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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, pork will be observed when the public good is most valuable precisely because it 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 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 highly 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 if there is general agreement on the high social value of public goods, that is, general agreement on the existence and magnitude of a "crisis", reflecting common information. Similarly, general agreement on public goods expenditure in a time of acknowledged crisis is possible when legislators are homogeneous in their preferences over spending. That is, all agree there is a crisis, on its depth, and on what should be done. 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 agreement on politics as usual. 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].

[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 supermajority coalitions.

In reality, we do not see such a simple dichotomy, where pork disappears in times when certain types of spending are agreed to have a high social value. This is no doubt due in part to such agreement being less common than the above paragraph suggests. It is certainly also due to the nature of legislative decision-making, where enacting major legislation requires "deal-making". In fact, observation suggests not simply that pork does *not* disappear when high-priority legislative initiatives are adopted, but that provision of pork may be critical to the passage of such legislation – witness the failure of the 2008 Troubled Asset Relief Program legislation to pass in the House of Representatives on September 29th and its subsequent passage merely four days later when pork was added; or, the more recent passage of major health care legislation in the U.S.[2]

The more basic issue these observations raise is that the assumption of identical legislators, though analytically convenient in studying some issues, is not very realistic. Even considering a single economic policy, legislators differ in their beliefs about 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? Is handing out pork antithetical to a "responsible" policy-making in times of crisis, or, quite to the contrary, important in getting support for emergency measures?

The purpose of this paper is to address these questions. Our principal conclusion is that heterogeneity in legislators' ideology and information matters quite a bit in understanding how pork may be used when public spending has a high social value.[3] We find that introducing heterogeneity of this sort significantly changes the conventional wisdom about the distinction between BAU and RPM summarized in the opening paragraph. We find that in

[2]See http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/10/03/MNR813AHDN.DTL and http://www.lasvegassun.com/news/2009/dec/20/reid-compromise-gives-sweet-medicaid-deal-nebraska

[3]Baron and Diermeier (2001) consider a model of legislative bargaining with heterogeneity of legislators' preferences over policy, but agreement across legislators about the state of the world. See footnote 14 for a comparison of a key result.

situations that would lead to RPM under full information, pork will be given by the agenda setter to signal the state with asymmetric information. 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. We also find that in BAU pork may go to all legislators ("Complete BAU") or only some ("Partial BAU"); in the latter case, it may be either the agenda setter or the coalition partners who get pork, with the agenda setter getting none in the latter case. This contrasts with standard "divide-the-dollar" models of legislative bargaining, in which the agenda setter gets more pork than her coalition partners.

The logic of our results that pork may be used when the public good is most valuable may be explained as follows. 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 is conceptually different from bribing other legislators where their beliefs about the state are unchanged.

In the paper, we concentrate on a positive analysis of pork – showing how pork may allow information transmission about the state of nature which would be impossible in the absence of pork – rather than on a normative analysis. We believe, however, that our results have significant normative implications as well. Pork implies a set of public goods policies which would not be politically feasible if pork were restricted. Some of these policies would imply higher social welfare than the no-pork status quo, but which policy emerges from the political process depends on the political mechanism; more specifically, it depends on the bargaining protocol between the agenda setter and other legislators in the winning coalition. We analyze a "closed amendment" process where the agenda setter makes "take-it-or-leave-it" offers. In this case, there are equilibria where allowing pork increases welfare and equilibria where pork reduces welfare. The latter arise primarily because of the agenda-setter's ability to extract all the bargaining surplus from other coalition members. We nevertheless show that

even when pork is welfare reducing when the agenda setter receives all bargaining surplus, the feasible bargaining set includes policies where allowing allocation of pork increases social welfare. These feasible bargaining outcomes are consistent with the agenda setter having less bargaining power and other coalition members having more. An "open amendment" process, allowing coalition members to make counterproposals in the political process – which would be a more realistic description of the legislative process – may allow these superior outcomes to be reached. Hence, our positive analysis may serve as the basis for an analysis of alternative legislative processes, more descriptive of how legislatures actually work, which would show how pork improves welfare under asymmetric information.

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 present some evidence of asymmetrically-informed lawmakers. In section 3 we set out the basic model and the legislative process, as well as defining political equilibrium in the model. In section 4 we derive the political equilibrium under full information and characterize the various regimes. Section 5 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 6, 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. In section 7 we discuss some welfare implications of our results. Section 8 presents conclusions.

2 Asymmetrically Informed Legislators

Crucial to our argument about the signaling value of distributive policies is that lawmakers differ both in their information about the state of the world and in their ideology about what policy should be adopted in a given state of the world. An agenda setter may therefore want to transmit information to other differentially informed lawmakers about the state of

the world. Note that for a positive analysis of the use of pork in the legislative process under asymmetric information, the agenda setter's information need not be correct, but only different from that of other legislators. (A possible improvement in welfare due to the signaling role of pork of course depends on the agenda setter's information in fact being superior.)

The leading example of agenda setters being better informed is the case of standing committee chairs, for example in the U.S. House and Senate. Committee chairs (and to a lesser degree members) exhibit a higher level of expertise on topics covered by their committee due to self-selection into the committee, and through experience serving on the committee. The drafter of legislation probably gains additional information about the state of the economy relevant to the proposed bill in the process of drafting legislation. Moreover, committee chairs and other agenda setters are better informed about topics for which they propose legislation due to the increased intensity of lobbying by special interest groups (who themselves are well informed about the topics on which they lobby) towards these legislators.[4] The permanent committee system in the U.S. Senate means that "the committees assumed the prerogative of determining which substantive provisions the Senate should consider, and they became policy-making bodies instead of merely technical aids to the chamber. Whereas the Senate formerly set the agenda, the committees came to be, in effect the Senate's "agenda-maker."[5] The same is true, perhaps even more so, in the U.S. House of Representatives, since House committee members specialize more than those in Senate. As Asher (1974) puts it, "congressmen accomplish their business largely by relying on the judgment of others." See also Shepsle (1988) in this regard.

In short, the organization and effective operation of Congress via the committee system means that those in positions of agenda-setting power on an issue are better informed and relied upon on that issue.

Although conventional wisdom is that lawmakers may have similar information in times of extreme crisis when there is a "need for action", we do not agree. Though there may be a common perception that there is a crisis which calls for a policy response, there will likely be disagreement among lawmakers about the causes, development, and magnitude of the crisis. Hence, in addition to any differences in preferred response due to ideological

[4] See, for example, Ansolabehere, Snyder, and Tripathi (2002).

[5] http://www.senate.gov/artandhistory/history/common/briefing/Committees.htm

differences, lawmakers will likely disagree about the nature of the crisis and hence about the policy response. This was certainly the case for the 2008 financial crisis in the U.S. and the Bailout bill in September and October. This was true in other countries as well. In Spain, for example, in 2008 there were heated debates between the incumbent PSOE party, led by Zapatero, and the opposition party PP, led by Rajoy, about the severity of the economic downturn.[6]

Another example concerns New York State. Though the state is facing large budget shortfalls in the current economic downturn, "a lot of [state] legislators don't feel the sense of emergency," or, as one legislator put it,"it's not clear that the sky is in fact falling".[7] In contrast, Governor Patterson viewed the fiscal shortfall with such alarm, that he proposed cuts in his own "pet projects", it would appear to emphasize the severity of the budget situation.[8] This obviously points to heterogeneous beliefs about the magnitude of the States's budget crisis among state legislators, where the administration proposing budget cuts faces disagreement the how serious the problem really is. In this paper we explore the possibility that cuts in pet projects could be more than mere budgetary necessity, but also an attempt to signal information about the severity of the State's fiscal standing.

We further note that observing pork in major legislative packages, such as TARP or health care as mentioned above, does not necessarily tell us whether it is being used to inform or to bribe legislators to get their support. Discriminating the actual functions of pork in specific cases is an interesting, albeit difficult task. It is particularly challenging given that our theory implies that in equilibrium pork barrel spending will have both informational and bribing roles. In this paper we explore the possibility that there are uses for pork other than bribing in which the agenda setter can transfer information by giving pork to other legislators and forgoing it herself. We hope that our theoretical work will inform future empirical explorations of the of role pork barrel spending as a communication device in legislatures.

[6] We are indebted to Monica Martinez-Bravo for bringinging this to our attention. See for example, http://www.libertaddigital.com/economia/zapatero-se-burla-del-congreso-con-un-discurso-triunfalista-en-plena-crisis-1276334002/

[7] http://www.thisamericanlife.org/radio-archives/episode/410/social-contract , minute 28.

[8] See for example http://www.syracuse.com/news/index.ssf/2010/07/ny_gov_david_paterson_vetoes_p.html, http://www.syracuse.com/news/index.ssf/2010/12/report_gov_paterson_doled_167.html.

3 Model

3.1 Set-up

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

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

where g and c^i are the consumption of public and private goods, respectively, and l 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:

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

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

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

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 a combination of households' utility from consumption *net* of s^i (that is, from $(1 - \tau)\, l$) and from the disutility of labor l. Note that this is only a function of τ and

is identical across all individuals. We may write this indirect utility function as

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

where $\hat{u}\left(\tau\right)(\equiv \frac{\varepsilon^{\varepsilon}(1-\tau)^{\varepsilon+1}}{\varepsilon+1})$ denotes the utility from leisure and labor-financed consumption.

3.2 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.[9] 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. These information assumptions represent the potentially superior information of agenda setters on some policy matters discussed in section 2. Consistent with the notion that the $z = \underline{z}$ state reflects normal times, while $z = \bar{z}$ reflects a crisis, we assume that $p < \frac{1}{2}$. We will state explicitly whenever this assumption affects our results.

3.3 Political equilibrium

We consider the case with three legislators, with $n^R = n^C = n^L = 1$ and $m = 2$.[10] Suppose that the agenda setter is "left-wing" in that $\alpha^{AS} = +\alpha$.[11] 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

$$g + s^C + s^{\alpha} \leq R\left(\tau\right) - X \tag{5}$$

where X denotes prior obligations which must be met (for example, debt service) and $R\left(\tau\right)$ is government revenue as a function of τ defined by

[9] For ease of exposition, the agenda setter will be female, the independent legislator male.

[10] When there are more than three legislators, the basic arguments are the same.

[11] 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.

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

from $R(\tau) = 3\tau l(\tau)$ and $l(\tau)$ given by (3). We naturally assume that $X < R(\tau^{\max})$, where $\tau^{\max} = \frac{1}{\varepsilon+1}$ is the revenue-maximizing tax rate. Any obligations exceeding this level would not be serviceable, and in a richer dynamic model, with non-defaultable debt, such levels of debt would violate the government's transversality condition.

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 $R(\tau^q) = g^q + X$).[12] 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.

