. \tag{23}$$

The left hand side of (23) is always larger than one, while the right hand side is smaller than one if $\mu(\tau^q) < \frac{1}{2}$. Thus $\mu(\tau^q) < \frac{1}{2}$ is a sufficient condition for pork being provided.

Thus (22) is a necessary condition for pork to be provided, while together with (23) the two are necessary and sufficient.

But now consider $\frac{1}{2} < \mu(\tau^q) < 1$ and assume that X is such that (23) holds. We then know that at least one legislator (the centrist) obtains pork, and the first order conditions (16) to (19) give that at the political equilibrium:

$$\frac{(\underline{z}+\alpha)\, v_g(g)}{1-\underline{z} v_g(g)} = \frac{\mu(\tau)}{1-\mu(\tau)}, \tag{24}$$

which is (23) holding with equality.

Note that when

$$\mu(\tau) = \frac{1}{2} \tag{25}$$

then (24) reads

$$(2\underline{z}+\alpha)\, v_g(g) = 1. \tag{26}$$

These last two equations are precisely the first-order conditions (16) through (19) when $\varsigma^\alpha = \varsigma^C = 0$, that is, they give taxation and government expenditure when both the agenda setter and the centrist obtain pork. (The marginal cost of taxation to the entire coalition $2\mu(\tau)$ is made equal to 1 which is the collective marginal value of pork to the coalition; and pork is the marginal use of taxes. The marginal cost to the entire coalition of cutting public good expenditures by one unit is $(2\underline{z}+\alpha)\, v_g(g)$ and is made equal to the collective marginal value of pork the coalition.)

Next notice that the right hand side of (23) is decreasing in g while the left hand side is increasing in τ. Moving from $\{\tau^q, g^g\}$ to their values in the political equilibrium involves increasing both τ and g, which increases the right hand side and decreases the left hand side.

Both g and τ are increasing in the movement from the status quo to the equilibrium. Thus if $\mu(\tau^q) > \frac{1}{2}$, it must be the case that $\mu(\tau) > \frac{1}{2}$ in equilibrium, and thus the agenda setter does not obtain pork in equilibrium.

We conclude that there are three regions of the state space. These are:

- *RPM*: neither legislator gets pork in equilibrium if $\mu(\tau^q) > 1$ or if $\mu(\tau^q) < 1$ and (23) does not hold. The equilibrium is the status quo, as the legislators cannot agree on whether, given high levels of debt, limited fiscal resources should be allocated to cutting taxes from their high status quo rates or increasing public expenditures from their low status quo levels..

- *"Partial" BAU:* The agenda setter forgoes pork, but offers pork to the centrist. This occurs if $\mu(\tau^q) < 1$, (23) holds and the non-negativity constraint on the agenda setter's pork is binding in equilibrium. This is certainly the case if $\frac{1}{2} < \mu(\tau^q) < 1$ and (23) holds. Equilibrium $\left\{g, \tau, s^C\right\}$is characterized by (13), (11) and (24), with $s^\alpha = 0$. The tax rate goes up; tax revenues are allocated partially to the public good and partially to pork, as some pork is required to bring the centrist on board.

- *"Complete" BAU:* Both legislators obtain pork and the equilibrium tax and public goods provision are as described in equations (25) and (26). This occurs if $(\underline{z} + \alpha) v_g(g^q) < 1$ and only if $\mu(\tau^q) < \frac{1}{2}$ (but the two together are not sufficient).

4 Asymmetric Information

We now begin our consideration of asymmetric information about the state z. In the static case our equilibrium concept is Perfect Bayesian Equilibrium. We concentrate on the case of the $+\alpha$ agenda setter.

4.1 Characterization of Equilibrium

Definition 1 *A perfect Bayesian equilibrium (PBE) of the described game is defined as follows:*

1. *Given coalition members' beliefs on the state z, which we denote $\tilde{z}$, the agenda setter (in each state $z = \bar{z}$ and $z = \underline{z}$) offers a proposal that satisfies the following:*

$$\max_{g,\tau,\{s^i\}} \hat{u}(\tau) + (z + \alpha) v(g) + s^{\alpha} \tag{27}$$

subject to the constraints (11), (12), (13), (14), and (15) In other words, the proposal maximizes the agenda setter's utility subject to the participation of the coalition member and the non-negativity constraints.

2. *Beliefs $\tilde{z}$ are consistent with the strategies of the agenda setter when $z = \bar{z}$ and $z = \underline{z}$. In other words, if the proposals offered by the agenda setter in the two states, following from part 1 of this definition, are identical, then $\tilde{z} = z^e \equiv (1-p)\underline{z} + p\bar{z}$. If the proposals are different then $\tilde{z} = \bar{z}$ when the $z = \bar{z}$ agenda setter's optimal legislation is proposed and $\tilde{z} = \underline{z}$ when the $z = \underline{z}$ agenda setter's optimal legislation is proposed.*

As usual, the definition of the PBE does not restrict beliefs on z off the equilibrium path, and equilibrium refinements will be necessary to restrict the large number of PBE that emerge from this definition. We will use the Cho-Kreps (1987) intuitive criterion to rule out "unreasonable" off-the-equilibrium-path beliefs.

There are two types of candidate equilibria of this model:

- *Pooling*: the agenda setter proposes the same legislation $\forall z \in \{\underline{z}, \bar{z}\}$. Coalition members beliefs (other than those of the agenda setter) are $\tilde{z} = (1-p)\underline{z} + p\bar{z}$ when observing this legislation.

- *Separating*: when $z = \bar{z}$ the agenda setter proposes an offer $\left\{g, \tau, s^C, s^{\alpha}\right\}$ that would not be incentive compatible when $z = \underline{z}$, given coalition members' beliefs. Coalition members' beliefs include $\tilde{z} = z$ when the optimal proposals of the $z = \bar{z}$ and the $z = \underline{z}$ legislators are observed.

4.2 Restricting Pork

As another benchmark, we begin with the case in which pork barrel spending is *restricted by law*. Trying to restrict pork is often seen as a socially beneficial reform.[9] When pork is unavailable, the agenda setter proposes legislation that maximizes her own utility

$$\max_{g,\tau} \hat{u}(\tau) + (z+\alpha) v(g),$$

subject to a feasibility constraint

$$g = R(\tau) - X$$

and subject to legislator C's participation constraint

$$\hat{u}(\tau) + \tilde{z} v(g) \geq \hat{u}(\tau^q) + \tilde{z} v(g^q) \tag{28}$$

and possibly to other constraints as we outline below.

