Pork Barrel as a Signaling Tool: The Case of US Environmental Policy*

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February 2014

Abstract

This paper provides evidence that signaling is a driving force of pre-electoral pork barrel policies. I develop a two-period model of electoral competition where politicians use current policies to signal their preferences to rational, forward-looking voters. There exists an equilibrium where incumbents use pork barrel spending for signaling in majoritarian systems. Results show that pork spending is directed towards ideologically homogeneous groups and is mitigated if the incumbent is a "lame duck" or has a high discount rate. The predictions of the model are tested using data on US State level environmental expenditures. The results support the signaling motive as a central mechanism in generating pork barrel towards issues that elicit strong preferences.

JEL classification: D72, H76, Q58, C23
Keywords: Pork Barrel, Signaling, Electoral Competition, Environmental Spending

1 Introduction

It is a well documented fact that economic decisions are distorted by electoral competition, across a variety of issues.[1] One particular tool used by

*I thank Jérôme Adda, Niall Hughes, Andrea Mattozzi, and Massimo Morelli for valuable comments. I acknowledge the support of the Portuguese Science and Technology Foundation (FCT) under grant with reference SFRH/BD/60628/2009.

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[1]See Brender and Drazen (2005) for an empirical study on a large panel of countries.

politicians in order to obtain political advantage is the assignment of benefits to particular groups, geographically or otherwise determined. These benefits, typically called pork barrel,[2] might take the form of increases in highly visible local public goods, approval of particular projects, or even transfers from the central government. Pork barrel is often used in legislatures as a "currency" to build coalitions that allow to pass general interest legislation, but it is also an instrument in electoral competition used by incumbent politicians to gain the voters' support. And while in the former case it might generate benefits, by *greasing the wheels* of the legislative process (Evans, 2004), election-motivated changes in the composition of spending are widely accepted as constituting efficiency losses: by distributing pork when the budget is limited and fixed, politicians deviate from the welfare maximizing level of collective goods (Hicken and Simmons (2008)). Assessing the mechanism that is behind them, and the incentives to perform these policies is, therefore, of significant importance.

Large part of the existing theory on the use of pork distribution as an instrument to seek voter support focuses on models with full commitment by downsian politicians: following Downs (1957), candidates are purely office-motivated, and make binding promises as to the amount of pork spending they offer to voters. Some examples are Lizzeri and Persico (2001) and Persson and Tabellini (1999). However, politicians as citizens are likely to care not only about being in office but also about the policies performed, such that full commitment cannot be guaranteed. This idea is explored in citizen-candidate models (Osborne and Slivinski, 1996 and Besley and Coate, 1997), where politicians are citizens who decide to apply for office in order to implement their preferred policy. A model of pork spending where politicians have policy preferences is developed by Bouton *et al.* (2013), who use a retrospective probabilistic voting model to determine when politicians cater to a secondary issue, gun control, that a minority cares about, or a primary issue. However, a large body of research has found that prospective evaluations are important determinants of voting choices, in some cases more so than retrospective ones.[3]

Pre-electoral distortions are conciliated with forward-looking voters by political business cycle models, where incumbent politicians signal their competence by increasing expenditures or decreasing taxes, at the expense of

[2]The expression is said to have originated in the pre civil war United States, when barrels of salt pork were given to slaves, who were required to compete for a share of it.

[3]See for example Lewis-Beck, 1990, Lockerbie, 1992, and Erikson *et al.* (2000).

the lately observed deficit.[4] The main idea is that, because information is costly, rational forward looking voters infer incumbent's quality by the amount of expenditure they can provide, for a given level of taxes, and vote for the ones perceived as competent. However, these models imply voters do not observe some economic variable prior to elections, which is less likely to happen in developed democracies where more and better information is available.[5] In established democracies distortions are more likely to arise from incomplete information regarding preferences of the incumbent. If these persist over time, current policy can be used as an indicator of future actions. This idea is used to evaluate how a politician may signal preference for expenditures that benefit the population instead of herself, by Drazen and Eslava (2010), with an empirical application evaluating the increase of highly visible expenditures in election years in Colombian municipalities. Redistribution between issues that population groups value differently, however, may also arise for signaling purposes. Preferences for different groups or issues has been studied in two papers. Focusing on preferences for different groups, Morelli and Weelden (2013) develop a theoretical framework to study politicians' incentives to focus effort on issues where they can best signal their preferences to voters, and the effects of increased transparency on this allocation. Drazen and Eslava (2012), in turn, study programmatic targeting of different groups of population, finding that politicians target with expenditures larger groups and those with more swing voters, and do not often target to mobilize groups into going to vote. However, none of the previous papers offers an empirical analysis of the validity of the framework of signaling preferences for issues that given groups value but others do not. This paper aims at providing an insight into the mechanism generating election-year pork barrel policies, particularly regarding expenditures in goods or services likely to have strong support from some citizens, by deriving theoretical implications from a simple model and testing them empirically. It evaluates whether signaling is a driving force behind pre-electoral pork, where *signaling* refers to the conveying of preferences of the politician, true or not, through enacted policies. The idea is that politicians cannot commit to implement policies that they do not favor, and in the absence of this commitment, they use current policies to signal preferences, which are persistent over time, to the electorate. The implications of the mode are tested on United States (US) environmental policy.

[4]The seminal work by Nordhaus (1975) was later extended to include rational expectations by Rogoff and Sibert (1988) and Rogoff (1990).

[5]Brender and Drazen (2005) find that political budget cycles tend to disappear in established democracies, as voters become better at collecting and reporting relevant data.

Environmental policy is particularly prone to political pressure. The fact that the environment triggers strong opinions from the electorate renders it particularly suitable to test the current model. Recent literature has focused on many aspects of the political economy of environmental policy. In particular, environmental expenditures in the US have been the subject of empirical analysis of political economy theories, mostly related to lobbying, but also to a lesser extent to electoral incentives. An example of the latter is List and Sturm (2006), who test how a secondary policy issue is affected by electoral incentives. In their model voters do not observe an economic shock happening prior to the election, as well as the politician's type. In another study, Fredriksson *et al.* (2011) use regression discontinuity approaches to test whether elected politicians are mostly office or policy motivated. Both analysis focus on differences between terms where incumbents can be re-elected and those she cannot (she is a "lame duck"). Instead I focus on election year behavior, which allows me to clearly identify electoral incentives, while testing hypothesis from a different underlying behavior.

I develop a two-period model of electoral competition, based on the framework of Persson and Tabellini (1999), where an incumbent divides a fixed budget between a national public good and expenditures on three "particularistic" issues - one of which is environmental spending - that assign extra benefits for those voters with strong preferences for them. Here, however, the politician is both policy and office motivated, and there is no commitment. The incumbent in the first period chooses her policy so as to maximize her utility, which depends on her policy preferences and the probability of being re-elected. Voters are rational, forward-looking, and informed about economic policies but imperfectly informed about the preferences of the politician. So they use current policies to infer them through bayesian updating: an increase in expenditures might mean the politician is performing pork barrel or that she has a genuine preference for them. Finally, all agents are also ideologically biased.

The model generates conditions under which pork barrel arises as a political equilibrium for signaling purposes. I find that this occurs in majoritarian systems, both in single and multi-electoral district systems, and that it occurs less when the politician's discount factor is higher than a threshold and when she is not a "lame duck". These findings are consistent with previous results of downsian models. The former occurs because multi-district systems increase competition for a more restricted set of votes, such that signaling is credible or *effective*, and the two latter occur because a high discount rate decreases the incentives of an incumbent to seek re-election through pork. So for example establishing terms limits should decrease the

amount of pork, even if these are not binding in a given election. Finally, I find that pork spending with signaling purposes occurs less towards the most ideologically dispersed group. This happens because in practice pork shifts the identity of the swing voter in the group receiving it towards the ideology of the incumbent. So by targeting voters more densely concentrated ideologically the incumbent is able to shift more votes with the same amount of expenditures. Intuitively, it means that it is easier to sway more homogeneous groups.