3.4 The status quo and preferred policy

Our focus on the problem of information transmission suggests considering a status quo policy which the centrist would consent to change only if he believed that the state is $z = \bar{z}$. A simple assumption in this respect is that the status quo policy is that which would be chosen by a social planner who distributes no pork and who does not know the value of z. In other words, the status quo solves

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

The optimality of τ^q when no legislator knows the state means that our results are not driven by extreme assumptions about the default policy.

It is also useful for the exposition to define the most preferred policy of any legislator in the absence of pork as

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

where we note that $\tau^*(\zeta, X)$ is increasing in both ζ and X.[13] This equation may be solved

[12] 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 features of equilibrium in their paper would not change if they used the protocol we use here given their assumptions on legislator homogeneity and perfect information.

[13] $\tau^*(\zeta, X)$ solves $v'\left(R\left(\tau^*(\zeta, X) - X\right)\right)\frac{1-\tau^*(\zeta,X)-\varepsilon\tau^*(\zeta,X)}{1-\tau^*(\zeta,X)} = \frac{1}{3\zeta}$, which implies the above drivatives.

for

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

that is, a legislator with preferences ζ for the provision of public goods who is constrained not to distribute pork will equate her marginal value of the public good $\zeta v_g\left(g\right)$ to the marginal cost of raising a unit of tax revenues $\mu\left(\tau\right)$. This marginal cost (per legislator) is given by

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

With this notation in hand, the status quo is simply

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

Our assumption about the status quo policy combined with the assumption that the agenda setter is left-wing ($\alpha > 0$) implies that the following must be true of desired tax rates:

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

The second two inequalities simply reflect the assumption on τ^q summarized in (8), so that $\bar{z} > z^e > \underline{z}$ implies $\tau^*\left(\bar{z}, X\right) > \tau^q > \tau^*\left(\underline{z}, X\right)$. The first inequality follows simply from a left-wing agenda-setter preferring higher taxes than the centrist in a given state of nature.

The potential problem faced by the agenda-setter under asymmetric information comes from the relationship between the preferred policy of the *centrist in a "crisis"* ($z = \bar{z}$) and the *agenda setter in "normal" times* ($z = \underline{z}$). There is no conflict if $\tau^*\left(\bar{z}, X\right) > \tau^*\left(\underline{z}+\alpha, X\right)$, that is, when the difference in policy preferences due the state of nature outweighs the difference due to different ideology (or $\bar{z} - \underline{z} > \alpha$). In this case, $\tau^*\left(\bar{z}+\alpha, X\right) > \tau^*\left(\bar{z}, X\right) > \tau^*\left(\underline{z}+\alpha, X\right) > \tau^*\left(\underline{z}, X\right)$. The agreement on the need for higher taxes in $\bar{z}$ than in $\underline{z}$ means policy itself may signal the state.

A problem arises for the agenda-setter, however, when her preferred policy even in normal times exceeds that of the centrist in a crisis. When $\tau^*\left(\underline{z}+\alpha, X\right) > \tau^*\left(\bar{z}, X\right)$, the agenda-setter's ideology implies that she would like higher spending no matter what the state ($\alpha > \bar{z} - \underline{z}$). Under asymmetric information the centrist doesn't know whether the agenda-setter's proposed higher spending (which the centrist would accept when $z = \bar{z}$ but not when $z = \underline{z}$)

reflects a crisis or simply the agenda-setter's taste for high spending. The ranking of preferred policies is

$$\tau^*(\bar{z}+\alpha, X) > \tau^*(\underline{z}+\alpha, X) > \tau^*(\bar{z}, X) > \tau^q > \tau^*(\underline{z}, X) \tag{10}$$

The agenda-setter can gain agreement of the centrist to raise taxes above the status quo τ^q if she can convince him the state is $\bar{z}$ rather than $\underline{z}$, but her conflict of interest with the centrist over ideological preferences for high or low spending presents her with a cheap talk problem.[14] This is the problem we want to consider, so from here on we assume that $\alpha > \bar{z} - \underline{z}$ so the ranking in (10) holds.

4 Full-Information Benchmark

As a benchmark and as an aid in understanding the possible informational role of pork, we begin with the case of full information. The nature of the equilibrium that obtains depends on the parameter values α, $\bar{z}$, and $\underline{z}$.

4.1 The agenda-setter's optimization problem

When the value of z is common knowledge, the agenda setter proposes legislation for $z \in \{\underline{z}, \bar{z}\}$ that maximizes

$$\max_{g,\tau,\{s^i\}} \hat{u}(\tau) + (z+\alpha)\, v(g) + s^\alpha \tag{11}$$

subject to

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

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

$$g + s^C + s^\alpha \leq R(\tau) - X, \tag{12c}$$

$$s^C \geq 0, \tag{12d}$$

$$s^\alpha \geq 0. \tag{12e}$$

[14] This is 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 available. However, the addition of pork (or some other policy) may enable the left-winger to signal and enact optimal policy.

where (12a) is the participation constraint of the centrist, while (12b) is the "participation constraint" of the agenda setter. It can be shown that under full information (12b) is always slack (as long as equilibrium implies a deviation from the status quo) and (12a) is always binding in equilibrium. (12d) and (12e) are the non-negativity constraints, which will be useful in characterizing whether the equilibrium is BAU or RPM.

4.2 Policy choice when $z = \underline{z}$

We exposit the case where $z = \underline{z}$, which will also give the policy choices in a separating equilibrium under asymmetric information under separation in this state. (The full information case where $z = \bar{z}$ has no relevance for asymmetric information and is technically more complex. It is treated in Appendix A.2.)

The assumption that $\alpha > \bar{z} - \underline{z}$, so that (10) holds, means that desired tax rates are $\tau^*(\underline{z} + \alpha, X) > \tau^q > \tau^*(\underline{z}, X)$. This implies the following 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):

$$\underline{z} v_g\left(R\left(\tau^q\right) - X\right) < \mu\left(\tau^q\right) < \left(\underline{z} + \alpha\right) v_g\left(R\left(\tau^q\right) - X\right). \tag{13}$$

This ranking reflects the conflict of interest described earlier. While the agenda setter would prefer a policy mix with higher taxes and higher government expenditure, all else equal, the centrist would prefer a policy mix with lower taxes and lower government expenditures.

A key observation in deriving regimes is that while these *relative* magnitudes are fixed by the assumption that $\alpha > \bar{z} - \underline{z}$, the *absolute* magnitudes are not. The absolute magnitudes will also depend on X, which therefore determines the nature of the equilibrium. This full-information characteristic parallels Battaglini and Coate (2008) when X represents preexisting debt-service requirements which determine whether the economy is in BAU and RPM.

Ideological differences between the agenda setter and the centrist imply that BAU is comprised of two regimes: one where both legislators obtain pork as in the homogeneous legislator case, which we term *"Complete" BAU*; and one where only the centrist gets pork, which we term *"Partial" BAU*, just enough pork to get him to agree to the spending and

tax changes the agenda setter proposes. Hence, including RPM in which neither legislator gets pork, there are now three regions of the state space. Which region obtains depends on the values of the marginal cost of taxation and the marginal benefit of public goods in the status quo. This may be summarized as

Proposition 1 *If* $p < \frac{1}{2}$*, there are three regions of the state space which are mutually exclusive and exhaustive.*

1. RPM *when* $\mu(\tau^q) > 1$ *or when* $1 > \mu(\tau^q) > ((\underline{z}+\alpha) v_g(g^q)/(1+\alpha) v_g(g^q))$*. Neither legislator gets pork and the equilibrium is the status quo;*

When $\mu(\tau^q) < 1$ *and* $\mu(\tau^q) \leq (\underline{z}+\alpha) v_g(g^q)/(1+\alpha v_g(g^q))$*, there are two possibilities:*

2. Complete BAU *when*

$$\hat{u}(\tau^q) + \underline{z}v(g^q) + X < R\left(\tau^{BAU}\right) + \hat{u}\left(\tau^{BAU}\right) + \underline{z}v\left(g^{BAU}\right) - g^{BAU},$$

where $\left\{\tau^{BAU}, g^{BAU}\right\}$ *are the solutions to* $\mu\left(\tau^{BAU}\right) = \frac{1}{2}$ *and* $(2\underline{z}+\alpha) v_g\left(g^{BAU}\right) = 1$*. Both legislators get pork.*

3. Partial BAU *when*

$$\hat{u}(\tau^q) + \underline{z}v(g^q) + X \geq R\left(\tau^{BAU}\right) + \hat{u}\left(\tau^{BAU}\right) + \underline{z}v\left(g^{BAU}\right) - g^{BAU}.$$

Only the centrist gets pork.

Proof. See Appendix C. ■

The intuition of this division of the state space is as follows. When the marginal cost of taxation in the status quo is above the value of pork ($\mu(\tau^q) > 1$), then no pork will be given. With every legislator agreeing that the marginal value of pork is lower the marginal cost of taxation – even if he were the sole beneficiary – pork cannot be part of the equilibrium proposal. The equilibrium may still be one with no pork even if $\mu(\tau^q) < 1$ if there is no division of increased tax revenue when $\tau > \tau^q$ between higher g and pork for the centrist that makes both the centrist and the agenda setter better off. The last equality in part 1 of the proposition must be reversed for such a division to exist. When this inequality is reversed (and ($\mu(\tau^q) < 1$), pork will be given in the political equilibrium, that is, the equilibrium will be BAU, where one or both legislators will get pork.

Whether both legislators or only the centrist gets pork when $\mu(\tau^q) < 1$ and pork is consistent with both legislators being better off depends on the common marginal value of pork, the collective marginal value of the public good to the two legislators ($(2\underline{z} + \alpha) v_g(\cdot)$), and the collective marginal cost of taxation. Note first that τ in political equilibrium can never be less than τ^{BAU}, defined by

$$2\mu\left(\tau^{BAU}\right) = 1, \tag{14}$$

the value of the tax rate such that the marginal cost of taxation to the entire coalition $2\mu(\tau)$ is equal to 1, the common marginal value of pork. At any lower tax rate, the marginal cost of taxation would be less than $\frac{1}{2}$, so that each coalition member would favor higher taxes for pork equally distributed.

If $(2\underline{z} + \alpha) v_g\left(R\left(\tau^{BAU}\right) - X\right) < 1$ (that is, the collective value of pork exceeds the collective marginal value of g when all net revenues at $\tau = \tau^{BAU}$ go to g) then pork is distributed until $(2\underline{z} + \alpha) v_g\left(R\left(\tau^{BAU}\right) - X - s^{\alpha} - s^{C}\right) = 1$. Both coalition members get pork and we are in Complete BAU.