A perfect Bayesian equilibrium of this game is defined in section 4.1, but where transfers s are restricted to be zero.

4.3 Separating and pooling equilibria

4.3.1 The $\underline{z}$ agenda setter

In a separating equilibrium, the $z = \underline{z}$ agenda setter proposes a policy that maximizes her utility subject to the budget constraint, C's participation constraint (28), and her own participation constraint (12) evaluated at $z = \underline{z}$ when the s^i are set to zero. Our assumption that τ^q is the social optimum for z^e implies $\tau^*(\underline{z}+\alpha) > \tau^q > \tau^*(\underline{z})$. The equilibrium policy is then obviously $\underline{\tau}' = \tau^q$.

4.3.2 The $\bar{z}$ agenda setter

Now consider the problem facing the $z = \bar{z}$ agenda setter. Of the three cases set out at the beginning of section 3.1.2, case C was the interesting one in which $\tau^*(\bar{z}+\alpha, X) > \tau^*(\underline{z}+\alpha, X) > \tau^*(\bar{z}, X) > \tau^q > \tau^*(\underline{z}, X)$. In this case the $\bar{z}$ cannot signal the state and

[9] In the U.S., restricting pork is often associated with Sen. John McCain (see, for example, *Washington Post* [2006]), though it has made little headway (*Washington Post* [2009]).

only a pooling equilibrium exists at $\tau' = \tau^q$. Any τ above τ^q acceptable to the centrist would be favored by both the $\bar{z}$ and the $\underline{z}$ agenda setter and hence could not signal the state. The centrist would therefore prefer τ^q. The $\bar{z}$ agenda setter would not find it optimal to propose any $\tau < \tau^q$, so that τ^q is the only political equilibrium. With both types of agenda setter proposing τ^q, a pooling equilibrium obtains. Hence, when pork is restricted to be 0, information about the state cannot be conveyed.

5 Pork As A Signal

We now turn to our main question – possible use of pork under asymmetric information about the state z in order to signal z. We consider the case where information cannot be transmitted if pork is restricted to be zero, that is, Case C, reflecting $\alpha > \bar{z} - \underline{z}$. The following ranking of costs and benefits of fiscal policy must hold:

$$\underline{z} v_g\left(R\left(\tau^q\right) - X\right) < \mu\left(\tau^q\right) < \bar{z} v_g\left(R\left(\tau^q\right) - X\right) < \left(\underline{z} + \alpha\right) v_g\left(R\left(\tau^q\right) - X\right) < \left(\bar{z} + \alpha\right) v_g\left(R\left(\tau^q\right) - X\right). \tag{29}$$

5.1 Complete business as usual

To illustrate the role of pork under asymmetric information, we consider two parts of the state space. (We believe there are two others, but have not yet completed the analysis.) The first case is where $\left(\bar{z} + \alpha\right) v_g\left(R\left(\tau^q\right) - X\right) < 1$ (and hence all other magnitudes in (29) are also less that 1). This is sufficient (but not necessary) for the non-negativity constraint on pork to be slack for both coalition members. This is "complete BAU" and will be useful primarily in illustrating the signaling role of pork under asymmetric information.

5.1.1 Separating equilibrium

In a separating equilibrium the agenda setter proposes different policies when $z = \bar{z}$ and when $z = \underline{z}$ and, on observing an equilibrium proposal, the other legislators set $\tilde{z} = z$.

When $z = \underline{z}$ the agenda setter proposes legislation that maximizes (27), subject to the constraints (11), (12), (13), (14), and (15) with $\tilde{z} = z = \underline{z}$. Since the non-negativity constraint on pork is not binding, the participation constraint (11) can be substituted into

the feasibility constraint (5) which can then be rewritten as:

$$s^{\alpha} \leq s^{\alpha}_{Part}\left(\underline{z}\right) \equiv R\left(\tau_{\underline{z}}\right) - X - g_{\underline{z}} + \left[\left(\hat{u}\left(\tau_{\underline{z}}\right) + \underline{z}v\left(g_{\underline{z}}\right)\right) - \left(\hat{u}\left(\tau^{q}\right) + \tilde{z}v\left(g^{q}\right)\right)\right] \tag{30}$$

for any policy $\left(\tau_{\underline{z}}, g_{\underline{z}}\right)$.

Since transfers between the agenda setter and the independent enter linearly in the utility functions of both, utility is transferable across legislative districts. The maximization problem can therefore be simplified to choosing g and τ to maximize the expected utility of the entire coalition (given centrist's beliefs $\tilde{z}$). The agenda setter then obtains pork s^{α} as given by (30). The agenda setter's optimal choices of τ and g solve

$$v'\left(g_{\underline{z}}\right) = \frac{1}{2\underline{z} + \alpha}, \tag{31}$$

and

$$\frac{\tau^{BAU}}{1 - \tau^{BAU}} = \frac{1}{3\varepsilon}, \tag{32}$$

so that the political equilibrium tax rate τ^{*} is independent of the identity of the agenda setter and of the state of nature. The agenda setter obtains pork barrel transfers of

$$s^{\alpha}_{\underline{z}} = \left[R\left(\tau^{BAU}\right) - X - g_{\underline{z}}\right] - \left[\left(\hat{u}\left(\tau^{q}\right) - \hat{u}\left(\tau^{BAU}\right)\right) + \underline{z}\left(v\left(g^{q}\right) - v\left(g_{\underline{z}}\right)\right)\right], \tag{33}$$

where the first bracketed term on the right-hand side is the total amount available for pork and the second bracketed term is the amount the centrist must be compensated to join the coalition and pass the policy $\left(g_{\underline{z}}, \tau^{BAU}\right)$ in place of the status quo policy $\left(g^{q}, \tau^{q}\right)$.

It is the existence of pork, which enters linearly into utility of all legislators, that allows the choice of $g_{\underline{z}}$ and τ to be separated. Were there a lump-sum revenue source available to the social planner, there would be a similar separation. Conversely, if the non-negativity constraint on pork were binding, we would get something similar to the social planner's solution in which $g_{\underline{z}}$ would depend on the distortionary nature of taxation.