I test these predictions using a panel of state level data for the US from 1970 to 2000, including public expenditure and revenue, demographic characteristics, electoral data, and voters' preferences for the environment. To measure the latter I create an indicator, based on surveys, that measures the ideological dispersion of environmentally biased voters in each state. To measure pork barrel I focus on systematic increases in environmental expenditures in election years, relative to total expenditures, as well as deviations on these years relative to the mean of all the other years of the mandate of the same politician. US state policy is a particularly relevant laboratory to test the predictions of the model, since environmental expenditures are decided at the state level with a large degree of independence and strong policy preferences of voters are known to politicians before elections. Additionally, the large amount of years available and detail of the data facilitate the identification strategy.

The empirical results indicate that environmental expenditures in the US are in fact subject to pre-electoral pork barrel with signaling purposes. Particularly, I find that election-year deviations in environmental expenditures occur more in states where term limits legislation is in place, implying a higher discount factor for incumbents, when the politician is not up for re-elections, and that they do not happen systematically for states where environmentally biased voters are more ideologically dispersed. The latter result more directly corroborates the signaling framework, as it is predicted by the present model but is not explained by other pre-electoral pork generating theories.

The analysis thus provides an insight into the mechanism behind distortionary policies with electoral incentives, particularly regarding policies generating strong support from some groups of the population, and contributes to the literature on the political economy of environmental policy in countries with elected governments. These insights have implications for theoretical studies of electoral distortions, interest group power, and governance discussions around mechanisms to prevent inefficient behavior. These are discussed in the conclusion.

The remainder of the paper is organized as follows. The next section describes and solves the theoretical model, and sets out the testable hypothesis it generates. Section 4 describes the empirical analysis and the results, and Section 5 concludes the paper and puts forward implications of the analysis.

2 The Model

The model in this section fits the citizen-candidate framework (Osborne and Slivinski, 1996, and Besley and Coate, 1997), in the sense of having politicians who, as citizens, have intrinsic policy preferences. Thus, they cannot credibly commit to a given platform. However, in this model, the politicians' preferences are not observed by the voters prior to elections. I will abstract from the entry decision, by assuming there is only one challenger, selected randomly from the pool of citizens, conditional on ideology. The model also borrows from the Downsian framework (Downs, 1957), in the sense that candidates, in addition to having policy preferences, are office-motivated, which means that they obtain an additional payoff solely for being in power. Additionally, the model incorporates the possibility of using changes in current policies as a signaling tool for incumbents' unobserved characteristics, set out in the models of Rogoff and Sibert (1988) and Rogoff (1990). The distribution of the agents' policy and ideological preferences is the one in Persson and Tabellini (1999).

2.1 Setup

The economy is composed by a continuum of citizens, divided into three groups of equal size, $i = 1, 2, 3$, that differ in two dimensions: their preferences regarding fiscal policies (how the budget is divided) and their ideology. There are two time periods, $t = 1, 2$, with a single election taking place at the end of period 1, between an incumbent politician (I) and a randomly selected challenger (C). The incumbent in each period decides on how to allocate a fixed budget, T_t, between expenditures targeted at one of three particular issues, $g_{i,t}$, and a pre-defined bundle of efficient national level expenditures, which benefit all the population equally, G_t.[6] The targeted expenditures are expenditures on issues for which voters care in different ways - namely, voters who have a preference for certain issues derive utility from those expenditures, while the others do not. A good example is spending in environmental protection, for which some citizens with environmental

[6] This allocation is called the fiscal policy.

concerns have strong preferences and so they value them, while others do not. In particular, I assume voters in each of the three groups derive utility from only one of the three expenditures: voters in group i derive utility from $g_{i,t}$. Politicians, as citizens, also have policy preferences - i.e., they derive utility from one of the targeted expenditures. Policy preferences are not known to voters, but only the distribution of preferences of the population. Politicians also derive utility simply from being in office, from extracted rents or prestige.
The agents in the model also have ideological preferences, which are known and separate from their policy preferences, and include for example their position on issues like abortion or drug policy. The model further assumes the incumbent belongs to a party that is on one side of the ideological spectrum and the challenger to the one on the opposite. The fact that the parties locate symmetrically around the median voter follows theoretical results for downsian models with slightly policy-motivated politicians and some uncertainty on voters' behavior.[7] Finally, ideological preferences include a shock to general popularity shock: the incumbent may be more or less popular before the election, because of some personal factor.[8] The realization of the popularity shock is not known to the incumbent prior to the election.

The timing of the model is the following: in period zero nature chooses the policy preferences and ideology of the incumbent, challenger and voters, and during the first period, the incumbent chooses the allocation of the budget, which voters observe. At the end of period one, the challenger is chosen from the population, the popularity shock is realized, and the citizens vote. In the second period the candidate who is elected, according to the electoral system in place, chooses the policy to be implemented.

2.1.1 The budget constraint

In a given period t the incumbent politician faces the following budget constraint:

$$\sum_{i}^{3} g_{i,t} + G_t = T \tag{1}$$

[7] See, for example, Calvert (1985).

[8] Voters may be more inclined to vote for a politician if she is perceived as respectful or competent in the latest public appearances or news reports.

where T is a fixed value, equal for each period. G_t is continuous, with $0 < G_t < T_t$, and expenditures targeted at each issue $g_{i,t}$ have a discrete cost, with $g_{1,t} + g_{2,t} + g_{3,t} = T_t$.The incumbent's fiscal policy can then be summarized as a vector $q_t^I = \left[\{g_{i,t}\}_{i=1,2,3}, G_t\right]$, where the superscript I indicates that it is the incumbent's choice. As is standard in the pork barrel literature,[9] G_t is the efficient choice, which benefits all groups equally.[10] However, $g_{i,t}$ can be targeted to a specific group, thereby increasing the probability of getting the votes of the particular group more sharply. So the incumbent faces a trade-off between efficiency and targetability.

2.1.2 Voters

Voters are divided into three groups, $i = 1, 2, 3$, each with a continuum of citizens with unit mass, where preferences over fiscal policy are identical for all members of each group. The one-period utility, derived from fiscal policy of a voter from group i in time t if policy q_t^I is being performed can be written as:

$$U_{i,t}(q_t^I) = \mu_i g_{i,t} + v(G_t), g_i = \{1, 0\} \tag{2}$$

where μ_i is a markup measuring the increase in utility from having expenditures in the preferred issue made, $g_{i,t}$ is equal to 1 if these expenditures are made and 0 otherwise, and $v(.)$ is monotonically increasing and concave. The fact that μ_i varies across groups accounts for the intensity of preferences, as some issues elicit stronger positions.
In addition to deriving utility from fiscal policy, voters have preferences over other aspects of political decision making ("ideological preferences"), which include individual ideologies and the general popularity of the incumbent. The ideological distribution used here is the one in Persson and Tabellini (1999), but adapted to the signaling structure of the present model. A voter j in group i has an ideological preference for the challenger, which can be positive of negative, given by $(\delta + \sigma^j)$. Here, δ is the general popularity of the challenger,[11] due to some personal characteristic or charisma, and is a random variable with uniform distribution with expected value zero and

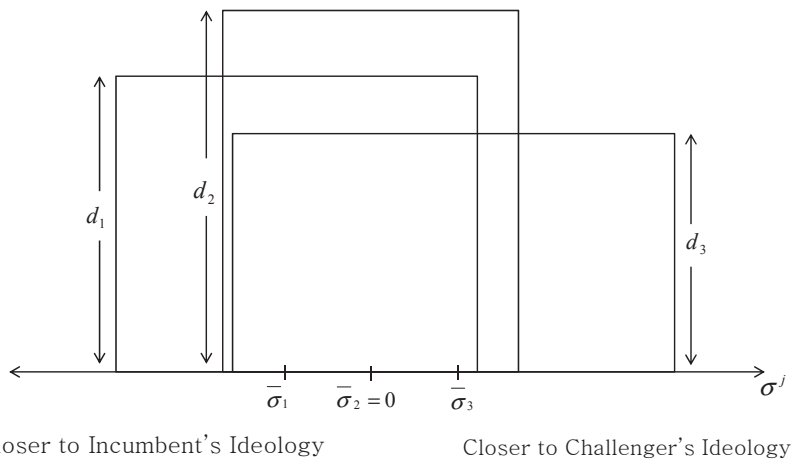
[9] See, for example, Lizzeri and Persico (2001).