Conversely, if $(2\underline{z} + \alpha) v_g\left(R\left(\tau^{BAU}\right) - X\right) > 1$, the agenda setter prefers higher g to receiving pork and gives the centrist enough pork to induce him to accept the increase in τ and g above the status quo that the agenda setter desires. In equilibrium, $\tau > \tau^{BAU}$.

These possibilities may be illustrated in the top panel Figure 1 (shown below in section 6 in the discussion of asymmetric information), giving the importance of the magnitudes in (13) relative to 1. Since the relative values of the marginal benefit of the public good to the centrist, of the marginal cost of taxation, and of the marginal benefit of the public good to the agenda setter in the status quo are fixed by the assumption that $\alpha > \bar{z} - \underline{z}$, rather than sliding this ranking along the real number line, one can equivalently think of "sliding 1" over this ranking as represented in the diagram in the center.[15]

[15] An alternative interpretation of the number lines in Figure 1 is as representing decreasing values of X as we move to the right. As all the values on the central axis increase (in absolute terms and thus relative to the value 1) as X increases, lower values of X would place 1 farther to the right along this number line. There is a mapping between values of X–decreasing along the axis–and the cutoff points between the regimes.

5 Asymmetric Information

We now begin our consideration of asymmetric information about the state z. Our equilibrium concept is Perfect Bayesian Equilibrium.

5.1 Characterization of Equilibrium

Definition 1 *A perfect Bayesian equilibrium (PBE) of the political 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:*

$$\max_{g,\tau,\{s^i\}} \hat{u}(\tau) + (z + \alpha) v(g) + s^{\alpha} \tag{15}$$

subject to the constraints (12a), (12b), (12c), (12d), and (12e). 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 $z = \underline{z}$.*

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 the asymmetric information model. In a *Pooling* equilibrium, 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. In a *Separating* equilibrium the $z = \underline{z}$ agenda setter chooses his full information policy analyzed above, while the $z = \bar{z}$ agenda setter chooses policy the $z = \underline{z}$ agenda setter would not mimic. Coalition members' beliefs are $\tilde{z} = z$ when the optimal proposals of the $z = \bar{z}$ and the $z = \underline{z}$ agenda setters are observed.

In the separating equilibrium when $z = \bar{z}$, the agenda setter proposes a policy that maximizes her utility, subject to the participation of the centrist, and subject to informing that $z = \bar{z}$. This additional informational constraint augments the maximization problem in

Definition 1 with

$$\hat{u}(\tau) + (\underline{z} + \alpha) v(g) + s^{\alpha} \leq U^{\alpha}_{\underline{z}}, \tag{16}$$

where $U^{\alpha}_{\underline{z}}$ is the agenda setter's utility in the separating equilibrium when $z = \underline{z}$. That is, the proposal when $z = \bar{z}$ is informative only if it would be undesirable for the agenda setter to mimic if $z = \underline{z}$. The first order conditions of this maximization problem are outlined in Appendix B.

In a candidate pooling equilibrium, on the other hand, when $z = \underline{z}$, the agenda setter successfully mimics the proposal of the $z = \bar{z}$ agenda setter. The information set of the centrist is accordingly $\tilde{z} = z^e$. The $z = \bar{z}$ agenda-setter's proposal given the centrist's beliefs is the solution to the full information problem defined by (11) and (12), but where (12a) is replaced with

$$\hat{u}(\tau) + z^e v(g) + s^C \geq \hat{u}(\tau^q) + z^e v(g^q). \tag{17}$$

In this candidate equilibrium, the agenda setter $z = \underline{z}$ simply mimics this proposal.

Our main results are, first, that if no pork is allowed, pooling at the status quo is the only equilibrium; there is no separating equilibrium. Hence, in the absence of pork, the agenda-setter's information about the state cannot be transmitted. In sharp contrast, when pork is available a separating equilibrium always exists, and it is the only equilibrium that satisfies the Cho-Kreps intuitive criterion. No pooling equilibrium satisfies this criterion. Hence, when pork is available, the equilibrium is separating and the agenda setter can successfully reveal the state through use of pork. For any X that doesn't exhaust total possible revenues $R(\tau^{\max})$, some of revenue will go to pork, so that when $z = \bar{z}$ only BAU exists. There are no RPM equilibria when $z = \bar{z}$ because it is pork which allows policy to respond to the high value of public goods. Hence, pork is not antithetical to "responsible policy-making", but integral to it.

5.2 Restricting Pork

As a benchmark, we begin with the case in which pork barrel spending (i.e., earmarks) is *restricted by law* (which "conventional wisdom" sees as socially beneficial.) The maximization problem is that given in Definition 1, with the additional constraint that $s^C = s^{\alpha} = 0$. With this restriction on parameter values, legislative bargaining is over g and τ, alone, which

subject the budget constraint (12c), is equivalent to a choice of a single policy instrument τ.

The main result is that when pork is restricted to be zero, the only equilibrium is pooling at the status quo policy $\tau^q = \tau^* (z^e, X)$. Separation is not possible. To see why, note first that given the centrist's information $\tilde{z} = z^e$, the status quo policy τ^q is already the optimal policy for the centrist. Thus, any change in policy without changing the centrist's information set would violate his participation constraint and would therefore be infeasible. In other words, the only pooling equilibrium is at $\tau = \tau^q$.

To see why no separating equilibrium is possible, recall the ranking in (10) consistent with $\alpha > \bar{z} - \underline{z}$, where $\tau^* (\underline{z} + \alpha, X) > \tau^* (\bar{z}, X)$. Any tax increase the centrist would accept when he believes $\tilde{z} = \bar{z}$ would also be preferred relative to the status quo by the agenda setter when $z = \underline{z}$. Hence, any shift in policy acceptable to the centrist would be mimicked by the $z = \underline{z}$ agenda setter. Separation requires the $z = \bar{z}$ agenda setter to shift policy farther to the left than would be acceptable to the $z = \underline{z}$ agenda setter, but a shift so far to the left would also be unacceptable to centrist even though he believes $\tilde{z} = \bar{z}$. Hence, no proposal satisfies both the informational constraint and the centrist's participation constraint. Therefore no separating PBE exists, and we are left with pooling at $\tau = \tau^q$. We summarize this result in the following proposition.

Proposition 2 *If pork is exogenously restricted to zero, the unique PBE equilibrium is pooling at the status quo.*

Proof. In the text above. ■

As no separating PBE exists, the unique PBE is the pooling equilibrium where the agenda setter proposes the status quo regardless of the state of nature z. *Information transmission in the legislature is never possible in the absence of pork.* In contrast, with pork, information transmission is almost always possible, as we show in the following section.

6 Pork As A Signal

We now turn to our main question: under asymmetric information about the state z, can pork be used to signal z? We now show that a separating (i.e., signaling) equilibrium is possible when pork is available. Not only is signalling possible, but for *all* values of X, the

unique PBE satisfying the Intuitive Criterion is separating. This result is summarized in the following proposition, whose proof can be found in Appendix C.

Proposition 3 *For any* $X \in (-\infty, R(\tau^{\max}))$*, a separating Perfect Bayesian Equilibrium exists. There is a unique separating equilibrium that satisfies the intuitive criterion, and it always contains a positive amount of pork provided to at least one legislative district. No pooling equilibrium satisfies the intuitive criterion.*

Proof: See Appendix.

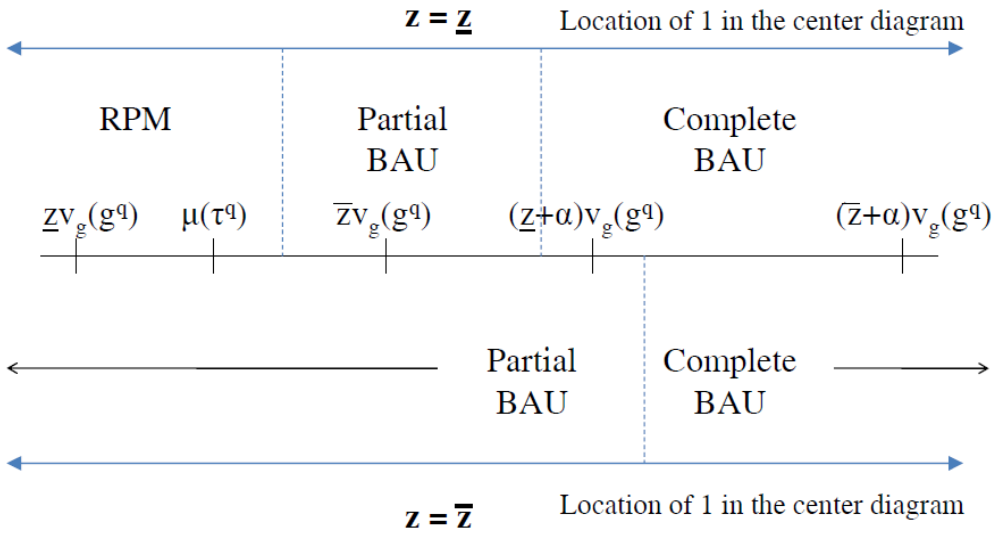
Possible political equilibria under asymmetric information are illustrated in Figure 1. The central axis gives the ranking of $\zeta v_g(g)$ for different values $\zeta \in \{\underline{z}, \bar{z}, \underline{z}+\alpha, \bar{z}+\alpha\}$ and $\mu(\tau)$. The top and bottom panels give the location of the value 1 relative to these terms for $z = \underline{z}$ and $z = \bar{z}$, respectively. Dotted lines indicate the cutoffs between regimes. This divides the state-space into three regions, depending on whether the $z = \underline{z}$ proposal is RPM, Partial BAU, or Complete BAU.

In a separating equilibrium, when $z = \underline{z}$ the agenda setter proposes policies identical to the full information equilibrium for $z = \underline{z}$. This may be seen in the upper panel of Figure 1. When $z = \bar{z}$, the agenda offers the best legislation (from her perspective) that the centrist would accept, but with the additional constraint that the proposed policy signals that $z = \bar{z}$. This constraint is as described in (16).

6.1 Separating equilibrium – the basic argument

Proving the existence of a separating equilibrium relies on constructing such an equilibrium, where the essence of the construction is useful in understanding the result. The key point is that since the agenda setter values spending less when $z = \underline{z}$ than when $z = \bar{z}$, a costly marginal increase in tax revenues relative to the status quo could be used for a small enough increase in g (so that the agenda setter would accept it only if $z = \bar{z}$) and a large enough remainder in pork going to the centrist that he agrees to the change when the state is revealed to be $\bar{z}$. Crucial to the argument is that the marginal tax increase goes neither entirely to higher g nor to pork, but is divided in such a way to make both the $z = \bar{z}$ agenda setter and the centrist better off (the latter to satisfy his participation constraint) but to leave the $z = \underline{z}$ no better off (to satisfy the separation condition).