The policy vector $\left(g_{\underline{z}}, \tau^{BAU}, s^{\alpha}_{\underline{z}}\right)$ gives the agenda setter the following utility:

$$U^{\alpha}_{\underline{z}} = \hat{u}\left(\tau^{BAU}\right) + \left(\underline{z} + \alpha\right)v\left(g_{\underline{z}}\right) + R\left(\tau^{BAU}\right) - X - g_{\underline{z}} - \left[\left(\hat{u}\left(\tau^{q}\right) - \hat{u}\left(\tau^{BAU}\right)\right) + \underline{z}\left(v\left(g^{q}\right) - v\left(g_{\underline{z}}\right)\right)\right] \tag{34}$$

Now consider the problem confronting the agenda setter when $z = \bar{z}$. An equilibrium has the agenda setter maximizing (27) subject to (30),with $z = \tilde{z}$, but with the additional restriction that the $z = \underline{z}$ agenda setter does not want to mimic this strategy:

$$\hat{u}\left(\tau^{BAU}\right) + (\underline{z} + \alpha)\, v\left(g_{\bar{z}}\right) + s^{\alpha} \leq U^{\alpha}_{\underline{z}}. \tag{35}$$

Using (34) this may be written

$$s^{\alpha} \leq s^{\alpha}_{\bar{z},sep} \equiv \begin{array}{c} (\underline{z} + \alpha)\, v\left(g_{\underline{z}}\right) - (\underline{z} + \alpha)\, v\left(g_{\bar{z}}\right) + R\left(\tau^{BAU}\right) - X - g_{\underline{z}} \\ - \left[\left(\hat{u}\left(\tau^{q}\right) - \hat{u}\left(\tau^{BAU}\right)\right) + \underline{z}\left(v\left(g^{q}\right) - v\left(g_{\underline{z}}\right)\right)\right] \end{array}, \tag{36}$$

where $s^{\alpha}_{\bar{z},sep}$ denotes the maximum pork that the type-$\bar{z}$ agenda setter can retain consistent with separating herself from the type-$\underline{z}$ agenda setter. The participation constraint of the centrist when $z = \bar{z}$ may be written

$$s^{\alpha} \leq s^{\alpha}_{Part}\left(\bar{z}\right) \equiv \left[R\left(\tau^{BAU}\right) - X - g_{\bar{z}}\right] - \left[\left(\hat{u}\left(\tau^{q}\right) - \hat{u}\left(\tau^{BAU}\right)\right) + \bar{z}\left(v\left(g^{q}\right) - v\left(g_{\bar{z}}\right)\right)\right] \tag{37}$$

The Cho-Kreps intuitive criterion will imply that one of the conditions (37) and (36) must be binding. To see why, consider a legislative proposal with $s^{\alpha} = s'$ that is sufficiently small to allow both (37) and (36) to hold with strict inequality. Bayes' law implies that on observing such a legislative proposal, the centrist must update his beliefs to $z = \bar{z}$, as this proposal would not be incentive compatible for the agenda setter if $z = \underline{z}$. Such a legislative proposal would be accepted by the centrist because (37) is satisfied with $\tilde{z} = \bar{z}$. It may appear at first that such a strategy could not be optimal for the the agenda setter, as it seems she could propose legislation with identical taxes and public good provision, more pork for herself, and that would still inform and obtain the participation of the centrist. However, if the centrist's beliefs are such that $\tilde{z} = \underline{z}$ on observing any $s^{\alpha} > s'$, the agenda setter may be induced to offer s'. Otherwise, she finds herself bargaining with a centrist who thinks that $z = \underline{z}$ and desires a lower level of the public good. Notice that these beliefs of the centrist do not violate Bayes' law, as Bayes' law does not inform as to how to formulate off-the-equilibrium-path beliefs.

However, we can reject such equilibria based on the intuitive criterion. Specifically, if the centrist were to observe any $s^{\alpha} > s'$ that still satisfies (37) and (36), it would be unreasonable

for him to assume put a positive probability on the state being $z = \underline{z}$, as such a proposal would not be incentive compatible for the agenda setter if $z = \underline{z}$. To summarize, in any perfect Bayesian equilibrium that satisfies the intuitive criterion, either (37) or (36) must hold with equality.

Not only must one of the constraints (37) or (36) be binding in an intuitive perfect Bayesian equilibrium, but also *only* one of them can be binding, as both can be written as an upper bound on s^{α}. If the centrist's participation constraint (37) is binding (that is, if value of s^{α} that satisfies (37) is below the value that satisfies (36)), then the highest feasible s^{α} consistent with the centrist being willing to join the coalition is sufficient to signal that $z = \bar{z}$.

Alternatively, if (36) is the binding constraint, the agenda setter needs to sacrifice additional pork beyond what would induce the centrist to join the coalition in order signal to him that $z = \bar{z}$. The agenda setter needs to burn additional pork (or provide this pork to other coalition members), so that the pork she takes for her own district is low enough that a $z = \underline{z}$ would not be willing to accept.

Note crucially that pork plays an informative role in *both* cases. In the latter case, the informational role of pork is clear. Burning additional pork informs coalition members that the state $z = \bar{z}$. But even in the former case, pork may be informative in the sense that the equilibrium would not self-separate in the absence of pork.

As before, since utility is transferable, the choice of g and τ can now be viewed as one of maximizing the utility of the coalition as a whole. The first order conditions of this decision problem gives $\tau = \tau^{BAU}$ and $v'(g_{\bar{z}}) = \frac{1}{2\bar{z}+\alpha}$.

In the self-separating equilibrium, that is, when it is the participation constraint (37) that is binding, the agenda setter obtains pork of

$$s^{\alpha}_{\bar{z},self} = \begin{array}{c} R\left(\tau^{BAU}\right) - X + \hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right) \\ +\bar{z}\left[v\left(g_{\bar{z}}\right) - v\left(g^{q}\right)\right] - g_{\bar{z}} \end{array},$$

and the following utility:

$$U^{\alpha}_{\bar{z},self} = \begin{array}{c} \hat{u}\left(\tau^{BAU}\right) + (2\bar{z}+\alpha)\, v\left(g_{\bar{z}}\right) + R\left(\tau^{BAU}\right) - X - g_{\bar{z}} + 2\hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right) \\ + \left[\left(\hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right)\right) + \bar{z}\left(v\left(g_{\bar{z}}\right) - v\left(g^{q}\right)\right)\right] \end{array}. \quad (38)$$

The self-separating equilibrium exists if (36) holds with strict inequality:

$$\left[\hat{u}\left(\tau^{BAU}\right)-\hat{u}\left(\tau^{q}\right)\right]+\left(\underline{z}+\alpha\right)\left[v\left(g_{\bar{z}}\right)-v\left(g^{q}\right)\right]+s_{\bar{z},self}^{\alpha}<U_{\underline{z}}^{\alpha}$$

or

$$\left(\underline{z}+\bar{z}+\alpha\right)\left[v\left(g_{\bar{z}}\right)-v\left(q\right)\right]-g_{\bar{z}}<\left(2\underline{z}+\alpha\right)\left[v\left(g_{\underline{z}}\right)-v\left(g^{q}\right)\right]-g_{\underline{z}}. \tag{39}$$