[10] More formally, we may think of the economy as having a weakly concave welfare function, $W(U_{1,t}, U_{2,t}, U_{3,t}; G_t, g_{i,t})$, where $W^{high}(.; G_t^{high}, 0) > W^{medium}(., G_t^{medium} = T - g_{i,t}, g_{i,t}, 0) > W^{low}(., G^{low} = T - g_{i,t} + g_{j,t}, g_{i,t}, g_{j,t})$, where g_i stands for one targeted expenditure being made and g_i, g_j for two.

[11] The general popularity of the incumbent is the symmetrical opposite of the challenger's popularity.

density z. That is, $\delta \sim U\left[-\frac{1}{2Z}, \frac{1}{2Z}\right]$. The shock is realized at the end of the first period, before the election, so the incumbent decides on first period policies under uncertainty. In turn, σ^j is the individual ideology of voter j of group i, which is distributed according to a uniform distribution with expected value $\overline{\sigma}^i$ (group i's specific mean), and density d^i. That is, $\sigma^j \sim U\left[-\frac{1}{2}d^i + \overline{\sigma}^i, \frac{1}{2}d^i + \overline{\sigma}^i\right]$. The distributions are common knowledge, but only the agent j observes her own parameter σ^j. As in Persson and Tabellini (1999), I assume $\overline{\sigma}^1 < \overline{\sigma}^2 < \overline{\sigma}^3$, and $\overline{\sigma}^2 = 0$. That is, group 2 is the one with more ideologically neutral, or swing, voters. Additionally, as they do, I assume group 2 is the one with the highest density ($d^2 > d^1, d^3$), that $d^1 > d^3$ and that $\overline{\sigma}^1 d^1 + \overline{\sigma}^3 d^3 = 0$. The assumptions on the ordering of densities are made without loss of generality: the results do not change qualitatively for any ordering.[12] The last assumption, along with $\overline{\sigma}^2 = 0$, is made for simplicity, and means that the number of voters to the right and the left of the ideologically neutral ones is the same. If this assumption was to be relaxed, the ordering of densities would have an effect, as one of the politicians would have an ideological advantage (which would be larger the higher the density of the group with the same ideology). However, this analysis is beyond the scope of the paper. The ideological distribution of voters can be summarized in Figure 1.

Figure 1: Ideological distribution of voters



[12] As will be clear from the equilibrium conditions, changing the ordering of densities will only affect the type of incumbent that plays a given strategy, but not the qualitative results.

The figure shows that all the groups have ideologically neutral voters. However, according to the density distribution, group 2 has the most, followed by 1, and finally, group 3 has the least swing voters. The main idea is that, if $\delta = 0$, an ideologically neutral voter will cast her vote solely on basis of her fiscal utility (i.e., vote for the incumbent if $E\left[U_i(q^I_{t+1})\right] > E\left[U_i(q^C_{t+1})\right]$).

2.1.3 The Politicians

The politician's utility in period t is analogous to that of a citizen, but includes the payoff from being in office, γ. That is, for an incumbent with a preference for issue k, $k = 1, 2, 3$:

$$U^I_{k,t}(q^I_t) = u^I_{k,t}(q^I_t) + \gamma = \mu_k g_k + v(G) + \gamma, g_k = \{1, 0\} \tag{3}$$

The incumbent chooses current policy in order to maximize her two-period utility, which depends on the utility in equation (3) and the probability of being re-elected, π, which is defined later:

$$WU^I_k = u^I_{k,t}(q^I_t) + \beta\left[\pi\left(u^I_{k,t}(q^I_t) + \gamma\right) + (1-\pi)\left(E\left[u(q^C_{t+1})\right]\right)\right] \tag{4}$$

where β is the discount factor, and the superscripts I and C indicate choices of the incumbent and the challenger, respectively.

Ideologically, the incumbent is located in $\overline{\sigma}^1$ and the challenger in $\overline{\sigma}^3$.

2.1.4 Voting Behavior and Beliefs

Voters make their decision according to their policy and ideological preferences. They are forward-looking and wish to maximize their second period expected utility. So, in choosing the best candidate, they compute their expected utility in $t+1$ under each of them, and vote for the one that gives them the highest, conditional on the ideological bias not offsetting this. Voter j in group i will, therefore, vote for the incumbent if:

$$E\left[U_{i,t+1}(q^I_{t+1})\right] > E\left[U_{i,t+1}(q^C_{t+1})\right] + \left(\delta + \sigma^j\right) \tag{5}$$

Since policy is multi-dimensional, the notion of probabilistic voting will be used to find an equilibrium. The vote share of the incumbent in group i, $S^{I,i}$, is thus given by:

$$S^{I,i} = d^i\left[E\left[U_{i,t+1}(q^I)\right] - E\left[U_{i,t+1}(q^C)\right] - \delta - \overline{\sigma}^i\right] + \frac{1}{2} \tag{6}$$

The probability of winning the election differs depending on the electoral system in place. Although Persson and Tabellini (1999) name the systems *proportional* and *majoritarian*, I argue that they both best define a majoritarian rule, with a single or a multi electoral districts.[13] Under a single-district system, a politician wins the election if she obtains more than $\frac{1}{2}$ of the total votes of the population. Thus the incumbent's probability of winning in given by:

$$\pi_{q^I}^{I,Sd} = \Pr\left[\frac{\sum_{i=1}^{3} S^{I,i}}{3} \geq \frac{1}{2}\right] \tag{7}$$

where Sd stands for single-district. By equation (7), the assumption on the distribution of δ, and the assumptions on the distribution of voters' preferences,[14] this probability is given by:

$$\pi_{q^I}^{I,Sd} = \frac{z}{\sum_{i=1}^{3} d^i}\left[\sum_{i=1}^{3} d^i \varepsilon^i\right] + \frac{1}{2} \tag{8}$$

where $\varepsilon^i = E\left[U_{i,t+1}(q^I)\right] - E\left[U_{i,t+1}(q^C)\right]$ Under a multi-district system, in turn, a politician is elected if she obtains a majority of votes in a majority of the electoral groups. For simplicity, I assume the electoral groups correspond to the preference groups.[15] This implies in this setting that the politician wins the election if she has at least $\frac{1}{2}$ of votes in at least two groups. The winning probability of the incumbent is given, for each group i, by:

$$\pi_{q^I,i}^{I,M} = \Pr\left[S^{I,i} \geq \frac{1}{2}\right] \tag{9}$$

where M stands for multidistrict.
Voters have prior probability λ_i^P that a politician $P = I, C$ is of type i, for each $i = 1, 2, 3$. After observing first period policies, voters in each group update their beliefs on the incumbent's type through Bayesian updating, while keeping their prior on the challenger. Hence, the incumbent has a scope to

[13] Particularly, elections at the state level in the US fit the former framework, with one electoral system where a candidate is elected if she has over a half of the total vote. At the national level elections would fit the latter framework.