Figure 1: Equilibrium under asymmetric information



Consider a marginal deviation from the status quo where an infinitessimal increase (of unit measure) in tax revenues is used to finance a combination of higher public expenditure Δg and pork to the centrist of $\Delta s^C = 1 - \Delta g$, and such that

$$(\underline{z} + \alpha)\, v_g\,(g^q)\, \Delta g = \mu\,(\tau^q)$$

or

$$\Delta g = \frac{\mu\,(\tau^q)}{(\underline{z} + \alpha)\, v_g\,(g^q)} < 1. \tag{18}$$

In words, consider a fraction Δg of the tax increase such that the marginal cost of the increase in taxation is just equal to the marginal value of the increase in g to the agenda setter if $z = \underline{z}$. This is obviously budget feasible since $(\underline{z} + \alpha)\, v_g\,(g^q) > \mu\,(\tau^q)$ (the left-wing agenda setter supports an increase in public goods spending even when $z = \underline{z}$). This change leaves the centrist better off. To see this, observe that the utility of the centrist changes by

$$\Delta U^C = \bar{z} v_g\,(g^q)\, \Delta g + 1 - \Delta g - \mu\,(\tau^q)\,,$$

or, using (18), the change in the centrist's utility is

$$\Delta U^C = [\bar{z} v_g\,(g^q) - 1]\, \frac{\mu\,(\tau^q)}{(\underline{z} + \alpha)\, v_g\,(g^q)} + 1 - \mu\,(\tau^q)\,.$$

$\Delta U^C \geq 0$ is equivalent to

$$\frac{1-\bar{z}v_g\left(g^q\right)}{\left(\underline{z}+\alpha\right)v_g\left(g^q\right)} \leq \frac{1-\mu\left(\tau^q\right)}{\mu\left(\tau^q\right)}.$$

This inequality must hold since $\bar{z}v_g\left(g^q\right) > \mu\left(\tau^q\right)$ (the centrist supports an increase in public goods spending when he believes the state is $\bar{z}$) and $\left(\underline{z}+\alpha\right)v_g\left(g^q\right) > \mu\left(\tau^q\right)$. Hence, such a deviation always makes the centrist better off.

The deviation also increases the agenda setter's utility when $z = \bar{z}$. Her utility increases if and only if

$$\left(\bar{z}+\alpha\right)v_g\left(g^q\right)\Delta g - \mu\left(\tau^q\right) \geq 0,$$

which using (18) in this inequality yields

$$\frac{\left(\bar{z}+\alpha\right)v_g\left(g^q\right)}{\left(\underline{z}+\alpha\right)v_g\left(g^q\right)}\mu\left(\tau^q\right) - \mu\left(\tau^q\right) \geq 0,$$

which always holds as $z = \bar{z}$. Hence, *regardless of the value of* X, there is a policy $\hat{\pi} = \left\{\tau, g, s^C, s^\alpha\right\}$ strictly different than $\pi^q = \left\{\tau^q, g^q, 0, 0\right\}$ that is acceptable to the coalition if $z = \bar{z}$ but would not be if $z = \underline{z}$, thus signaling the state.

The formal proof shows that this argument demonstrates that $\hat{\pi}$ satisfies the Cho-Kreps criterion in ruling out π^q. Moreover, the necessary conditions for an intuitive separating equilibrium indicate that only one separating equilibrium may satisfy the intuitive criterion. Finally, one may show that no pooling equilibrium satisfies the intuitive criterion.

The intuition of why pork allows a policy response when $z = \bar{z}$, a response that would not be possible if pork were outlawed, may be explained as follows. The combined task of signalling and coalition building requires aiding and hurting different legislators – and in different states of nature – differentially. Hurting the agenda setter differently when $z = \underline{z}$ and $z = \bar{z}$ can be done in two ways, each optimal under different conditions. One is for the agenda setter to finance increased government spending with decreases in her own pork in a magnitude that she would find acceptable only if $z = \bar{z}$, where the value of the public good relative to pork is high. This will be acceptable to the centrist, as he is always happy to see public goods funded with the agenda setter's pork. In fact, once he learns that $z = \bar{z}$, he will be willing to forgo pork in favor of the public good as well.

Alternatively, the agenda setter can raise tax revenues to finance public good expenditures. As demonstrated above, if *few* enough of the tax resources are allocated to public

good expenditure, only when $z = \bar{z}$ would the agenda setter be willing to tolerate the cost of public funds required to finance them, hence signaling that $z = \bar{z}$. However, for this to be an equilibrium, the residual tax revenues cannot simply be "burned", which points to the coalition-building aspect of pork. As was the case when pork was restricted, a tax-expenditure trade-off that is unacceptable to the agenda setter when $z = \underline{z}$ will also be unacceptable to the centrist in either state of nature. Rather than disposing of the remaining tax revenues, the agenda setter uses them to bribe the centrist to accept the policy proposal. The proof of Proposition 3 shows that with pork, a joint signalling-coalition building proposal is always feasible.

The popular view of pork is that it is wasteful because it sacrifices the common good for sectorial interests. But this is *precisely* what make pork a potent information-transmission tool. The joint task of signalling and coalition building cannot be achieved with common-good instruments alone if different factions disagree on the nature of the common good. An additional, discriminatory instrument is required, and pork is particularly suited for this task.

We note that this additional instrument need not be pork. Other policies (such as specific legislative details) that have differential effects both across legislative districts and across "states of nature" would serve the same purpose, if they signal the state and allow a coalition to be formed to support a policy change. In equilibrium information and participation constraints are always binding: the information constraint requires the agenda setter to harm herself (differentially relative to the $z = \underline{z}$ state) while participation requires making the centrist better off than he would be in status quo. Hence, one requires redistribution both across districts and across states of nature. Thus policies that are usually viewed as inefficient may be required. Use of a policy that affects the "common good" would not work.

6.2 Provision of pork when $z=\bar{z}$

As noted in Proposition 3, the $z = \bar{z}$ proposal must involve the allocation of pork. Under asymmetric information, the regime must be either Complete or Partial BAU when $z = \bar{z}$; RPM does not occur. The first order conditions which determine the possible regimes in PBE are in Appendix B. We here characterize the two regimes.

6.2.1 Complete BAU

The first order conditions imply that in a Complete BAU, the informational constraint may or may not be binding. In the latter case, it is the centrist's participation constraint that is binding and that determines the transfer s^C to the centrist. The agenda setter proposes the $z = \bar{z}$ full information equilibrium which the $z = \underline{z}$ agenda setter would not want to mimic. That is, the agenda setter under $z = \bar{z}$ and has no need to alter her full information proposal in order to signal the state. The equilibrium is characterized by

$$\begin{aligned} 1 &= [2\bar{z} + \alpha]\, v_g(g) = 2\mu(\tau) && \text{(19a)} \\ s^C &= \hat{u}(\tau^q) - \hat{u}(\tau) + \bar{z}\,[v(g^q) - v(g)] && \text{(19b)} \\ s^\alpha &= R(\tau) - X - g - s^C. && \text{(19c)} \end{aligned}$$

Condition (19a) says that that the common marginal values to the coalition of both pork and the public good must equal the common marginal cost of taxation. The tax rate that satisfies this condition is τ^{BAU} in (14) . Condition (19b) determining s^C is the centrist's participation constraint implying indifference between the status quo and the agenda setter's proposal, with residual revenues going to s^α. This proposal will satisfy the informational constraint (16) with inequality.

Alternatively, when the information constraint is binding, the $z = \bar{z}$ agenda setter cannot signal the state with her full information proposal and must "distort" (τ, g) away from this policy. In this case, the problem's first order conditions imply that the equilibrium is characterized by $\tau = \tau^{BAU}$ and $\{g, s^C, s^\alpha\}$ given jointly by (19b), (19c), and (16) holding with equality. Complete BAU can occur in state $z = \bar{z}$ only when separating from a Complete BAU proposal in $z = \underline{z}$. Thus this regime is represented in the right-most region of the lower panel of Figure 1.

6.2.2 Partial BAU

In Partial BAU only one legislator gets pork. Partial BAU may occur when separating from any of the three $z = \underline{z}$ regimes. In contrast to the full information case above, it may be either the centrist or the agenda setter who receives pork when $z = \bar{z}$.

If it is the centrist who receives pork, we once again may be in an equilibrium in which the information constraint is or is not binding. In the latter case, the proposed policy is identical to one that would be proposed under full information with $z = \bar{z}$. This policy $\left\{\tau, g, s^C\right\}$ solves (19b), (19c), and

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

where the proposed values g and τ satisfy (16) with inequality. In contrast, when the information constraint binds, that is, (16) holds with equality, signaling $\bar{z}$ would require a further increase in pork to the centrist to inform him that $z = \bar{z}$. This policy is characterized by (19b), (19c), and (16).

Under different parameter values, it is possible that the agenda setter rather than the centrist will obtain pork barrel spending under Partial BAU. This would occur if there were a *pork-free* policy available to the $z = \bar{z}$ agenda setter sufficient to signal that $z = \bar{z}$ and also to ensure the participation of the centrist once he is informed that $z = \bar{z}$, with the centrist's participation constraint holding with some slack.[16] In this case, if the marginal value of pork exceeded the agenda-setter's marginal value of g, she would then exploit the slack in the centrist's participation constraint to obtain some pork barrel spending for her own district.[17]

6.2.3 ... versus RPM when z is low

It is perhaps most surprising that when the $z = \underline{z}$ equilibrium legislation is RPM, the $z = \bar{z}$ legislation is always Partial BAU, as it violates two intuitive results under complete

[16] The possibility of signaling that $z = \bar{z}$ and satisfying the centrist's participation constraint without pork may seem to contradict the logic of Proposition 2. We argued there that when pork is outlawed, a policy that is far enough to the left to signal that $z = \bar{z}$ is too far to the left to allow the participation of the centrist. What allows signaling without pork when $z = \bar{z}$ is the *availability of pork when* $z = \underline{z}$. The use of pork to bribe the centrist when $z = \underline{z}$ gives the agenda setter some surplus relative to the status quo in that state. When $z = \bar{z}$, separating equilibrium requires that the centrist be better off than in the status quo, but the $z = \underline{z}$ agenda setter be worse off than under the $z = \underline{z}$ policy proposal. When pork is unavailable the latter policy proposal is the status quo as well, so that the two objectives are contradictory. But when pork is used when $z = \underline{z}$, the policy proposal in that state gives the agenda setter a higher utility than in the status quo. There may therefore some no-pork policies that make the $z = \bar{z}$ agenda setter worse off relative to the $z = \underline{z}$ proposal, but the centrist better off relative to the status quo.