Finally, we need to confirm our conjecture that the agenda setter does not want to mimic the strategy of the $z=\underline{z}$ agenda setter, that is, that (35) is satisfied. This equation simplifies to

$$\left(2\bar{z}+\alpha\right)\left[v\left(g_{\bar{z}}\right)-v\left(g^{q}\right)\right]-g_{\bar{z}}\geq\left(\bar{z}+\underline{z}+\alpha\right)\left[v\left(g_{\underline{z}}\right)-v\left(g^{q}\right)\right]-g_{\underline{z}}$$

Lemma 1 *Let $g_{\bar{z}}$ and $g_{\underline{z}}$ be given by*

$$\begin{aligned} v'\left(g_{\bar{z}}\right) &= \frac{1}{2\bar{z}+\alpha} \\ v'\left(g_{\underline{z}}\right) &= \frac{1}{2\underline{z}+\alpha}, \end{aligned}$$

then if and only if

$$\underline{z}\left[v\left(g_{\bar{z}}\right)-v\left(g_{\underline{z}}\right)\right]<\begin{array}{c}\left(\underline{z}+\alpha\right)\left[v\left(g_{\underline{z}}\right)-v\left(g^{q}\right)\right]-g_{\underline{z}}\\-\left\{\left(\bar{z}+\alpha\right)\left[v\left(g_{\bar{z}}\right)-v\left(g^{q}\right)\right]-g_{\bar{z}}\right\}\end{array}\leq\bar{z}\left[v\left(g_{\bar{z}}\right)-v\left(g_{\underline{z}}\right)\right] \tag{40}$$

holds, there exists an equilibrium where an α agenda setter proposes $\tau=\tau^{BAU}$; and proposes $g=g_{\bar{z}}$ and $g=g_{\underline{z}}$ when $z=\bar{z}$ and $z=\underline{z}$, respectively; and the minimal amount of pork required to obtain the participation of the centrist coalition member. The proposals reveal the value of z to the centrist, who accepts the offer.

Proof: See appendix (to be added)

We now turn to the other separating equilibrium. Here, (36) is binding so that

$$s_{\bar{z},sep}^{\alpha}=U_{\underline{z}}^{\alpha}-\left[\hat{u}\left(\tau^{BAU}\right)-\hat{u}\left(\tau^{q}\right)\right]-\left(\underline{z}+\alpha\right)\left[v\left(g_{\bar{z}}\right)-v\left(g^{q}\right)\right],$$

which gives

$$s^{\alpha}_{\bar{z},sep} = \begin{array}{c} R\left(\tau^{BAU}\right) - X + \hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right) \\ + \left(2\underline{z} + \alpha\right)\left[v\left(g_{\underline{z}}\right) - v\left(g^{q}\right)\right] - g_{\underline{z}} \\ - \left(\underline{z} + \alpha\right)\left[v\left(g_{\bar{z}}\right) - v\left(g^{q}\right)\right] \end{array},$$

giving utility of

$$U^{\alpha}_{\bar{z},sep} = \begin{array}{c} R\left(\tau^{BAU}\right) - X + 2\left[\hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right)\right] \\ + \left(2\underline{z} + \alpha\right)\left[v\left(g_{\underline{z}}\right) - v\left(g^{q}\right)\right] - g_{\underline{z}} \\ + \left(\bar{z} - \underline{z}\right)\left[v\left(g_{\bar{z}}\right) - v\left(g^{q}\right)\right] \end{array} \tag{41}$$

Then this separating equilibrium is feasible only if (30) holds with strict inequality, which gives:

$$\left(2\underline{z} + \alpha\right)\left[v\left(g_{\underline{z}}\right) - v\left(g^{q}\right)\right] - g_{\underline{z}} < \left(\bar{z} + \underline{z} + \alpha\right)\left[v\left(g_{\bar{z}}\right) - v\left(g^{q}\right)\right] - g_{\bar{z}}. \tag{42}$$

This condition is the inverse of (39), so that the two span the entire state space. But we also need to ensure that the $z = \bar{z}$ agenda setter does not want to mimic the $z = \underline{z}$ strategy:

$$U^{\alpha}_{\bar{z},sep} \geq \hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right) + \left(\bar{z} + \alpha\right)\left[v\left(g_{\underline{z}}\right) - v\left(g^{q}\right)\right] + s^{\alpha}_{\underline{z}}.$$

This is equivalent to

$$v\left(g_{\bar{z}}\right) \geq v\left(g_{\underline{z}}\right),$$

which always holds.

Lemma 2 *Let $g_{\bar{z}}$ and $g_{\underline{z}}$ be given as in Lemma 1, then if*

$$\left(2\underline{z} + \alpha\right)\left[v\left(g_{\underline{z}}\right) - v\left(g^{q}\right)\right] - g_{\underline{z}} < \left(\bar{z} + \underline{z} + \alpha\right)\left[v\left(g_{\bar{z}}\right) - v\left(g^{q}\right)\right] - g_{\bar{z}}. \tag{43}$$

holds, there exists an equilibrium that satisfies the intuitive criterion where an α agenda setter proposes $\tau = \tau^{BAU}$; and proposes $g = g_{\bar{z}}$ and $g = g_{\underline{z}}$ when $z = \bar{z}$ and $z = \underline{z}$, respectively. When $z = \underline{z}$ the agenda setter proposes the minimal amount of pork to obtain the participation of the centrist coalition member, while when $z = \bar{z}$ she proposes

$$s^{\alpha} = \begin{array}{c} R\left(\tau^{BAU}\right) - X + \hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right) \\ + \underline{z}\left[v\left(g_{\underline{z}}\right) - v\left(g^{q}\right)\right] - g_{\underline{z}} \end{array} \tag{44}$$

The proposals reveal the value of z to the centrist, who accepts the offer.