[14] In particular, that $\overline{\sigma}^2 = 0$ and $\overline{\sigma}^1 d^1 + \overline{\sigma}^3 d^3 = 0$

[15] The results can be generalized to the case where they do not completely overlap, but do so to a certain extent.

use current policy to change voter's beliefs regarding her preferences, that is, to *signal* a type, which might not be the true one. If the politician's signaling changes the voters' prior beliefs, we say it was *effective*.
The fact that politicians locate ideologically in $\overline{\sigma}^1$ and $\overline{\sigma}^3$ has the implication that, for each i, $\lambda^i = \frac{d^i}{\sum_{i=1}^{3} d^i} = d^i$; that is, that the priors for each type are equal to the densities of each group. The notation will be kept separate for the sake of explicitness.

2.2 Full Information Benchmark

The model is solved by backwards induction. Since there are no more elections after the last period, in $t+1$ the politician of type $k = 1, 2, 3$ in power simply chooses the policy that maximizes her utility:

$$\begin{aligned} \max_{g_{i,t+1}} \quad & \mu_k g_{k,t+1} + v(G_{t+1}) + \gamma \\ s.t. \quad & \sum_{i}^{3} g_{i,t+1} + G_{t+1} = T \end{aligned} \tag{10}$$

for $i = 1, 2, 3$. Thus the politician will never decide to spend on other issues apart from her preferred one. Assuming $v(T) - v(T - g_{k,t+1}) < \mu_k g_{k,t+1}), \forall k$, the politician will spend on $g_{k,t+1}$, instead of using all the budget for the national level good. Hence, $q^P_{t+1} = \{G^*_{t+1}, g_{k,t+1}\}$, where $G^*_{t+1} = T - g_{k,t+1}$.

With full information on the voters' side the preferences of the politician are known, so there is no scope for signaling. Thus also in the first period the incumbent chooses the fiscal policy that maximizes her period utility, $q^I_t = \{G^*_t, g_{k,t}\}$, where again $G^*_t = T - g_{k,t}$ and $k = \{1, 2, 3\}$ is the incumbent's preferred issue. The only uncertainty is on the incumbent's side, regarding the realization of the popularity shock δ.
In this setting there are two categories of equilibria, depending on whether the politicians are of the same type or of different types. If the incumbent and the challenger have a preference for the same issue, then on both multi and single-district systems the probability of winning is equal to $\frac{1}{2}$, independent of group densities or the politicians' popularity. To see this note that $U_{i,t+1}(q^I_{t+1}) = U_{i,t+1}(q^C_{t+1}), \forall i = \{1, 2, 3\}$, that is, $\varepsilon_i = 0$, so the incumbent's vote share in each of the three groups simplifies to $S^{I,i} = d^i \left[-\delta - \overline{\sigma}^i\right] + \frac{1}{2}$. This means that, in a single-district system, $\pi^{I,Sd}_{q^I} = \frac{z}{\sum_{i=1}^{3} d^i} \left[\sum_{i=1}^{3} d^i \varepsilon^i\right] + \frac{1}{2} = \frac{1}{2}$.

In a multi-district system, $\pi^{I,M}_{q^I,2} = \frac{1}{2}$ and each politician will win solely on the basis of the ideological bias on the other two districts.
If the politicians are of different types, with the incumbent of type k and the challenger j, the utility differential of having the incumbent in power for voters in group k is positive and given by $\varepsilon^k = U_{k,t+1}(q^I_{t+1}) = U_{k,t+1}(q^C_{t+1}) > 0$. Similarly, $\varepsilon^j < 0$ and for the third group it is once again zero. The incumbent's winning probability is thus given by $\pi^{I,Sd}_{q^I} = \frac{z}{\sum_{i=1}^{3} d^i}\left[d^k\varepsilon^k + d^j\varepsilon^j\right] + \frac{1}{2} = \frac{1}{2}$. Whether the expression in brackets is positive or negative depends on the densities of the two groups. Since $d^2 > d^1 > d^3$ a politician of type two will win over the other two types, and type one will win over type three. In the multi-district system, assuming the ideological bias is small enough, each politician wins in the group they have a fiscal preference for, and the result in the third group depends on the ideological bias. With full information the policy performed is always $q^P_t = \{G^*_t, g_{k,t}\}$, where k stands for the politician's preference.

2.3 Asymmetric Information

2.3.1 Equilibrium Definition

In the asymmetric information case, the equilibrium concert used will be that of a *Perfect Bayesian Equilibrium* (PBE).

Definition 1 ***Equilibrium***
A Perfect Bayesian Equilibrium in this setting satisfies the following conditions:
(a) In the first period, the incumbent decides on the fiscal policy q^I_t that maximizes her two period utility given by (4), subject to the belief system given by the priors and bayesian updating, her expected popularity, and the optimal strategies of voters;
(b)At the voting stage, voters in each group i maximize their expected utility, subject to the belief system and the incumbent's first period decisions, and therefore vote for the incumbent if $E\left[U_i(q^I_{t+1})\right] > E\left[U_i(q^C_{t+1})\right] + \left(\delta + \sigma^j\right)$;
(c) Beliefs are consistent on the equilibrium path.

For simplicity, I restrict the analysis to PBE in pure strategies. With the distributional assumptions made, three particular cases arise, depending on which issue the incumbent has a preference for:

1. The incumbent has a preference for the issue favored by the most ideologically dispersed group (group 3)

2. The incumbent has a preference for the issue favored by the group with the most swing voters (group 2), that it, with higher density around the ideological mean

3. The incumbent has a preference for the group with intermediate ideological density (group 1)

The incentives for the incumbent to choose different policies vary between the cases. Due to the discrete nature of the expenditures targeted at each of the three issues, the incumbent's actions are also of a discrete nature: she can spend on all, three, one, or none of the issues. At this point it is convenient to define the *pork barrel* strategy.

Definition 2 ***Pork Barrel***
Performing Pork Barrel in the current setting consists of spending, for reelection purposes, on more issues than what maximizes the politician's period utility.

More specifically, an incumbent's pork barrel (PB) strategy is given by $q_t^{PB} = \{G_t^{PB}, g_{k,t}, g_{i,t}\}, \forall i \neq k$, where $G_t^{PB} = T - 2g_{i,t}, \forall i = \{1,2,3\}$ and the superscript I was suppressed since only the incumbent chooses first period policy. The incumbent's non pork barrel ($\overline{PB}$) strategy is defined as $q_t^{\overline{PB}} = \{G_t^*, g_{k,t}\}$, where $G_t^* = T - g_k$. I will restrict attention to comparing the optimality of these two strategies, while assuming $v(G_t)$ is concave enough such that it is never optimal to perform a strategy that hides a politician's type.

2.3.2 Political Economic Equilibrium Across Systems

When deciding between the two policies, q_t^{PB} and $q_t^{\overline{PB}}$, the incumbent of type $k = \{1,2,3\}$ compares her expected utility under each, that is $E\left[WU^I(q_t^{PB})\right] > E\left[WU^I(q_t^{\overline{PB}})\right]$ which substituting in the previous equations is:

$$v(G_t^{PB}) - v(G_t^*) + \beta\left[\left(\pi^I_{q_t^{PB}} - \pi^I_{q_t^{\overline{PB}}}\right)\left(\left[1-\lambda^k\right]\mu_k g_{k,t+1} + \gamma\right)\right] > 0 \quad (11)$$

By assumption $v(G_t^{PB}) - v(G_t^*) < 0$. Whether or not there is an equilibrium where the politician performs pork then depends on whether

$\pi^I_{q_t^{PB}} - \pi^I_{q_t^{\overline{PB}}}$ can be positive.