[17] In Baron and Diermeier (2001), where legislators have preferences over policy, the agenda setter can use the unsuitabilty of the staus quo to other legislators to extract rents from them.

information and homogenous agents. First, we would expect that pork be eliminated when X is sufficiently high (or 1 is sufficiently far to the left in Figure 1). Second, we would expect that pork is always decreasing in z all else equal. For example, in Battaglini and Coate (2008) 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.

We note first that in the part of the state space where the $z = \underline{z}$ proposal would be RPM under asymmetric information, the regime would be RPM under complete information, regardless of the value of z. A sufficient (but not necessary) condition for this to be the case is $\underline{z} v_g \left(R \left(\tau^q \right) - X \right) > 1$ (and hence all other magnitudes along the central axis of Figure 1 are also greater than 1). Such a 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 $\mu \left(\tau^q \right)$ and $v_g \left(R \left(\tau^q \right) - X \right)$. Under complete information, where legislators are homogeneous in their valuation of the public good, a high value of the public good implies that no pork is distributed.

This intuition doesn't hold under asymmetric information and legislator heterogeneity precisely because of these two features. Under asymmetric information pork is used to signal the value of the public good to less informed legislators who know the agenda setter has different preferences but do not know the state. That is, pork is used precisely *because* the public good is valuable and the informed agenda setter wants to signal this information, and the signal is most valuable to the agenda setter when the public good is most valuable. Hence, provision of 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. And, pork is given to the centrist under asymmetric information even though he gets higher direct utility from public goods.

6.3 Illustration of allocation of pork

This result that pork is allocated when $z = \bar{z}$ under asymmetric information in cases where RPM holds in both states under full information may be better understood from Figure 2, showing points of indifference with the status quo and the (top, 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 (second from

top, green) indifference curve of the agenda setter when $z = \underline{z}$ and the (bottom right, black) indifference curve of the agenda setter when $z = \bar{z}$. Both these indifference curves 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 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.

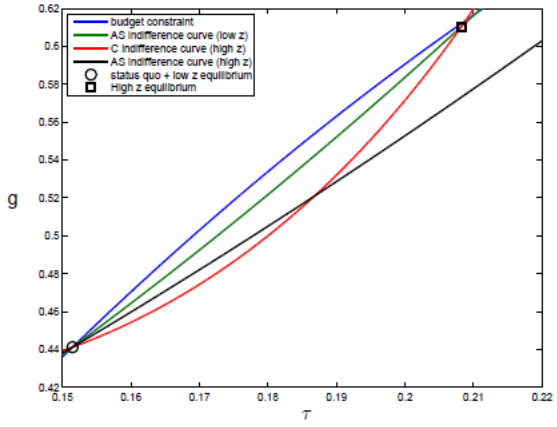
The lowest curve to intersect with the square (red) is the indifference curve of the centrist when it has been revealed that $z = \bar{z}$, while taking into account that the centrist receives all residual pork. It thus represents the centrist's participation constraint in the coalition conditional on his having learned the state $\bar{z}$. 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). Proposition 3 implies that the red line is below the green line to the right of the status quo. A separating equilibrium in which pork is provided is therefore feasible.

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 this information set and parameter values, the status quo is equilibrium.

7 When is Pork Welfare Improving?

We have concentrated on a positive analysis of pork, showing how pork may allow information transmission about the state of nature which would be impossible in the absence of pork. Can pork improve welfare relative to the case in section 5.2 where pork is outlawed? Two basic results emerge from our analysis. First, under the bargaining protocol we consider

Figure 2: Informational Pork in a Fiscal Crisis



here – where the agenda setter may make take-it-or-leave-it offers – the welfare effects of restricting pork depend on how pork is allocated in equilibrium, when it is allowed. In a partial BAU equilibrium in which it is the centrist who receives pork, allowing pork is unambiguously welfare reducing even though it allows signaling of the state. Conversely if the partial BAU equilibrium is one where it is the agenda setter who receives pork, allowing pork unambiguously increases welfare in a crisis relative to the case where it is restricted.

Second, the result that pork is welfare-reducing in the first case even though it allows signaling of the state depends critically on the assumption that the agenda setter extracts all the surplus in the bargaining process. When the bargaining protocol is such that the agenda setter does not obtain the entire surplus, pork may, more generally be welfare increasing.

On the first result, it is easy to show that the equilibrium illustrated in Figure 2 – in which only the centrist gets pork in an information-revealing equilibrium – is not welfare improving relative to the no pork status quo. At any $\{g, \tau, \{s^i\}\}$, the utility of the centrist when $z = \bar{z}$ is given by

$$U(\bar{z}) = \hat{u}(\tau) + \bar{z}v(g) + s^C. \tag{20}$$

The utility of the representative agent is:

$$\begin{aligned} U &= \hat{u}(\tau) + \bar{z}v(g) + \frac{\sum_i s^i}{3} \\ &= \hat{u}(\tau) + \bar{z}v(g) + \frac{s^C}{3} \end{aligned} \tag{21}$$

where the second line follows from the fact that only the centrist receives pork. Since the centrist's participation constraint is binding, we have $U(\bar{z}) - U^q(\bar{z}) = 0$, where $U^q(\bar{z})$ is the utility of the centrist in status quo. But as $U = U(\bar{z}) - \frac{2s^C}{3}$, it must be the case that allowing pork, with the resultant equilibrium, is welfare reducing.

Conversely, when the equilibrium is such that it is the agenda setter but not the centrist who receives pork in the separating equilibrium, an analogous argument shows the allowing pork *increases* welfare when $z = \bar{z}$ relative to the case where it is restricted. At any $\{g, \tau, \{s^i\}\}$, the utility of the centrist when $z = \bar{z}$ in (20) is simply

$$U(\bar{z}) = \hat{u}(\tau) + \bar{z}v(g).$$

The utility of the representative agent is now

$$\begin{aligned} U &= \hat{u}(\tau) + \bar{z}v(g) + \frac{\sum_i s^i}{3} \\ &= U(\bar{z}) + \frac{s^\alpha}{3}. \end{aligned}$$

But the (binding) participation constraint of the centrist implies that $U(\bar{z})$ is equal to the utility of the centrist (and the representative agent) in the status quo. Thus utility of the representative agent is higher with pork than without (at the status quo). Whether pork is welfare enhancing overall depends on whether this increase in welfare is enough to outweigh the cost of pork being used when $z = \underline{z}$, which always makes the representative agent worse off than the status quo. One may show however that there are reasonable parameter values for which expected welfare rises.

Key to these results is the agenda-setter's extracting all surplus, due to the assumption that she may make take-it-or-leave-it (TOL) offers. This means that the centrist's participation constraint is always binding in this equilibrium and he receives no surplus. Since the agenda setter always wants more spending independent of the state ($\alpha > \bar{z} - \underline{z}$, which is precisely what gives pork an informative role), the agenda setter will use her agenda setting power to push policy farther to the left (higher g) than is socially optimal. Hence the bargaining protocol implies that the centrist – whose preferences over public goods mirror those of the "average district" – is left just indifferent between the status quo and the equilibrium proposal. When combined with the assumption that the status quo is, by definition, one

where no pork is given, the result is that pork must lower welfare.

Given the centrality of the bargaining protocol for the possibly adverse welfare results of allowing pork, it is natural to ask whether other bargaining protocols would have a similar implication. A general answer to that question depends on the set of feasible bargaining outcomes, which is why the positive analysis we have presented is important. The set of bargaining outcomes is the set of points that are above both the red and black lines (so that both legislators agree to participate) and below the green line (so that information is conveyed) in Figure 2. Are there points inside this "lens" that welfare dominate the status quo? If so, a bargaining protocol the agenda-setter does *not* have all the bargaining power can imply a political equilibrium that is not only quantitatively different but *qualitatively* different as well, in that social welfare is higher.[18]

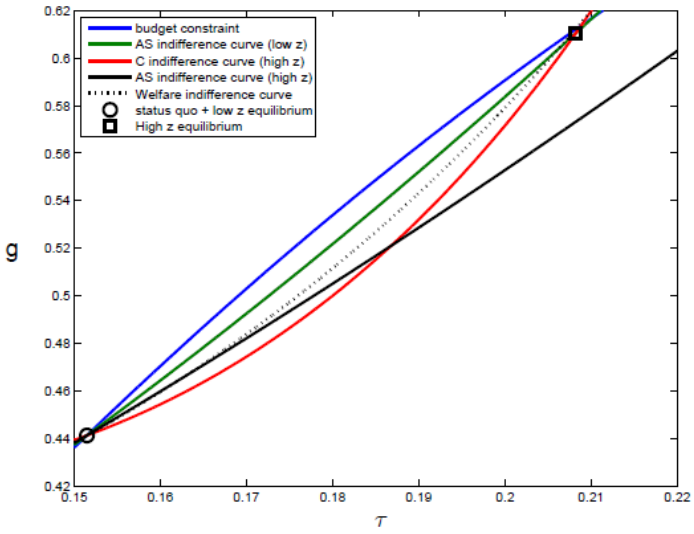
Consider parameter values so that α approaches $\bar{z}-\underline{z}$ from above. We have seen in section 6.2.3 that with these parameter values pork will always be provided when $z = \bar{z}$. With α arbitrarily close to $\bar{z} - \underline{z}$, $\underline{z} + \alpha$ is arbitrarily close to $\bar{z}$. This means that the indifference curve of the centrist without pork is everywhere arbitrarily close (from above) to the green line. The *with-pork* indifference curve of the representative agent is however strictly below this line (and therefore strictly below the green line) as (21) shows that the utility of the representative agent is obtained by adding $\frac{s^C}{3}$ to the no-pork utility of the centrist. We may represent this in Figure 3, which adds this indifference curve, represented by the dotted line, to Figure 2.

Any equilibrium policy above the dotted line, the indifference curve of the representative agent that runs through the status quo, is welfare increasing relative to the equilibrium where pork is outlawed. Thus the region between the dotted line and the green line is the set of policies that are within the bargaining set of the agenda setter and the centrist that are welfare improving. A bargaining protocol that instead of leading to the extreme outcome represented by the square in this figure, leads to such a point within the bargaining set, would lead to a welfare-improving equilibrium.

Since the bargaining set with pork includes outcomes that imply higher welfare than when pork is restricted to be zero, the question becomes whether such outcomes are po-

[18] This is a more general result in political models. A bargaining protocol such that bargaining power is interior implies qualitatively different results to one where one side may make TOL offers, sometimes substantially so. See Drazen and Limão (2008).