Proof: See appendix (to be added)

5.1.2 Pooling equilibrium

In any candidate pooling equilibrium, the agenda setter proposes the same policy when $z = \bar{z}$ and when $z = \underline{z}$, so that $\tilde{z} = p\bar{z} + (1-p)\,\underline{z} = z^e$ on the equilibrium path. Consider the main candidate for a pooling equilibrium where the agenda setter in state $z = \bar{z}$ proposes the policy that maximizes (27) subject to (5) with $\tilde{z} = z^e$. Denote this proposal by $\delta^+_{\bar{z}}(z^e) \equiv \left\{g^+_{\bar{z}}, \tau^{BAU}, s^{\alpha+}_{\bar{z}}\right\}$, where $g^+_{\bar{z}}$ (that is, optimal $g_{\bar{z}}$ at $\tilde{z} = z^e$) is given by

$$v'\left(g^+_{\bar{z}}\right) = \frac{1}{\bar{z} + z^e + \alpha}$$

and $s^{\alpha+}_{\bar{z}}$ (that is, $s^{\alpha}_{\bar{z}}$ at $\tilde{z} = z^e$) is given by (5), which may be written

$$s^{\alpha+}_{\bar{z}} = R\left(\tau^{BAU}\right) - X + \hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^q\right) + z^e\left[v\left(g^+_{\bar{z}}\right) - v\left(g^q\right)\right] - g^+_{\bar{z}} \tag{45}$$

This policy provides the agenda setter of type z with utility

$$U_z\left(\delta^+_{\bar{z}}, \tilde{z} = z^e\right) = \begin{array}{c} R\left(\tau^{BAU}\right) - X + 2\left[\hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^q\right)\right] \\ +\left(z + z^e + \alpha\right)\left[v\left(g^+_{\bar{z}}\right) - v\left(g^q\right)\right] - g^+_{\bar{z}} \end{array}, \tag{46}$$

denoted $U_{\bar{z}}\left(\delta^+_{\bar{z}}, \tilde{z}\right)$ for "type" $z = \bar{z}$. If the agenda setter mimics this proposal when $z = \underline{z}$, she obtains $s^{\alpha+}_{\bar{z}}$ defined by (45) and $U_{\underline{z}}\left(\delta^+_{\bar{z}}, z^e\right)$ defined by (46) for $z = \underline{z}$. For her to mimic it must be the case that

$$U_{\underline{z}}\left(\delta^+_{\bar{z}}, z^e\right) \geq U^{\alpha}_{\underline{z}} \tag{47}$$

where $U^{\alpha}_{\underline{z}}$ is given by (34). Note that utility (46) could be written as

$$U_z\left(g, \tilde{z}\right) = \left(z + \tilde{z} + \alpha\right)\left[v\left(g\right) - v\left(g^q\right)\right] - g + K\left(\tau^{BAU}, \tau^q\right), \tag{48}$$

where $K\left(\tau^{BAU}, \tau^q\right) \equiv R\left(\tau^{BAU}\right) + 2\left[\hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^q\right)\right]$ is identical across all candidate policies δ the agenda setter may propose. (In both (46) and (48), the $s^{\alpha}_{\bar{z}}$ consistent with political equilibrium is implicit in the derivation of $U_z(\cdot)$.)

Though there may be pooling equilibria consistent with (47) that satisfy the conditions

of a PBE, we now rule them out by showing they violate the Cho-Kreps intuitive criterion. We demonstrate this for the agenda setter when $z = \bar{z}$ by showing there is a deviation from the pooling equilibrium that "type" $\underline{z}$ would not mimic. An analogous demonstration would imply that when $z = \underline{z}$ there is a deviation from the pooling equilibrium that "type" $\bar{z}$ would not mimic.

Suppose there exists a feasible proposal $\bar{\delta} \equiv \left\{\bar{g}, \tau^{BAU}, \bar{s}^{\alpha}\right\}$ such that

$$U_{\bar{z}}\left(\bar{g}, \tilde{z}\right) \geq U_{\bar{z}}\left(g_{\bar{z}}^{+}, z^{e}\right) \tag{49}$$

and

$$U_{\underline{z}}\left(\bar{g}, \tilde{z}\right) \leq U_{\underline{z}}\left(g_{\bar{z}}^{+}, z^{e}\right) \tag{50}$$

for any $\tilde{z}$. If these inequalities hold, then the agenda setter in the state $z = \bar{z}$ would deviate to $\bar{\delta}$ from the pooling equilibrium $\delta_{\bar{z}}^{+}\left(z^{e}\right)$, which the agenda setter in state $z = \underline{z}$ would not find it optimal to mimic for any centrist beliefs $\tilde{z} > z^{e}$.

It is easy to show that a proposal must always exist. (49) defines possible deviations $\bar{g}$ for any $\tilde{z} > z^{e}$. Such deviations $\bar{g} > g_{\bar{z}}^{+}$ must exist since

$$\frac{\partial U_{\bar{z}}\left(g, \tilde{z}\right)}{\partial \tilde{z}}_{g = g_{\bar{z}}^{+}} = v\left(g_{\bar{z}}^{+}\right) - v\left(g^{q}\right) > 0$$

and

$$\frac{\partial U_{\bar{z}}\left(g, \tilde{z}\right)}{\partial g}_{\tilde{z} = z^{e},\ g > g_{\bar{z}}^{*}} = \left(\bar{z} + z^{e} + \alpha\right) v'\left(g\right) - 1 < 0$$

where the second inequality follows from the definition of $g_{\bar{z}}^{+}$ as the optimum at z^{e}, so that $\left(\bar{z} + z^{e} + \alpha\right) v'\left(g_{\bar{z}}^{+}\right) = 1$. One may then combine (49) and (50) to yield (after some algebra)

$$\begin{aligned}
\left(\bar{z} + \tilde{z} + \alpha\right)\left[v\left(\bar{g}\right) - v\left(g_{\bar{z}}^{+}\right)\right] &\geq \left(z^{e} - \tilde{z}\right)\left[v\left(g_{\bar{z}}^{+}\right) - v\left(g^{q}\right)\right] + \bar{g} - g_{\bar{z}}^{+} \\
&\geq \left(\underline{z} + \tilde{z} + \alpha\right)\left[v\left(\bar{g}\right) - v\left(g_{\bar{z}}^{+}\right)\right]
\end{aligned}$$

The first inequality defines possible deviations $\bar{g}$ as above which induce agenda setter $\bar{z}$ to separate. The second inequality limits $\bar{g}$ for any $\tilde{z} > z^{e}$ to those $\underline{z}$ won't mimic. Since $\left(\bar{z} + \tilde{z} + \alpha\right)\left(v\left(g_{\bar{z}}^{+}\right) - v\left(\bar{g}\right)\right) > \left(\underline{z} + \tilde{z} + \alpha\right)\left(v\left(g_{\bar{z}}^{+}\right) - v\left(\bar{g}\right)\right)$ for $\bar{z} > \underline{z}$, this set is non-empty. Hence, there exist feasible proposals $\bar{\delta}$ that would induce an agenda setter under $\bar{z}$ to deviate

from the pooling equilibrium $\delta_{\tilde{z}}^{+}(z^e)$ which an agenda setter under $\underline{z}$ would not mimic. Such a $\bar{\delta}$ exists because the right-hand side of the first equation above can be chosen freely–we need only show that there exists some $\bar{g}$ for which these inequality holds for all $\tilde{z}$.