The probability of re-election is affected by the incumbent's actions if they alter the voters' beliefs. The incumbent may target other issues apart from her favorite in order to affect the voters' expected utility differential, ε^i_{t+1}, $i = \{1, 2, 3\}$. In particular, if she signals a type other than her own $(-k)$ and this signaling is *effective*, ε^{-k}_{t+1} increases.
If she performs $q_t^{\overline{PB}}$ her type is revealed. This is because $Pr(q_t^{\overline{PB}}|I \neq k) = 0$, that is, the incumbent will never spend only on $g_{k,t+1}$ if she is of another type. So voters update their beliefs that the incumbent is of type k according to:

$$\Pr\left(I = k|q_t^{I,\overline{PB}}\right) = 1 \tag{12}$$

which means that for voters in group k the expected utility differential becomes positive, that is,$\varepsilon^k = (1 - \lambda_k)\mu_k g_{k,t+1}$, while the opposite is true for the other two groups, where $\varepsilon^{-k} = -\lambda_{-k}\mu_{-k}g_{-k,t+1}$. The incumbent's probability of re-election in a single-district system is therefore given by the following expression.

$$\pi^{I,Sd}_{q_t^{I,\overline{PB}}} = \frac{z}{\sum_{i=1}^{3} d^i} g_{t+1}\left(d^k\mu_k\left[(1-\lambda_k)\right] + \sum^{2} d^{-k}\mu_{-k}\left[-\lambda_{-k}\right]\right) + \frac{1}{2} \tag{13}$$

where $g_{i,t+1} = g_{t+1}, \forall i = \{1, 2, 3\}$.
Alternatively, the incumbent may choose $q_t^{PB} = \{G_t^{PB}, g_{k,t}, g_{i,t}\}, \forall i \neq k$. In this case, she will spend on her favorite issue, k, and in one of the other two $i \neq k$. In choosing which of the other issues to target she compares the gain in the probability of winning in the other two. She will then perform the strategy if the gains in terms of votes in the targeted group outweigh the loses in her own group plus the utility loss.
Denoting the targeted group j, voters in all groups update their beliefs that the politician is of types k, and symmetrically j, according to:

$$\Pr\left(I = k|q_t^{PB}\right) = \frac{\Pr(q_t^{PB}|I = i).\lambda^i}{\Pr(q_t^{PB}|I = k).\lambda^k + \Pr(q_t^{PB}|I = -k)(1 - \lambda^k)} \tag{14}$$

with $i = \{k, j\}$.
To solve for the equilibrium, I first assume that the incumbent has an incentive to perform the pork barrel policy, and then check whether this is

true. So $Pr(q_t^{PB}|I=k)=1$ and $Pr(q_t^{PB}|I=-k)=\frac{\lambda^j}{\lambda^j+\lambda^{-j-k}}$. Substituting in the previous expression, we have that for voters in group k, and symmetrically for those of group j:

$$\varepsilon^k=\varphi^k\mu_k g_{k,t+1} \tag{15}$$

where

$$\varphi^k=\frac{\lambda^k\left[1-\lambda^k-\left(1-\lambda^k\right)\frac{\lambda^j}{\lambda^j+\lambda^{-k-j}}\right]}{\lambda^k+(1-\lambda^k)\frac{\lambda^j}{\lambda^j+\lambda^{-k-j}}}>0 \tag{16}$$

Once again, for the group whose preferred issue is not spent on, $\varepsilon^{-k-j}=-\lambda_{-k-j}\mu g_{-k-j,t+1}$. Substituting in the re-election probabilities we have that the difference in re-election probabilities for an incumbent of type k of performing or not pork barrel by targeting group j is given by:

$$\pi^I_{q_t^{PB}}-\pi^I_{q_t^{\overline{PB}}}= \tag{17}$$

$$\frac{z}{\sum_{i=1}^{3}d^i}\left[d^k\mu_k g_{k,t+1}\underbrace{\frac{\left(\lambda^k-1\right)\frac{\lambda^j}{\lambda^j+\lambda^{-k-j}}}{\lambda^k+(1-\lambda^k)\frac{\lambda^j}{\lambda^j+\lambda^{-k-j}}}}_{A}+d^j\mu_j g_{j,t+1}\underbrace{\frac{\lambda^j}{\lambda^j+(1-\lambda^j)\frac{\lambda^k}{\lambda^k+\lambda^{-k-j}}}}_{B}\right]$$

Since A is negative and B is positive, and $g_{k,t+1}=g_{j,t+1}$, whether the (17) is positive or negative depends solely on the ordering of densities and the intensity of preferences given by μ_i. When the politician has a preference for the group with the highest density's preferred issue, that is, $k=2$, for (17) to be positive and so pork barrel to be *effective* $\mu_1-\mu_2$ or $\mu_3-\mu_2$ has to be large enough to compensate the fact that $d_1,d_3<d_2$. So, for given preference intensities, an incumbent is more likely to target highly densely concentrated groups. This means in particular that the group with the most dispersed ideology, group 3, is less likely to be targeted, as for it to be targeted μ_3 would need to be very high. If this does not happen when a politician has a preference for a more heterogeneous group signaling is not *effective* and so the incumbent does not perform the pork barrel strategy.
In practice, if it is *effective* in terms of altering the voters' beliefs about the preferences of the incumbent, delivering pork corresponds to a shift in the position of a given group in Figure 1 towards the left. This implies that it is always better for the incumbent to target groups with higher densities. Under a proportional system, an incumbent will only target a group with

a lower density than the one she has a preference for if the valuation of the preferred issue by that group is strong enough. Thus, the pork barrel strategy might arise in equilibrium for signaling purposes, but is less likely to occur towards ideologically heterogeneous groups.

In the multi-district case, existence of an equilibrium cannot be guaranteed without further assumptions. Unlike Persson and Tabellini (1999), who assume the distance between the groups' ideological means ($\overline{\sigma^1}$ and $\overline{\sigma^3}$) is large enough such that parties only compete for for votes with ideologically neutral voters, I assume that the weight put in ideology by voters is infinitesimally small, such that not only is $\overline{\sigma^2} = 0$ but also $\overline{\sigma^1}$ and $\overline{\sigma^3}$ are infinitesimally close to zero. More specifically, this means that the groups in Figure 1 overlap to a greater extent: that is, the groups differ only in the dispersion of ideology, while ideology matters when the utility differential is zero. In practice this means that groups make their decision primarily based on the utility differential they expect each party to provide them with.
Performing the two different policies will generate the same utility differentials, ε_i, as calculated previously. We now have, if an incumbent of type k performs $q_t^{\overline{PB}}$:

$$\pi^{I,M}_{q_t^{\overline{PB}}} = zd^k\left[(1-\lambda_k)\mu g_{k,t+1}\right] + \frac{1}{2} > \frac{1}{2}$$
$$\pi^{I,M}_{q_t^{\overline{PB}}} = zd^{-k}\left[-\lambda_{-k}\mu g_{-k,t+1}\right] + \frac{1}{2} < \frac{1}{2}$$

for $-k = \{1,2,3\} \neq k$. That is, the incumbent is expected to have a majority only in the group with the same preference as her, and thus not to win the election. If, on the contrary, she performs q_t^{PB}, targeting group j, these probabilities become:

$$\pi^{I,M}_{q_t^{\overline{PB},k}} = zd^k\left[\varphi^k\mu_k g_{k,t+1}\right] + \frac{1}{2} > \frac{1}{2}$$
$$\pi^{I,M}_{q_t^{\overline{PB},j}} = zd^j\left[\varphi^j\mu_j g_{j,t+1}\right] + \frac{1}{2} > \frac{1}{2}$$
$$\pi^{I,M}_{q_t^{\overline{PB},-k-j}} = zd^{-k-j}\left[-\lambda^{-k-j}\mu_{-k-j} g_{-k-j,t+1}\right] + \frac{1}{2} < \frac{1}{2}$$