Figure 3: Welfare Improving Pork



litically feasible. That is, is there a legislative decision-making mechanism that will imply one of these outcomes as the political equilibrium? As already indicated this would be one in which the agenda-setter cannot make TOL offers, that is, where instead of a "closed-amendment" protocol, there is an "open-amendment" protocol allowing coalition members to make counterproposals in the political process.[19] Analyzing what equilibria would obtain under alternative, more realistic legislative decision-making procedures – and hence the welfare consequences of pork under those processes – is the next item on our research agenda.

8 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

[19] We note that experimental work on two-person "ultimatum games" finds that proposers in fact do not extract all the bargaining surplus but tend to propose a more even split. See, for example, Palfrey (2009).

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 policy-making. 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. 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 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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APPENDICES

A Analysis of full-information equilibrium

A.1 First order conditions of full-information problem

Let λ be the multiplier on the budget constraint (12c) and ϕ^C the multiplier on the participation constraint of the centrist (12a). ξ^C and ξ^α are the non-negativity constraints on s^C and s^α, respectively. Then the first order conditions of the full-information problem, described in (11) to (12d) are

$$\begin{aligned}\left[\left(1+\phi^C\right)z+\alpha\right]v_g\left(g\right) &= \lambda\\ \left(1+\phi^C\right)\mu\left(\tau\right) &= \lambda\\ 1+\xi^\alpha &= \lambda\\ \phi^C+\xi^C &= \lambda.\end{aligned}$$

We have four possible regimes, depending on the values of ξ^α, ξ^C, i.e. whether the agenda setter, the centrist, neither, or both receive pork.

The first such regime is Complete BAU where $\xi^\alpha = \xi^C = 0$ and $\lambda = \phi^C = 1$, so that

$$2\mu\left(\tau\right) = \left(2z+\alpha\right)v_g\left(g\right) = 1$$

and s^α and s^C are found through (12a) and (12c).

A second possible regime is RPM, where $s^\alpha = s^C = 0$. The analysis in Section **??** implies that when $z = \underline{z}$ RPM equilibrium is at the status quo, $\tau = \tau^q$ and $g = g^q$. We analyze RPM when $z = \bar{z}$ in Appendix A.2.

The final two regimes are Partial BAU and differ depending on whether the agenda setter or the centrist obtains pork in equilibrium. In Centrist Partial-BAU, the first order conditions imply that g, τ, and s^C are given jointly by (12a), (12c), with s^α set to zero in the latter, combined with

$$\frac{\left(z+\alpha\right)v_g\left(g\right)}{1-zv_g\left(g\right)} = \frac{\mu\left(\tau\right)}{1-\mu\left(\tau\right)}. \tag{22}$$

We show in the proof of Proposition 1 that as long as $p < \frac{1}{2}$, Partial BAU, where the agenda setter–but not the centrist–receives pork, does not occur when $z = \underline{z}$.

When $z = \bar{z}$, the nature of the Agenda-Setter Partial-BAU equilibrium–where the agenda setter, but not the centrist receives pork–depends on whether the participation constraint of the centrist (12a) is binding in equilibrium or not. If at the policy $\mu\left(\tau\right) = \left(\bar{z}+\alpha\right)v_g\left(g\right) = 1$, (12a) is satisfied with $s^C = 0$ then this is the Agenda-Setter Partial-BAU equilibrium.

Otherwise, the equilibrium is characterized by $s^C = 0$, (12a), (12c) and

$$\left(\frac{\bar{z}}{\mu(\tau)} + \alpha\right) v_g(g) = 1.$$

A.2 Policy choice when $z = \bar{z}$

We now set out the analysis of the full information case when $z = \bar{z}$. When $z = \bar{z}$, the parameter assumptions imply

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

The important difference with respect to the $z = \underline{z}$ case is that even in RPM–even when both legislators forgo pork–there will be a shift in policy, and equilibrium will not be at the status quo. As the above set of inequalities shows, in the absence of pork, both legislators agree that taxes aught to increase to finance additional government expenditures relative to the status quo.

We begin by analyzing RPM. If equilibrium is without pork, the agenda setter wishes to shift policy to the left, with the objective of reaching her preferred pork-free policy, $\tau^*(\bar{z} + \alpha)$. Whether this policy is feasible depends on whether the centrist prefers $\tau^*(\bar{z} + \alpha)$ to the status quo. To put this differently, let $\tilde{\tau}^q(\zeta) \neq \tau^q$ denote a pork-free policy that leaves a legislator with preferences ζ indifferent with respect to the status quo[20], defined implicitly by

$$\hat{u}(\tilde{\tau}^q(\zeta)) + \zeta v(R(\tilde{\tau}^q(\zeta)) - X) = \hat{u}(\tau^q) + \zeta v(R(\tau^q) - X).$$

If $\tau^*(\bar{z} + \alpha) > \tilde{\tau}^q(\bar{z})$ then the RPM equilibrium is at $\tau = \tilde{\tau}(\bar{z})$: the agenda setter is trying to shift policy to $\tau^*(\bar{z} + \alpha)$, but given that this is unacceptable to the centrist, she proposes the left-most policy the centrist would accept, which is $\tilde{\tau}(\bar{z})$. If in contrast $\tau^*(\bar{z} + \alpha) \leq \tilde{\tau}^q(\bar{z})$, RPM equilibrium is $\tau^*(\bar{z} + \alpha)$, which is feasible and leaves the centrist (weakly) better off relative to the status quo.

Which regime obtains under full-information when $z = \bar{z}$ depends then on the relative magnitude of $\mu(\tau^*(\bar{z} + \alpha))$ and $\mu(\tilde{\tau}^q(\bar{z}))$, and whether these two marginal costs of public funds are greater than or smaller than 1. We have four cases depending on this ranking. In what follows, we can think of adjusting from the status quo to equilibrium in two steps. First, the agenda setter adjusts policy alone, without distributing pork, to the most the favorable tax-expenditure mix from her perspective that the centrist would accept. That is, she shifts policy to either $\tau^*(\bar{z} + \alpha)$ or $\tilde{\tau}^q(\bar{z})$. Then, if she wishes to, she begins to distribute pork and adjust policy until reaching equilibrium. The four cases are as follows

1) $\tilde{\tau}^q(\bar{z}) < \tau^*(\bar{z} + \alpha)$, $\mu(\tilde{\tau}^q(\bar{z})) > 1$: The first inequality implies that $\tilde{\tau}^q(\bar{z})$ is the best feasible

[20] Given that, in the absence of pork, preferences are single-peaked in τ, there are always two tax rates that give a legislator the same utility, unless the tax rate is already the preferred policy of the legislator. $\tilde{\tau}^q(\zeta)$ gives the tax rate that gives a legislator with a marginal valuation of the public good of ζ the same utility as the status quo.

pork-free policy the agenda can obtain. The second inequality implies that both the agenda setter and the centrist prefer this policy to one with pork. Equilibrium is RPM with $\tau = \tilde{\tau}^q(\bar{z})$.

2) $\tilde{\tau}^q(\bar{z}) < \tau^*(\bar{z}+\alpha)$, $\mu(\tilde{\tau}^q(\bar{z})) < 1$: As before, the first inequality implies that $\tilde{\tau}^q(\bar{z})$ is the best feasible pork-free policy the agenda can obtain. However, the second inequality implies that there may be a mix of pork and policy-shift that is feasible and preferable to the agenda setter than the RPM policy of $\tilde{\tau}^q(\bar{z})$. Pork will be distributed to the centrist if and only if

$$\frac{(\bar{z}+\alpha)\, v_g\left(R\left(\tilde{\tau}^q(\bar{z})\right)-X\right)}{1-\bar{z}v_g\left(R\left(\tilde{\tau}^q(\bar{z})\right)-X\right)} > \frac{\mu\left(\tilde{\tau}^q(\bar{z})\right)}{1-\mu\left(\tilde{\tau}^q(\bar{z})\right)}, \tag{23}$$

while Complete BAU obtains if in addition

$$(2\bar{z}+\alpha)\, v_g\left(R\left(\tau^{BAU}\right)-X\right) < 1.$$

3) $\tau^*(\bar{z}+\alpha) < \tilde{\tau}^q(\bar{z})$, $\mu(\tau^*(\bar{z}+\alpha)) > 1$: The first inequality now implies that the agenda setter's preferred pork-free policy is feasible and moreover that the centrist's participation constraint is slack at the policy $\tau^*(\bar{z}+\alpha)$. By the second inequality, the agenda is better off at this pork-free policy than any one that provides her own district with pork. She does not need to provide pork to the centrist, as his participation constraint is slack. Thus equilibrium is RPM at $\tau = \tau^*(\bar{z}+\alpha)$.

4) $\tau^*(\bar{z}+\alpha) < \tilde{\tau}^q(\bar{z})$, $\mu(\tau^*(\bar{z}+\alpha)) < 1$: Again, the best feasible pork-free policy for the agenda setter is $\tau^*(\bar{z}+\alpha)$, but the second inequality states that the agenda setter would prefer to increase taxes beyond $\tau^*(\bar{z}+\alpha)$ to finance pork for her own district if feasible. But according to the first inequality, the centrist's participation constraint is slack at the pork-free policy $\tau^*(\bar{z}+\alpha)$, so that such an increase is feasible. In this case we therefore have Partial BAU with the agenda setter obtaining pork, or Complete BAU if in addition

$$(2\bar{z}+\alpha)\, v_g\left(R\left(\tau^{BAU}\right)-X\right) < 1.$$

B First order conditions with asymmetric information

The maximization problem for a separating equilibrium defined in Definition 1 yields the following first order conditions in each state $z = \bar{z}$ and $z = \underline{z}$, that solve for the nine variables $\left\{g, \tau, s^\alpha, s^C, \lambda, \phi^C, \zeta^c, \zeta^\alpha, \psi\right\}$:

$$\left[z\left(1+\phi^C\right)+\alpha(1-\psi)-\underline{z}\psi\right] v_g(g) = \lambda, \tag{24}$$

$$\left(1+\phi^C-\psi\right)\mu(\tau) = \lambda, \tag{25}$$

$$1+\xi^\alpha-\psi = \lambda, \tag{26}$$

$$\phi^C+\xi^C = \lambda, \tag{27}$$

$$\left\{\hat{u}(\tau)+zv(g)+s^C-\left[\hat{u}(\tau^q)+zv(g^q)\right]\right\}\phi^C=0, \tag{28}$$

$$R(\tau)-\left[X+g+s^C+s^\alpha\right]\geq 0, \tag{29}$$

$$\xi^C s^C=0 \tag{30}$$

$$\xi^\alpha s^\alpha=0 \tag{31}$$

$$\left\{\hat{u}(\tau)+(\underline{z}+\alpha)v(g)+s^\alpha-U^\alpha_{\underline{z}}\right\}\psi=0 \tag{32}$$

Where λ, ϕ^C and ψ are the Lagrange multipliers on the budget constraint, the participation constraint of the centrist, and the informational constraint (32), respectively. $\psi=0$ identically when the state is $z=\underline{z}$. ξ^c, ξ^α are the multipliers on the non-negativity constraints on s^C and s^α, respectively.