Analogously, one may show by similar reasoning that there exists a feasible $\underline{\delta} \equiv \left\{\underline{g}, \tau^{BAU}, \underline{s}^{\alpha}\right\}$ with $\underline{g} < g_{\tilde{z}}^{+}$ such that the inequalities in (49) and (50) are reversed for $\tilde{z} \leq z^e$. Hence, there exist feasible proposals $\underline{\delta}$ that would induce an agenda setter under $\underline{z}$ to deviate from the pooling equilibrium $\delta_{\tilde{z}}^{+}(z^e)$ which an agenda setter under $\bar{z}$ would not mimic. Therefore, $\delta_{\tilde{z}}^{+}(z^e)$ would then be an "unintuitive" equilibrium, that is, it would be ruled out by the Cho-Kreps intuitive criterion, as there exists profitable deviations for the agenda setter, either when $z = \bar{z}$ or when $z = \underline{z}$. In simpler political terms, a proposal that does not reveal information ("pure bribing") cannot be a legislative equilibrium since legislators know that in any economic situation, the agenda setter would want to choose some other proposal to reveal information.

We have shown that a profitable deviation exists from the best pooling equilibrium for the $z = \bar{z}$ agenda setter. We now argue that this is true for all pooling equilibria. First, note that the best pooling equilibrium from the perspective of the $z = \bar{z}$ agenda setter is the one that provides the highest level of g, as the agenda setter would find it profitable to deviate from a proposal with any higher level of g, regardless of z. Second, a similar argument demonstrates that no pooling equilibrium would provide a lower level than g than the pooling equilibrium that is best for the $z = \underline{z}$ agenda setter.

Now consider an alternative candidate for a feasible pooling equilibrium $\hat{\delta}$. When $z = \bar{z}$, this pooling equilibrium must provide the agenda setter with lower utility than the the pooling equilibrium that was the best from her perspective, by definition. Thus any deviation that was profitable from the best pooling equilibrium would also be profitable from the $\hat{\delta}$ pooling equilibrium. As for the $z = \underline{z}$ state, the agenda setter would obtain

$$U_{\underline{z}}\left(\hat{\delta}, \tilde{z} = z^e\right) = \begin{array}{c} R\left(\tau^{BAU}\right) - X + 2\left[\hat{u}\left(\tau^{BAU}\right) - \hat{u}\left(\tau^{q}\right)\right] \\ + \left(\underline{z} + z^e + \alpha\right)\left[v\left(\hat{g}\right) - v\left(g^q\right)\right] - \hat{g} \end{array}.$$

with $\hat{g}$ the proposed provision of the public good in the $\hat{\delta}$ proposal. As long as $\hat{g}$ is such that $v'\left(\hat{g}\right) > \frac{1}{\underline{z}+z^e+\alpha}$ (the agenda setter's best pooling equilibrium when $z = \underline{z}$), $\hat{\delta}$ provides higher utility to the $z = \underline{z}$ agenda setter than $g_{\tilde{z}}^{+}$. Thus the $z = \underline{z}$ agenda setter would

not want to deviate from $\hat{\delta}$ to any policy she was unwilling to accept under the $\delta_{\bar{z}}^{+}(z^e)$ candidate equilibrium. Thus with the intuitive criterion, a profitable deviation exists from any candidate pooling equilibrium. We summarize the above results in the following Lemma.

Lemma 3 *If pork is available, no perfect Bayesian equilibrium that satisfies the intuitive criterion has the agenda setter propose the same proposal in states $z = \bar{z}$ and $z = \underline{z}$.*

We can now summarize the political equilibrium in the following proposition, that collects the results of the Lemmas in this section.

Proposition 1 *The political game described here has a unique separating equilibrium. In equilibrium the agenda setter proposes legislation with $\tau = \tau^{BAU}$, $g = g^{BAU}(z)$, where*

$$\tau^{BAU} = \frac{1}{3\varepsilon + 1}$$

and $g^{BAU}(z)$ is given by

$$v'\left(g^{BAU}(z)\right) = \frac{1}{2z + \alpha}.$$

The distribution of pork depends on whether (40) or (43) holds. These are mutually exclusive conditions, that span the entire state space. In the former case s^{α} is given by (30); in the latter it is given by (30) when $z = \underline{z}$, but by (44) when $z = \bar{z}$, with $g_{\underline{z}} = g^{BAU}(\underline{z})$.

5.2 Responsible policy making

The second case we consider is where first case is where $\underline{z} v_g(R(\tau^q) - X) > 1$ (and hence all other magnitudes in (29) are also greater than 1). That is, we have

$$1 < \underline{z} v_g(R(\tau^q) - X) < \mu(\tau^q) < \bar{z} v_g(R(\tau^q) - X) < (\underline{z} + \alpha) v_g(R(\tau^q) - X) < (\bar{z} + \alpha) v_g(R(\tau^q) - X). \tag{51}$$

This ranking could result from a high level of pre-existing fiscal obligations, reflecting for example,a high level of existing debt. High X would mean high taxes τ but low g, hence, high values of $\mu(\tau^q)$ and $v_g(R(\tau^q) - X)$. Under full information no pork would be given in political equilibrium – the marginal value of the public good is above the marginal value of pork for both members of the coalition – so the economy would be in RPM. Conceptually, this would be the exact analogue of RPM in Battaglini and Coate (2008) where legislators

are homogeneous in their valuation of the public good – a high value of the public good, perhaps due to high debt, implies that no pork is distributed.