This means that if the incumbent distributes pork she is expected to have a majority in two out of three districts and thus to win the election. The difference in winning probabilities is calculated on the basis of the targeted

district.

$$\pi^{I,M}_{q_t^{PB}} - \pi^{I,M}_{q_t^{\overline{PB}}} = zd^j \mu_j g_{j,t+1} \left[\underbrace{\frac{\lambda^j}{\lambda^j + (1-\lambda^j)\frac{\lambda^k}{\lambda^k + \lambda^{-k-j}}}}_{C} \right]$$

where C is positive. The incumbent in power still prefers to target a group with a higher density, as it gives her a higher expected utility, which means that once again targeting group 3 is less likely to happen in equilibrium. Thus an incumbent of type 3 is also less likely to distribute pork for signaling purposes. The incentives in the multi-district system are even stronger, as they hold even for equal intensity of preferences ($\mu_1 = \mu_2 = \mu_3$).

From equation (11), whenever $\pi^I_{q_t^{PB}} - \pi^I_{q_t^{\overline{PB}}} > 0$ for each system the incumbent has an incentive to perform the pork barrel strategy. Her incentive to do so is larger the larger β is - that is, the more future oriented the politician is - the larger μ_k is - that is, the more the incumbent values her preferred issue - the lower the valuation of G_t and the prior on the challenger's type λ_k are, and the higher the payoff of being in office, γ, is. Intuitively, an incumbent that is future oriented or has a high payoff of being in office is willing to give up more utility in the present in exchange for re-election.

2.3.3 Empirical Implications

The model derives conditions under which pork barrel may arise as an equilibrium strategy for an incumbent, thus putting forward testable implications. The first is that in majoritarian systems in election years particularistic expenditures should be systematically higher than those made during the rest of a politician's mandate. When politicians behave differently in election years they are deviating from the policy that maximizes their fiscal utility $u^I_{k,t}(q^I_t)$. These distortions should arise both in single and multi-district systems.

The second and third refer to re-election incentives. Particularly, these distortions should not take place when a politician cannot be re-elected - when she is a "lame duck" - and they should be smaller when she is subject to term limits, even when are not binding. The intuition for the former is that, if an incumbent cannot run for re-election, she does not have an incentive to signal her preferences through current policy. The latter is a measure of the time horizon of the politician, and should therefore approximate her

discount factor: if an incumbent is not subject to term limits she has a much higher potential future payoff, which in our simplified framework means she has a smaller discount factor. Thus she should have a higher incentive to perform pork. Finally, we should not see election year increases in particularistic expenditures if voters with strong preferences for them are more ideologically dispersed than the average population. If these distortions are in fact generated by the signaling motive then politicians will choose to perform them towards groups that are more densely concentrated ideologically and are therefore easier to sway.

3 Empirical Strategy

The model is tested for the case of U.S. state level policy, namely for environmental expenditures. This more closely approximates the majoritarian single-district system. This is a particularly suitable laboratory for several reasons. The first is that U.S. governors have substantial control over several policy areas, including environmental policy (List and Strum, 2006). This provides state governments with significant discretion over their expenditures. The second is that the environment triggers strong opinions by the electorate, which makes it a natural candidate to represent one of the particular issues in the model that some voters care about. The third is that in the U.S. a large number of surveys are conducted before elections, such that incumbents are likely to be well informed of the preferences of the electorate, particularly regarding salient issues. Finally, the large number of years available and the detail of the data allows for a rich analysis of incentives, while facilitating the identification strategy.

3.1 Variable Definition

A first key empirical question is what constitutes pork barrel spending. I define it as the environmental expenditures occurring in election years in excess of what the politician's choice would be in the absence of electoral incentives.Accordingly, I use two alternative measures. The first are systematic increases in election year environmental spending as compared to all non-election years. This measures if in election years decisions differ from what is optimal in every other year. The second is calculated as the deviation in the environmental spending level in election years with respect to the average expenditure for each incumbent politician. This measures whether election year decisions differ from what is optimal for the same politician in every other year.

In order to measure voters' environmental preferences and ideological dispersion I use responses to surveys representative at the state level.[16] For each respondent I measure the degree of environmental preference and the ideological inclination. For the first I create a scale from responses on questions about the importance of the environment and government's action regarding the environment, env_i, and for the latter I use the answer to the question of whether the respondent is a conservative, moderate, liberal, or does not think in those terms. I use the latter to create an indicator of ideological dispersion at the state level,$totdisp_i$, by calculating the standard deviation of this measure in each state. Furthermore, using the degree of environmental preference I classify respondents into environmentally biased or not, simply by generating a dummy equal to 1 if env_i is higher than the mean of the population and 0 otherwise, and calculating the ideological dispersion in each state only if the dummy is 1, $envdisp_i$. I then calculate the dispersion of environmental voters' ideology relative to the total dispersion in state i as $disp_i = \frac{envdisp_i}{totdisp_i}$. I experiment with different cutoffs for the dummy variable, but since the results do not vary I use only this indicator.

3.2 Econometric Model

The analysis aims at assessing the existence of election-year distortions in environmental spending across states, and the factors contributing to them. The basic empirical model is given by

$$Environment_{it} = \alpha_1 + \delta elyear_{it} + \alpha_2 X_{it} + \eta_i + \epsilon_{it} \tag{18}$$

where $Environment_{it}$ stands for both $envexp_{it}$, real total environmental *per capita* expenditures in state i at time t, and dev_i, deviations from politician mean in environmental expenditures in state i at time t.[17] As in List and Sturm (2006), total environmental expenditures are the sum of expenditures in three categories: *forests and parks*, *fish and games*, and *others*. They argue they can be pulled together as all three record very similar types of spending and are used as substitutes. Expenditures are deflated to 1982-1984 dollars. $elyear_{it}$ is a dummy variable equal to 1 if there is an election in state i in year t and 0 otherwise, X_{it} is a vector of economic and demographic variables affecting fiscal choices for each state, η_i is a state fixed effect, and ϵ_{it} is the error term. The fixed effect is included to control for unobserved heterogeneity. The main coefficient of interest is therefore δ,

[16] The surveys are described in Section 3.3.

[17] Calculated as $envexp_{it} - av_P$ where av_P is the average environmental expenditure for a given politician.

that measures systematic changes in the dependent variable occurring in election years. If pork barrel takes place for environmental expenditures this coefficient should be positive and significant.
The control variables included in X_{it} aim at capturing a given state's resources and needs. The variables 17_{it} and 65_{it}, respectively the percentage of people between 5 and 17 and over 65 years old in state i at time t, measure population needs, $taxes_{it}$, the real *per capita* taxes in state i at time t, provide a measure of the state's resources, and pop_{it}, the state population in millions, is included to account for economies of scale or congestion effects in the provision of public goods. Finally, because public expenditures are likely to be persistent over time, I include a lagged dependent variable, $envexp_{i,t-1}$ in the estimations using total environmental expenditures as the dependent variable.
To the basic model I add additional variables, in turn, to test further implications. The predication that pork occurs less towards ideologically dispersed groups is tested by including the interaction of the dispersion index $disp_i$ with the election year dummy, while also including the index separately. For this variable a negative coefficient is expected: environmental expenditures in election years should be lower in states where citizens with environmental preferences are dispersed ideologically. To test the prediction that a higher discount rate leads to less environmental pork I include a dummy variable equal to 1 if state i has term limit legislation at time t and 0 otherwise, $limit_{it}$, and an interaction of this with the election year dummy. The coefficient of the interaction term is expected to be negative, indicating that if the time horizon of a politician is smaller, incentives to perform pork decrease. Finally, to test whether politicians who cannot be re-elected have different incentives I include $lame_{it}$, a dummy equal to 1 if the incumbent is a "lame duck" (is not up for re-election) and 0 otherwise. The interaction of this dummy with the election year dummy thus measures election year incentives for "lame ducks" as compared to incumbents up for re-election. Thus a negative sign is expected.
For the model having the deviation from the mean as a dependent variable I split the sample into states with term limits and without, and incumbents who are "lame ducks" and who are not, and run the regressions separately for an easier comparison.