C Proof of Propositions

Proposition 1

If $p<\frac{1}{2}$, there are three regions of the state space which are mutually exclusive and exhaustive.
1. RPM *when $\mu(\tau^q)>1$ or when $1>\mu(\tau^q)>((\underline{z}+\alpha)v_g(g^q)/(1+\alpha)v_g(g^q))$. Neither legislator gets pork and the equilibrium is the status quo;*
When $\mu(\tau^q)<1$ and $\mu(\tau^q)\leq(\underline{z}+\alpha)v_g(g^q)/(1+\alpha v_g(g^q))$, there are two possibilities:
2. Complete BAU *when*

$$\hat{u}(\tau^q)+\underline{z}v(g^q)+X<R\left(\tau^{BAU}\right)+\hat{u}\left(\tau^{BAU}\right)+\underline{z}v\left(g^{BAU}\right)-g^{BAU},$$

where $\left\{\tau^{BAU}, g^{BAU}\right\}$ are the solutions to $\mu\left(\tau^{BAU}\right)=\frac{1}{2}$ and $(2\underline{z}+\alpha)v_g\left(g^{BAU}\right)=1$. Both legislators get pork.
3. Partial BAU *when*

$$\hat{u}(\tau^q)+\underline{z}v(g^q)+X\geq R\left(\tau^{BAU}\right)+\hat{u}\left(\tau^{BAU}\right)+\underline{z}v\left(g^{BAU}\right)-g^{BAU}.$$

Only the centrist gets pork.

Proof: We begin with a Lemma that shows that pork will not be allocated in equilibrium when $\mu(\tau^q)>1$. The agenda setter does not wish to cut public expenditures nor increase taxes in favor of pork, even if her district were the sole beneficiary, as $(\underline{z}+\alpha)v_g(g^q)>\mu(\tau^q)>1$, so that agenda setter's marginal value of the public good and marginal cost of taxation exceeds the marginal value of pork. The agenda setter moreover prefers a policy mix with higher public expenditure and higher taxes, and will thus never propose an decrease in public expenditure from the status quo. While the agenda setter would be willing to bear the cost of higher taxation in order to increase the provision of public goods, there is no combination of higher pork and public good expenditure which would persuade the centrist to deviate from the status quo in that direction, as the marginal cost of taxation exceeds both 1 and

$\underline{z}v_g(g^q)$. To conclude:

Lemma 1 *When $\mu(\tau^q) > 1$ equilibrium is RPM.*

The remainder of the proof considers the alternative where $\mu(\tau^q) < 1$. We begin by showing that the agenda setter never obtains pork alone, put differently:

Lemma 2 *If $p < \frac{1}{2}$ the centrist always receives pork in Partial BAU. A Partial BAU where the agenda setter but not the centrist receives pork, does not exist.*

The proof of this proposition is as follows. If the centrist does not obtain pork, increasing tax rates leaves the centrist worse off relative to the status quo, even if all revenues contributed to public good provision as $\mu(\tau^q) > \underline{z}v_g(g^q)$. Thus, if only the agenda setter obtains pork, this has to be financed through decreases in public good expenditure, matched with a (smaller) decrease in tax revenues. Consider then a decrease in public good provision of one unit, matched with a decrease in taxes that lowers tax revenues by

$$\Delta R(\tau) = \frac{\underline{z}v_g(g^q)}{\mu(\tau^q)} < 1.$$

This leaves the centrist indifferent relative to the status quo and leaves $1 - \Delta R(\tau)$ of remaining fiscal room that can be allocated as pork to the agenda setter. This policy shift increases the utility of the agenda setter if and only if

$$\Delta R(\tau)\mu(\tau^q) - (\underline{z} + \alpha)v_g(g^q) + 1 - \Delta R(\tau) \geq 0,$$

which is equivalent to the first inequality in

$$\mu(\tau^q) \leq \frac{p(\bar{z} - \underline{z})}{\alpha} < \frac{1}{2}.$$

The second inequality follows from the assumptions $\alpha > \bar{z} - \underline{z}$ and $p < \frac{1}{2}$. Manipulating policy to obtain pork barrel spending for herself, without allocating pork to the centrist can only be beneficial to the agenda setter if $\mu(\tau^q) < \frac{1}{2}$. But if this is the case, equilibrium must involve pork allocation the centrist as well. As the agenda setter is reducing taxes along the path to an equilibrium where the agenda setter alone receives pork, this counterfactual equilibrium would have $\mu(\tau) < \mu(\tau^q) < \frac{1}{2}$. But this cannot be equilibrium, as a positive deviation exists wherein taxes are increased (at a utility cost of less than one to the coalition) and pork is distributed to both districts (at a utility value of one to the coalition). Thus equilibrium cannot involve pork allocation to the agenda setter alone. The proof of this claim relied on the sufficient (but not necessary) assumption that $p < \frac{1}{2}$, so that the "crisis" state of $z = \bar{z}$ is less likely to occur than the $z = \underline{z}$. If this assumption were reversed, a Partial BAU with the agenda setter being the sole recipient of pork is possible. This relates to the result in Baron and Diermeier (2001), where the agenda setter can exploit the inadequacy

of the status quo for current conditions–in this case being more relevant for crisis conditions rather than normal times–to obtain pork for her own district.

We now show that if $\mu(\tau^q) < ((\underline{z}+\alpha) v_g(g^q)/(1+\alpha))$, pork will be distributed in equilibrium, at least to the centrist. The centrist would agree to increase taxes on the margin to raise one unit of revenues if those revenues were used to finance public good expenditures of Δg and pork of Δs^C such that

$$\underline{z} v_g(g^q) \Delta g + \Delta s^C \geq \mu(\tau^q).$$

If the agenda setter were to forgo pork altogether, so that $\Delta s^C = 1 - \Delta g$, a feasible policy would require

$$\Delta g \leq \frac{1-\mu(\tau^q)}{1-\underline{z} v_g(g^q)}.$$

This deviation from the status quo is desirable to the agenda setter if

$$(\underline{z}+\alpha) v_g(g^q) \Delta g \geq \mu(\tau^q).$$

The agenda setter would choose to provide the minimal amount of pork (and maximal amount of the public good) consistent with the centrist's participation, giving

$$\frac{(\underline{z}+\alpha) v_g(g^q)}{1-\underline{z} v_g(g^q)} \geq \frac{\mu(\tau^q)}{1-\mu(\tau^q)} \tag{33}$$

as a necessary condition for the provision of pork to the centrist. Otherwise, there is no combination of pork and public good provision that would both persuade the centrist to deviate from the status quo and improve the utility of the agenda setter.

As (33) is equivalent to

$$\mu(\tau^q) \leq (\underline{z}+\alpha) v_g(g^q) / (1+\alpha v_g(g^q))$$

whenever $\mu(\tau^q) < 1$, the previous paragraph proves the following lemma:

Lemma 3 *If*

$$\mu(\tau^q) > (\underline{z}+\alpha) v_g(g^q) / (1+\alpha v_g(g^q))$$

the centrist does not obtain pork in equilibrium.

Lemma 1 shows that if $\mu(\tau^q) > 1$, no pork will be distributed in equilibrium. Lemma 3 shows that the centrist does not obtain pork if

$$1 > \mu(\tau^q) > (\underline{z}+\alpha) v_g(g^q) / (1+\alpha v_g(g^q)),$$

while the agenda setter never obtains pork along according to Lemma 2. Thus these three lemmas combine to give the part (1) of the proposition.

Finally, we demonstrate that the appropriate inequality in

$$\hat{u}(\tau^q) + \underline{z} v(g^q) + X \lesseqgtr R(\tau^{BAU}) + \hat{u}(\tau^{BAU}) + \underline{z} v(g^{BAU}) - g^{BAU}$$

determines whether equilibrium is Partial- or Complete-BAU, as summarized in the following Lemma.

Lemma 4 *If the centrist obtains pork, then the agenda setter also obtains pork if and only if*

$$\hat{u}\left(\tau^{q}\right)+\underline{z}v\left(g^{q}\right)+X<R\left(\tau^{BAU}\right)+\hat{u}\left(\tau^{BAU}\right)+\underline{z}v\left(g^{BAU}\right)-g^{BAU}.$$

This lemma completes the second and third part of the proposition. Its proof is as follows. As the analysis in section A.1 shows, whether in Complete- or Partial- BAU, (22) holds. (In the former case, both sides of the equation are equal to 1).

Consider increasing taxes and public expenditures relative to the status quo along both the centrist's participation constraint and the budget constraint, with $s^{\alpha}=0$. This increases the right hand side and decreases the left hand side of (33). Proceed until (22) is reached. If (22) is reached at a point where both sides of the equation exceed 1 in value, equilibrium must be partial-BAU, as reaching the complete BAU equilibrium is infeasible. If, on the other hand, (22) is reached at a point where both sides of the equation are smaller than 1, equilibrium must be complete BAU, as from this point, the marginal cost of taxation and the marginal value of public goods to the coalition as a whole are both smaller than 1, which is the marginal value of pork to the coalition.

The cutoff between partial and complete BAU is the value of X that allows both the participation constraint and the budget constraint to hold with equality with $\tau=\tau^{BAU}$, $g=g^{BAU}$, and $s^{\alpha}=0$. The participation constraint gives

$$s^{C}=\hat{u}\left(\tau^{q}\right)+\underline{z}v\left(g^{q}\right)-\hat{u}\left(\tau^{BAU}\right)-\underline{z}v\left(g^{BAU}\right),$$

which put into the budget constraint yields:

$$\hat{u}\left(\tau^{q}\right)+\underline{z}v\left(g^{q}\right)+X=R\left(\tau^{BAU}\right)+\hat{u}\left(\tau^{BAU}\right)+\underline{z}v\left(g^{BAU}\right)-g^{BAU}$$

which gives the condition in Lemma 4 and parts (2) and (3) of the proposition.

Proposition 3

For any $X\in\left(-\infty,R\left(\tau^{\max}\right)\right)$, a separating Perfect Bayesian Equilibrium exists. There is a unique separating equilibrium that satisfies the intuitive criterion, and it always contains a positive amount of pork provided to at least one legislative district. No pooling equilibrium satisfies the intuitive criterion.

Proof: We begin by showing that a separating equilibrium exists that satisfies the intuitive criterion. To do so, we first outline in Lemma 5 a sufficient condition for the existence of a separating equilibrium.