5.2.1 Allocation of pork under responsible policy making

We ask here what would be the nature of equilibrium when there is asymmetric information in a world where legislators have heterogeneous valuations of the public good. We will show that though no pork is given under full information, it may be given under asymmetric information. Moreover, it will be given when the state (observed by the agenda setter but not the centrist) is $\bar{z}$ rather than when it is $\underline{z}$! That is, under conditions of high X (that is, high debt) pork will be observed when the public good is *most* valuable, that is, in state $\bar{z}$. It is used in a "crisis" rather than in better states of the world. This is in contrast with what would be true under full information with homogeneous policymakers (for example, in Battaglini and Coate's (2008) two-state example), where at a given level of debt there may be pork in equilibrium for low but not high value of the public good, but not vice versa. Under asymmetric information pork may be used when the public good is most valuable in order to signal its high value to less informed legislators. Hence, pork is used precisely *because* the public good is valuable and the informed agenda setter wants to convey this information. That is, pork is not antithetical to "responsible policy making" but in fact crucial to policy being able to respond to a high valuation of the public good. Or, to put it provocatively, policy making is responsible because it is not RPM. And, pork is given to the centrist under asymmetric information even though he gets higher direct utility from public goods.

To see that equilibrium may involve pork, let's conjecture a separating equilibrium that satisfies the Cho-Kreps intuitive criterion. In a separating equilibrium, the $z = \underline{z}$ agenda proposes the status quo. The $z = \bar{z}$ agenda setter can successfully deviate from the status quo if she can propose a deviation from the status quo that is profitable to her, but would not be desirable for the agenda setter when $z = \underline{z}$. Specifically, let the agenda setter raise one unit of tax revenues. If less than

$$\partial g \leq \frac{\mu\left(\tau^{q}\right)}{\left(\underline{z}+\alpha\right) v_{g}\left(R\left(\tau^{q}\right)-X\right)}<1 \tag{52}$$

units of these revenues are allocated to the public good, this signals that $z = \bar{z}$, as the $z = \underline{z}$

agenda setter would be unwilling to bear the cost of taxation if so little of it is allocated to public good provision. However, if the $z = \bar{z}$ agenda setter would still be willing to give this amount of pork to the centrist, as

$$\frac{\mu(\tau^q)(\bar{z}+\alpha) v_g(R(\tau^q)-X)}{(\underline{z}+\alpha) v_g(R(\tau^q)-X)} > \mu(\tau^q).$$

The question remains whether the participation constraint of the centrist (with the value of z now revealed) can be satisfied. The answer is yes if:

$$\bar{z} v_g(R(\tau^q)-X)\partial g + 1 - \partial g \geq \mu(\tau^q).$$

This can be rewritten as

$$(\bar{z} v_g(g^q)-1)\partial g + 1 \geq \mu(\tau^q). \tag{53}$$

(52) gives an upper bound on ∂g for information to be conveyed. (53) gives a lower bound on ∂g for the participation of the centrist. The centrist would like a higher level of g rather than more pork. As the agenda setter obviously wants to give as little pork as possible consistent with the participation of the centrist and signaling that $z = \bar{z}$, it is clear that if both these equations are satisfied, (52) is the binding constraint. So

$$\partial g = \frac{\mu(\tau^q)}{(\underline{z}+\alpha) v_g(R(\tau^q)-X)}$$

and (52) becomes:

$$(\bar{z} v_g(R(\tau^q)-X)-1)\frac{\mu(\tau^q)}{(\underline{z}+\alpha) v_g(R(\tau^q)-X)} + 1 > \mu(\tau^q).$$

Rearranging terms, one sees that pork will be used to signal whenever

$$(\underline{z}+\alpha) v_g(R(\tau^q)-X) > (1+[\alpha-(\bar{z}-\underline{z})] v_g(R(\tau^q)-X))\mu(\tau^q). \tag{54}$$

If this condition holds (as well as (51)), then a separating equilibrium exists where, although no pork would be allocated under full information, regardless of the value of z, the agenda setter does not obtain pork, and provides pork to the centrist when $z = \bar{z}$

but *not* when $z = \underline{z}$. Conversely, when the inequality in (54) is reversed, then no pork is allocated and $\tau' = \tau^q$ under both $\bar{z}$ and $\underline{z}$ (which is the centrist's optimum policy when the state is not known.) No signaling takes place and the equilibrium is RPM as in Battaglini and Coate, but under asymmetric information. One sees that RPM under full information, which obtains when (51) holds, conceptually contains *two* sub-regimes under asymmetric information, corresponding to one where pork is allocated ("pork RPM"), the other where it is not ("complete RPM"). This result reflects once again the possible signaling role of pork.

It is easy to see that (54) may be satisfied. Since our derivation puts no restriction on the excess of α over $\bar{z} - \underline{z}$, the term $\alpha - (\bar{z} - \underline{z})$ on the right-hand side of (54) may be arbitrarily small, in which case the right-hand side approaches $\mu(\tau^q)$. The inequality is therefore satisfied due to (51).

This result about "pork RPM" may be better understood from Figure 1, showing points of indifference with the status quo and the (blue) budget line. Signaling of the state $\bar{z}$ requires the agenda setter when $z = \bar{z}$ to separate herself from the agenda setter when $z = \underline{z}$. Hence, signaling requires a non-empty lens between the green indifference curve (for the case when $z = \underline{z}$) and the black indifference curve (for the case where $z = \bar{z}$), where both are drawn under the assumption that the agenda setter gets no pork (an assumption that is confirmed in equilibrium). For any proposed tax rate, separating requires the agenda setter to propose a level of public good below the green line, which are levels of the public good that the agenda setter would not tolerate at that tax rate if $z = \underline{z}$. She will never propose less of the public good than implied by the black line, as she prefers the status quo to such a policies.

The vertical distance between the budget constraint and the level of public good proposed will be given to the centrist in the form of pork s^C. The agenda setter will not propose pork for herself, as it does not help separate herself from the agenda setter when $z = \underline{z}$, and provides her with a lower marginal utility than that of public good provision. Destroying resources rather than providing them to the centrist would not be effective either, as the centrist's participation constraint will be binding in equilibrium.