3.3 Empirical Issues

Due to unobserved heterogeneity a Fixed Effects (FE) model is estimated instead of Ordinary Least Squares (OLS). However, because of the inclusion

of the lagged dependent variable, the FE estimation biased as the fixed effect η_i is correlated with it. Thus, following Arellano and Bond (1991), I take the first difference of equation (18) including the lag, thus eliminating the fixed effect, and use lags of the dependent variable of two or more periods, which are not correlated with the variable in differences, as instruments. Their Generalized Method of Moments (GMM) estimates the model parameters directly from the moment conditions and combines the instruments efficiently. However, since there is a high level of persistence I use use the system GMM (GMMsys) estimation (Arellano and Bover, 1995 and Blundell and Bond, 1998) which additionally uses the moment conditions for the model in levels, and is more robust to problems like measurement errors and weak instruments.

3.4 Data

The database used includes information for the 48 continental states in the US between 1970 and 2000, making a total of 1488 observations.
Data on environmental expenditures as well as all political and demographic variables used in the analysis come from List and Sturm (2006). The latter are in turn updated versions of the data used in Besley and Case (1995) and the former were collected from the Census of State Governments. Environmental expenditures vary largely across states and time between a minimum of 6119 and 168297 dollars. The dummy for term limits includes states with a one, two or three period term limit, and the legislation in several states changed during the sample period.[18]
Data on state environmental preferences and ideology was collected from five surveys, conducted between 1980 and 2007.[19] These surveys were conducted by CBS with the New York Times, and ABC News with Stanford University and Time Magazine, and are available from the Inter-university Consortium for Political and Social Research (ICPSR). They include questions that measure environmental inclination (such as a classification of the importance of the environment and the government's role in it) as well as ideological preferences. According to List and Sturm (2006), environmental inclination is persistent over time in US states (namely between 1987 and 2000). Thus I pull together the information on the five surveys, which allows me to have 6325 individual observations, from which the state ideological dispersion and degree of environmental inclination are calculated.

[18] A description of the term legislation in each state, as well as detailed sources, can be found in List and Sturm (2006).

[19] Namely, April-May 1980, April 1983 and June 1983, March 2006 and April 2007.

The resulting measure of environmental preference is correlated, although varying considerably less, with that of List and Sturm (2006), consisting of the percentage of state population enroled as a member of the largest environmental organizations.
Table 1 presents the summary statistics for the data.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min	Max	Obs
Environmental Expenditures	27.058	16.983	6.119	168.297	1488
Forests & Parks	11.522	6.712	0.560	58.666	1488
Fish & Game	6.836	6.697	0.515	52.086	1488
Other Environmental 0	8.701	9.026	0.164	118.244	1488
Deviation	0	5.268	-29.86	44.458	1488
Taxes in State	817	219	316	1731	1488
Personal Income	12914	2537	6745	24093	1488
State Population in millions	4.955	5.191	0.333	34.002	1488
Percentage over 65	0.118	0.02	0.04	0.188	1488
Percentage between 5-17	0.209	0.029	0.071	0.304	1488
Lame Duck	0.261	0.439	0	1	1488
Term Limits	0.606	0.489	0	1	1488
Environmental Preference	146.156	3.058	129.437	150.228	1488
Environmental Dummy	0.663	0.111	0	1	1488
State Ideological Dispersion	2.039	1.224	0.705	8.452	1488
Dispersion Environmentalists	1.082	0.259	0.565	1.64	1488
Dispersion Index	0.656	0.291	0.1	1.424	1488

Sources: List and Sturm (2006) and ICPSR.

4 Results

The results from the dynamic model where the dependent variable is real *per capita* environmental expenditures are presented in Table 2. All estimations include the lagged dependent variable and the main variable of interest, $elyear_i$. This variable is positive and statistically significant across all estimations. The first two columns show the results for the dynamic model without controls estimated by OLS and FE. Although biased, these estimations are used as a benchmark for the consistent GMMsys estimations. They show a high persistence of environmental expenditures, corroborated by the GMMsys estimation in column (3). The latter places the coefficient of the lagged dependent variable between the upward biased OLS estimation and the downward biased FE estimation.

In columns (4) and (5) the full model is estimated. Again, because GMMsys estimations tend to depend largely on the choice of the instrument matrix, column (4) presents the biased FE results as a benchmark. Column (5) presents the consistent GMMsys estimation. All GMMsys estimations use a two-step estimation with a finite sample correction for standard errors (Windmeijer (2005)). They are robust to heteroskedasticity and error term serial correlation. Since the results show there exist first but not second order autocorrelation, I use two or more lags of the dependent variable as instruments, while considering the demographic variables exogenous. The political variables and the ideological dispersion are also considered exogenous, while state taxes are considered pre-determined. Accordingly, only lags of the latter of at least one period are used as instruments. As having too many instruments may invalidate the estimation, instruments are collapsed.

The results show that environmental expenditures present a large degree of persistence, with a coefficient of 0.779 (column 5) statistically significant at a 1% confidence level. In election years expenditures increase on average 1.19$, which is significant at a 5% level. The coefficient on the population is negative, suggesting the existence of economies of scale in environmental expenditures, and those on the percentage of population over 65 and under 17 are not statistically significant.

Finally, columns (6) and (7) present the results of the predictions of the model regarding features that increase incentives for pork barrel with signaling purposes. In column (6) the coefficient for $disp_i \times elyear_{it}$ is negative and statistically significant at a 10% level, corroborating the predictions of the model. It means that in election years, states with higher ideological dispersion than the average receive less environmental expenditures relative to those less dispersed, which indicates that incumbents choose to spend their budget in other types of spending. The dispersion index is not statistically significant. Finally, column (7) tests the "lame duck" and term limit predictions. In states where term limits are imposed expenditures are higher than in the others ($limit_{it}$ is positive and statistically significant). Additionally, election year environmental expenditures are smaller for states with term limit legislation in place by 11.33$, and this difference is statistically significant at a 5% level. This is in accordance with the prediction that politicians with a smaller time horizon in office have less incentives to perform pork. Finally, the coefficients for the "lame duck" dummy are not statistically significant.