Lemma 5 *Let $\pi=\left\{\tau,g,s^{C},s^{\alpha}\right\}$ denote a legislative proposal. A separating equilibrium that satisfies the intuitive criterion exists if there exists a policy proposal $\hat{\pi}\neq\pi^{q}$ (where*

$\pi^q \equiv \{\tau^q, g^q, 0, 0\}$*), such that*
(1) The $z = \bar{z}$ *agenda setter is no worse off with proposal* $\hat{\pi}$ *than with* π^q*.*
(2) The centrist is no worse off with proposal $\hat{\pi}$ *than with* π^q*, if his beliefs are* $\tilde{z} = \bar{z}$ *on observing the proposal* $\hat{\pi}$*.*
(3) The $z = \underline{z}$ *is worse off with proposal* $\hat{\pi}$ *than with* π^q*, if the centrist's beliefs* $\tilde{z} = \bar{z}$ *on observing the proposal* $\hat{\pi}$*.*

Proof. According to conditions (1) and (2), $\hat{\pi}$ is a policy that makes the agenda setter better off than the status quo, and makes the centrist better off than the status quo conditional on $\tilde{z} = z = \bar{z}$. Thus the status quo cannot be the equilibrium if the centrist's beliefs are $\tilde{z} = \bar{z}$ on observing the proposal $\hat{\pi}$. At the same time, $\hat{\pi}$ cannot be the the $z = \underline{z}$ agenda setter's optimal proposal, as she can always do better by proposing the status quo, according to condition (3). Thus there is some policy $\bar{\pi}$ (which may or may not be identical to $\hat{\pi}$) from which the agenda setter does not wish to deviate if $\tilde{z} = \bar{z}$ on observing that proposal, and which the $z = \underline{z}$ would never propose. Bayes' law implies then that the centrist updates his beliefs to $\tilde{z} = \bar{z}$ on observing the proposal $\bar{\pi}$. This constitutes the $z = \bar{z}$ policy in a separating PBE. ■

We now show that a policy $\hat{\pi}$ that satisfies conditions the conditions in Lemma 5 exists for any parameter values. Consider a marginal deviation from the status quo where an infinitessimal increase (of unit measure) in tax revenues is used to finance a combination of higher public expenditure Δg and pork to the centrist of $\Delta s^C = 1 - \Delta g$, and such that this proposal exactly satisfies condition (3) in Lemma 5:

$$(\underline{z} + \alpha)\, v_g\left(g^q\right) \Delta g = \mu\left(\tau^q\right).$$

This last equation can be rewritten as

$$\Delta g = \frac{\mu\left(\tau^q\right)}{(\underline{z} + \alpha)\, v_g\left(g^q\right)} < 1. \tag{34}$$

Δg gives a change in public good expenditures such that the marginal cost of a unit increase in tax revenues is equal to the marginal value of the increase in public good provision, from the perspective of the agenda setter if $z = \underline{z}$. This is true regardless of the beliefs of the centrist. The inequality in (34) demonstrates that such a deviation is budget-feasible, as $\Delta s^C = 1 - \Delta g > 0$, so that the deviation entails an increase, rather than a decrease in pork to the centrist. (Starting from the status quo, where $s^C = 0$,the latter would require a negative amount of pork, which is not feasible.)

Such a deviation always makes the centrist better off. The utility of the centrist changes by

$$\Delta U^C = \bar{z} v_g\left(g^q\right) \Delta g + 1 - \Delta g - \mu\left(\tau^q\right).$$

Using (34) this gives

$$\Delta U^C = \left[\bar{z} v_g\left(g^q\right) - 1\right] \frac{\mu\left(\tau^q\right)}{\left(\underline{z} + \alpha\right) v_g\left(g^q\right)} + 1 - \mu\left(\tau^q\right).$$

So the utility of the centrist increases if and only if

$$\frac{1 - \bar{z} v_g\left(g^q\right)}{\left(\underline{z} + \alpha\right) v_g\left(g^q\right)} \leq \frac{1 - \mu\left(\tau^q\right)}{\mu\left(\tau^q\right)}.$$

But as $\bar{z} v_g\left(g^q\right) > \mu\left(\tau^q\right)$ (in the numerators) and $\left(\underline{z} + \alpha\right) v_g\left(g^q\right) > \mu\left(\tau^q\right)$ (in the denominators), this inequality must always hold. Thus the described deviation satisfies condition (2) in Lemma 5 as well.

Finally, condition (1) of the lemma holds if the deviation increases the agenda setter's utility when $z = \bar{z}$. Her utility increases if and only if

$$\left(\bar{z} + \alpha\right) v_g\left(g^q\right) \Delta g - \mu\left(\tau^q\right) \geq 0.$$

Using (34) in this inequality gives

$$\frac{\left(\bar{z} + \alpha\right) v_g\left(g^q\right)}{\left(\underline{z} + \alpha\right) v_g\left(g^q\right)} \mu\left(\tau^q\right) - \mu\left(\tau^q\right) \geq 0,$$

which always holds as $\bar{z} > \underline{z}$. Thus this deviation constitutes a policy that satisfies conditions (1) to (3) in Lemma 5, for any value of X. Lemma 5 then states that a separating equilibrium exists

The necessary conditions for an intuitive separating equilibrium in Appendix B indicates that only one separating equilibrium may satisfy the intuitive criterion. It remains to show that no pooling equilibrium satisfies the intuitive criterion. We have thus demonstrated that a separating equilibrium exists and it is the unique separating equilibrium. It remains to show that no pooling equilibrium exists.

Proposition 2 states that in the absence of pork, pooling at the status quo is the only possible equilibrium. This implies that the only possible pooling equilibrium with no pork (RPM) is at the status quo. However, the discussion above shows that pooling at the status quo cannot satisfy the intuitive criterion. We outlined a deviation from the status quo that would not be beneficial to the agenda setter when $z = \underline{z}$, regardless of the beliefs of the centrist. In order to satisfy the intuitive criterion, the centrist's off-the-equilibrium beliefs must then set $\tilde{z} = \bar{z}$ on observing this deviation. But given these beliefs, the agenda setter can improve her welfare by proposing such a deviation when $z = \bar{z}$. Thus pooling at the status quo is not an equilibrium when off-the-equilibrium-path beliefs are constrained to satisfy the intuitive criterion.

Now consider a pooling equilibrium that contains pork. In such an equilibrium, the $z = \bar{z}$ agenda setter proposes a policy that solves (11) to (12d) with $z = \bar{z}$ and $\tilde{z} = z^e$. The $z = \underline{z}$

agenda setter mimics this proposal. With the information set $\tilde{z} = z^e$, the status quo is the centrist's preferred policy without pork, so that any deviation from the status quo requires $s^C > 0$. With the non-negativity constraint on the centrist's pork slack, the first order conditions of the proposal satisfy

$$\frac{\mu\left(\tau^{pool}\right)}{1-\mu\left(\tau^{pool}\right)} = \frac{\left(\bar{z}+\alpha\right) v_g\left(g^{pool}\right)}{1-z^e v_g\left(g^{pool}\right)}, \tag{35}$$

with both sides of the equation equalling one in Complete BAU.

We now show that this candidate pooling equilibrium cannot satisfy the intuitive criterion. Consider a deviation from this proposal in which taxes are increased by an infinitessimal margin (of unit magnitude) and public expenditure increases by

$$\Delta g = \frac{\mu\left(\tau^{pool}\right)}{\left(\underline{z}+\alpha\right) v_g\left(g^{pool}\right)}$$

with the remaining revenues allocated to pork to the centrist: $\Delta s^C = 1 - \Delta g$. It would be never be in the interest of the agenda setter to deviate from equilibrium in such a way when $z = \underline{z}$, regardless of the beliefs of the centrist. The intuitive criterion then requires that on observing such a deviation, the centrist updates his beliefs to $\tilde{z} = \bar{z}$, as such a deviation would, in contrast, increase the utility of the agenda setter by

$$\left(\bar{z}+\alpha\right) v_g\left(g^{pool}\right) \Delta g - \mu\left(\tau^{pool}\right) = \mu\left(\tau^{pool}\right)\left[\frac{\bar{z}+\alpha}{\underline{z}+\alpha} - 1\right] > 0.$$

This deviation relaxes (or tightens) the centrist's participation constraint by the discrete amount $\left(\bar{z}-z^e\right)\left[v\left(g^{pool}\right) - v\left(g^q\right)\right]$ (plus other infinitessimal terms). This term reflects the fact that updating the centrist's beliefs from $\tilde{z} = z^e$ to $\tilde{z} = \bar{z}$, alters his perceived valuation of proposed public consumption relative to that in the status quo. This term is positive if and only if $g^{pool} > g^q$, i.e. if proposed public expenditure in the candidate pooling equilibrium is greater than in the status quo. With beliefs satisfying the intuitive criterion, a profitable deviation exists for the $z = \bar{z}$ agenda setter, if $g^{pool} > g^q$.

When on the other hand $g^{pool} < g^q$, a profitable deviation is available to the agenda setter when $z = \underline{z}$. Consider a deviation from the candidate pooling equilibrium such that tax revenues decrease by an infinitessimal margin (of unit measure), financed by a decrease in public expenditure such that

$$\Delta g = \frac{\mu\left(\tau^{pool}\right)}{\left(\bar{z}+\alpha\right) v_g\left(g^{pool}\right)},$$

with the remainder financed by cutting the centrist's pork allocation. This deviation is unacceptable to the agenda setter when $z = \bar{z}$, regardless of the centrist's beliefs. The intuitive criterion then requires that $\tilde{z} = \underline{z}$ when the centrist observes this proposal, as the agenda setter does find such a deviation profitable when $z = \underline{z}$, conditional on the centrist's

acceptance. Her utility in this case would change by

$$\mu\left(\tau^{pool}\right) - \left(\underline{z} + \alpha\right) v_g \Delta g = \mu\left(\tau^{pool}\right)\left[1 - \frac{\underline{z} + \alpha}{\bar{z} + \alpha}\right] > 0.$$

On observing such a deviation from the pooling equilibrium, the centrist's participation constraint is relaxed by a margin of $\left(\underline{z} - z^e\right)\left[v\left(g^{pool}\right) - v\left(g^q\right)\right]$, which is positive if $g^{pool} < g^q$.

When beliefs are restricted to satisfy the intuitive criterion, a deviation from the candidate pooling equilibrium exists either when $z = \bar{z}$ or when $z = \underline{z}$, depending on whether whether $g^{pool} > g^q$ or $g^{pool} < g^q$, respectively. In either case, no pooling equilibrium can be sustained with beliefs that satisfies the intuitive criterion. In contrast, we have shown that a unique separating equilibrium supported by intuitive off-the-equilibrium-path beliefs always exists. Having shown above that this equilibrium always contains pork completes the proof.