The red indifference curve is that of the centrist when it has been revealed that $z = \bar{z}$, and takes into account that the centrist receives all residual pork, so it represents his participation constraint in the coalition conditional on his having learned the state $\bar{z}$. Total pork proposed is the difference between the blue budget line and the green "informational constraint", as the agenda setter would like to provide the smallest amount of pork, consistent with signalling

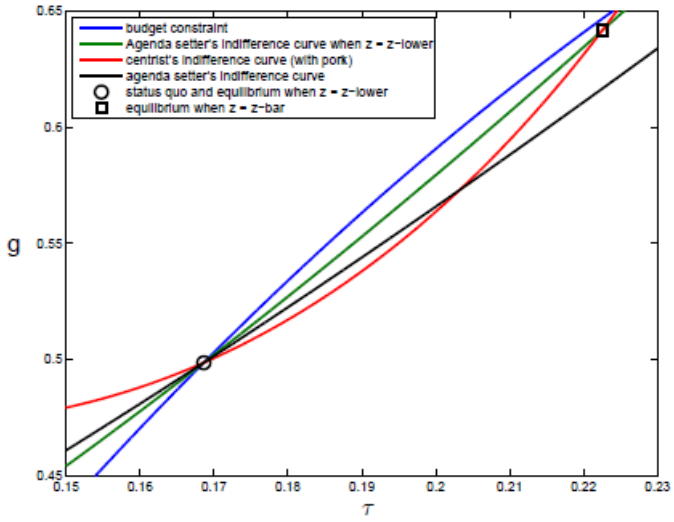

Figure 1: Informational Pork During a Fiscal Crisis

that the state is $z = \bar{z}$. An equilibrium is the intersection of the green and the red lines (so that the separating and the centrist's participation constraints are both binding and determine the equilibrium). As long as the red line is below the green line at some point the two will intersect between the black and blue lines implying a feasible separating equilibrium in which pork is provided.[10]

When $z = \underline{z}$ the agenda setter will not choose to mimic the $z = \bar{z}$ equilibrium, and therefore $z = \underline{z}$ is known to the centrist. As we have seen, with full information, the status quo is equilibrium.

5.2.2 The importance of X

Which of the subregimes obtains depends on parameter values, that is, ε and X, as well as on the distance between α and $\bar{z} - \underline{z}$. ε is literally the elasticity of labor supply, but mainly determines the degree of tax distortions, and could be interpreted as the inefficiency

[10] As $\alpha > \bar{z} - \underline{z}$ the indifference curve of the centrist *without* pork would be above the green line to the right of the status quo. It would therefore intersect with the (blue) budget line before the green line crosses the budget line. But at the budget line, the centrist's indifference curves with and without pork intersect, implying that the red line always crosses the blue line before the green line crosses the blue line. As the green line is always above the black line in this region, if the red line is ever below the green line, it will intersect the green line between the black and blue lines. Thus (54) provides a sufficient condition for informational pork, as it gives a condition for the red line to be below the green line directly to the right of the status quo.

inherent in the tax system. X, the level of pre-existing spending obligations, could represent non-discretionary spending that cannot be changed in a crisis, including, but not limited to, debt service obligations. We have suggested this last interpretation as it allows us to begin to examine the influence of existing debt on the choice of legislators of whether or not to allocate pork, a central question in the analysis of Battaglini and Coate.

High enough X will imply that the inequality in (54) is reversed so that no pork is allocated and we are in "complete RPM" as in Battaglini and Coate. Hence, our results support the general conclusion of their model that for high enough debt, the political equilibrium will be one without pork. In our model, however, there are intermediate levels of X, where the economy would be in RPM in Battaglini and Coate, while pork is provided for informational purposes in this model. Preliminary computations show that the level of X yielding "complete RPM" is quite high. For $\varepsilon = 1.6$ (following Greenwood, Hercowitz and Huffman, 1988) and the difference between $\bar{z}$ and $\underline{z}$ to allow $\bar{z}$ to reflect a 2-standard deviation increase in government consumption in U.S. data, X must take up around 90% of the budget for the regime to be "complete RPM". We explored a range of α values, from those slightly larger than $\bar{z} - \underline{z}$ to those that make ideology twice as important than ideology, and this figure never declines below 82%. Even adding entitlements to debt service, this is well above what is observed in OECD economies. Hence, the case of "pork RPM" does not appear to be pathological or a fluke.

Another issue arises in discussing the role of X in determining whether the economy is in "pork RPM" or "complete RPM". In a model of dynamic optimization X is endogenous. This suggests the question of whether legislators will ever choose debt accumulation such that given X_t, the implied X_{t+1} would move the economy to "complete RPM". This requires a dynamic model, which is the next step in our research agenda.

6 Conclusions

Pork-barrel spending is generally viewed as "politics as usual" with lawmakers choosing to make expenditures to benefit their constituents at the general expense and to be distinguished from "responsible policy making" when public goods have high value. In this paper we have re-examined this view when all legislators are not equally informed and differ in the value they assign to public spending in the current economic situation. We argued that once one

considers legislators who are heterogeneous both in ideology and their information about the economic situation, allocation of pork may serve a function in the legislative process of enabling the formation of coalitions to pass legislation appropriate to the situation.

Pork "greases the wheels" of the legislative process, but does this not by bribing legislators to accept legislation they view as harmful, but by conveying information about the state of the world and hence the value of policy change. We showed that it may be impossible to convey such information if signaling must be done via policies that affect welfare directly. Hence, conceptually, we think it is incorrect to argue that pork is simply "politics as usual" that is a sign of the absence of responsible policymaking. As we argued in the previous section, pork is not antithetical to "responsible policy making" but in fact may be crucial to policy being able to respond to a high valuation of the public good.

More generally, our results suggest that if signaling the value of policy change is important, it may better to use changes in policy that has no direct social benefit to convey information and build coalitions rather than using changes in policy with direct social benefits.[11] Or, a leader may want to signal the importance she assigns to larger policy goals (for example, energy independence) by forgoing her preferred policy on smaller goals (for example, by allowing offshore oil drilling in specific areas).

Our arguments are in line other work in political economy arguing that specific political institutions may be useful in conveying information. This may explain complex procedures, for example, standing committees and restrictive amendment procedures, as in Gilligan and Krehbiel (1987). As in the case of pork, information transmission may be important in an otherwise reviled practice, for example, special interest lobbies who have superior information about the effect of policies.

What should a reader take away from the paper? We think the general message is three-fold. First, in analyzing how legislatures operate, assuming homogeneous legislators may be reasonable for some questions but not others. This is more than the argument that heterogeneity is the *sine qua non* of political economy (Drazen, 2000); this is well recognized. It is the argument that the nature of heterogeneity may be crucial in analyzing political phenomena and especially how legislatures operate. Second, and more specifically, since

[11] A related positive consideration is the possibility of changing policy across broad categories, as opposed to redistributing benefits of existing policy – for example, changing level highway expenditure versus changing where the roads are built. Brender and Drazen (2009) find that leaders have no effect on the composition of expenditures in the short run.

coalition-building among legislators with different preferences is crucial to passing legislation, the allocation of pork or "favors" will play a role in the process. This too is recognized. Our addition is to show that this role may be for better-informed legislative leaders to convince less-informed legislators of the need for policy changes. Third, and most generally, our paper presents yet another example of pitfalls in using representative agent models.

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