Table 2: Basic Model Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Estimation	OLS	FE	GMMsys	FE	GMMsys	GMMsys	GMMsys
$envi_{it-1}$	0.963***	0.813***	0.901***	0.746***	0.779***	0.810***	0.777***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$elyear_i$	0.624*	0.536*	1.11*	0.533*	1.19**	9.79*	2.873**
	(0.0559)	(0.091)	(0.074)	(0.0826)	(0.037)	(0.044)	(0.0249)
pop_{it}				-5.31e-5	-2.37e-4**	-1.71e-5	-0.144
				(0.677)	(0.0170)	(0.182)	(0.445)
65_{it}				87.0	-19.2	-46.8	98.78
				(0.112)	(0.432)	(0.282)	(0.568)
17_{it}				11.0	-20.7	-48.9	-15.04
				(0.151)	(0.262)	(0.102)	(0.848)
$disp_i$						9.40	
						(0.355)	
$disp_i \times elyear_{it}$						-11.33*	
						(0.073)	
$limit_{it}$							8.336**
							(0.0142)
$limit_{it} \times elyear_{it}$							-3.316**
							(0.0241)
$lame_{it}$							0.229
							(0.653)
$lame_{it} \times elyear_{it}$							0.727
							(0.340)
Constant	1.39***	5.38***	2.90**	-9.90***	12.3	18.0	-2.496
	(0.0001)	(1.12e-010)	(0.0314)	(0.0794)	(0.149)	(0.103)	(0.949)
Observations	1,392	1,392	1,392	1,392	1,392	1,392	1,392
R-squared	0.886	0.649		0.662			
Number of states	48	48	48	48	48	48	48
AR1			-3.634		-3.483	-3.500	-3.335
p-value			0.000279		0.000495	0.000464	0.000854
AR2			0.349		0.290	0.633	0.173
p-value			0.727		0.772	0.527	0.863
Hansen			3.031		5.816	11.27	31.55
p-value			0.387		0.444	0.421	0.389
DF			3		6	11	30

P-values in parentheses. Dependent variable $envi_{it}$. Robust standard errors.
Significance level at which the null hypothesis is rejected: ***1%, **5%, *10%.

Finally, the results from the estimations using the mandate mean deviations are presented in Table 3. Only the coefficients for the variables of interest are presented, but the same set of controls of the previous estimations is included. If signaling is in fact driving election year systematic deviations from the mean for a given politician then these deviations should be smaller when the state has a term limit legislation and should not take place when the politician cannot be re-elected. The first two columns compare the cases where the politician can and cannot be re-elected, and the last two columns compare the states where term limit legislation is and is not in place. Particularly, I consider only states with short term limits (two mandates).
The results show that election year positive deviations from incumbent mean are only significant for politicians who can run for re-election and for those that are not subject to term limits (columns 2 and 4). Additionally, only in these two cases are election year deviations smaller for states with high ideological dispersion, although this difference is not statistically significant. The results thus show support for the signaling motivation for election year pork barrel spending.

Table 3: Election Year Deviations

	(1) Lame Duck	(2) No Lame Duck	(3) Term Limit	(4) No Term Limit
$elyear_i$	0.284	1.259**	0.048	1.535**
	(0.769)	(0.046)	(0.973)	(0.043)
$disp_i \times elyear_{it}$	0.234	-0.942	0.010	-1.522
	(0.868)	(0.266)	(0.996)	(0.208)
Observations	300	997	116	1194
Number states	32	47	8	45

P-values in parentheses. Dependent variable dev_{it}. Robust standard errors. Cluster environmental preferences; *** p<0.01, ** p<0.05, * p<0.1

5 Conclusion

This paper presents evidence of the existence of pork barrel spending with signaling purposes. A simple model of electoral competition derives conditions under which pork arises in equilibrium for an incumbent to signal preferences for different issues, for which groups in the population care about differently. The resulting conditions are tested for the case of US state en-

vironmental expenditures. Environmental issues are likely to be subject to electoral manipulation since they elicit strong preferences from particular subgroups. The empirical analysis shows support for the theoretical model. There are systematic increases in environmental spending in election years across states, even when controlling for a given politician's average choices. These are smaller when the environmentally biased groups are more ideologically dispersed, when term limits are implemented (which proxy for the incumbent having a high discount rate), and when the politician cannot be re-elected, although evidence for the latter is not robust across different measures.

These results have important implications for the theoretical literature on politically driven policy distortions, as well as for governance discussions. First, I present evidence of the signaling motive for pork barrel across issues and not geographic groups. To the best of my knowledge no study has shown this before. This allows to corroborate the assumptions made in several theoretical studies. Second, the fact that more homogeneous groups are targeted more often has implications for the literature on the formation and influence of special interest groups. It means that groups that are organized around ideology will be more able to attract benefits from politicians seeking re-election. Finally, the results show that issues that elicit strong preferences from the electorate are prone to distortions to get electoral advantage, through the signaling mechanism. This makes them particularly subject to electoral cycle variations. In particular for environmental policy, which requires continued action across time in order to be efficient, this has important implications. Namely, mechanisms restraining the discretionary power of politicians that limit the size of electorally driven cycles could increase the efficiency of environmental policy, by protecting it from electoral incentives.

References

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The review of economic studies*, **58** (2), 277–297.

— and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, **68** (1), 29–51.

Besley, T. and Case, A. (1995). Does electoral accountability affect eco-

nomic policy choices? evidence from gubernatorial term limits. *The Quarterly Journal of Economics*, **110** (3), 769–798.

— and Coate, S. (1997). An economic model of representative democracy. *The Quarterly Journal of Economics*, **112** (1), 85–114.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, **87** (1), 115–143.

Bouton, L., Conconi, P., Pino, F. and Zanardi, M. (2013). Guns and votes.

Brender, A. and Drazen, A. (2005). Political budget cycles in new versus established democracies. *Journal of Monetary Economics*, **52** (7), 1271–1295.

Calvert, R. L. (1985). Robustness of the multidimensional voting model: Candidate motivations, uncertainty, and convergence. *American Journal of Political Science*, pp. 69–95.

Downs, A. (1957). *An Economic Theory of Democracy*. Harper Collins, New York.

Drazen, A. and Eslava, M. (2010). Electoral manipulation via voter-friendly spending: Theory and evidence. *Journal of Development Economics*, **92** (1), 39–52.

— and — (2012). Programatic targeting. *Mimeo*.

Erikson, R. S., MacKuen, M. B. and Stimson, J. A. (2000). Bankers or peasants revisited:: economic expectations and presidential approval. *Electoral Studies*, **19** (2), 295–312.

Evans, D. (2004). *Greasing the Wheels: Using Pork Barrel Projects to Build Majority Coalitions in Congress*. Cambridge University Press.

Fredriksson, P. G., Wang, L. and Mamun, K. A. (2011). Are politicians office or policy motivated? the case of us governors' environmental policies. *Journal of Environmental Economics and Management*, **62** (2), 241–253.

Hicken, A. and Simmons, J. W. (2008). The personal vote and the efficacy of education spending. *American Journal of Political Science*, **52** (1), 109–124.

Lewis-Beck, M. (1990). *Economics and Elections: The Major Western Democracies*. University of Michigan Press.

List, J. A. and Sturm, D. M. (2006). How elections matter: Theory and evidence from environmental policy. *The Quarterly Journal of Economics*, **121** (4), 1249–1281.

Lizzeri, A. and Persico, N. (2001). The provision of public goods under alternative electoral incentives. *American Economic Review*, **91** (1), 225–239.

Lockerbie, B. (1992). Prospective voting in presidential elections, 1956-1988. *American Politics Research*, **20** (3), 308–325.

Morelli, M. and Weelden, R. V. (2013). *Re-Election Through Division*. Tech. rep., University of Columbia.

Nordhaus, W. D. (1975). The political business cycle. *The Review of Economic Studies*, **42** (2), 169–190.

Osborne, M. J. and Slivinski, A. (1996). A model of political competition with citizen-candidates. *The Quarterly Journal of Economics*, **111** (1), 65–96.

Persson, T. and Tabellini, G. (1999). The size and scope of government:: Comparative politics with rational politicians. *European Economic Review*, **43** (4-6), 699–735.

Rogoff, K. (1990). Equilibrium political budget cycles. *American Economic Review*, **80**, 21–36, ¡p¿© Copyright 1990 by the American Economic Association. Posted by permission. One copy may be printed for individual use only.¡/p¿.

— and Sibert, A. (1988). Elections and macroeconomic policy cycles. *Review of Economic Studies*, **55** (1), 1–16.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step gmm estimators. *Journal of econometrics*, **126** (1), 25–51.