A Voting Model of Environmental Legislation

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Abstract

I present a voting model to analyze motives towards overlegislation and underenforcement of environmental standards by democratic governments. Based on the framework developed by Selden and Terrones (1993), I build an electoral model with two types of politicians: an environmentalist whose preferences match the median voters' utility function, and an industrialist who derives utility only from a capital good. I show that in an equilibrium where proposed environmental policy reveals the incumbent's type, an environmentalist politician is willing to overlegislate only for a small set of parameter values. In an equilibrium where proposed policy does not convey information about the politician's type, an incumbent chooses overlegislatory policy depending on voters' equilibrium strategy. I also show that an industrialist politician underenforces standards following an election in all equilibrium specification, while an environmentalist politician either enforces or overenforces the socially optimal standards in the second period. Finally, when voters cannot observe the proposed green policy, an industrialist incumbent is reelected with higher probability which negatively affects social welfare.

Acknowledgements

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Contents

1 Introduction

Climate change is receiving increased attention in political election campaigns. Announcing policies that address environmental protection have become more important on political agendas to signal politicians' willingness to take green issues seriously. Furthermore, environmental sustainability plays a more important role in public discussion. Citizens around the world are becoming more aware of the long-term effects of climate change and the importance of acting in the present. In the United States, for example, the February 2020 Pew Research Center Report found that the public values protecting the environment as a top policy priority. The share of environmental policy proponents is nearly the same as those who advocate strengthening the economy, making these the public's top policy priorities. While a smaller number of Americans value climate change as a first concern, it has been constantly rising in the public's agenda for the president and the United States Congress in the past few years. (Pew Research Center, 2020)

Arguably, the government plays a major role in protecting the environment. It has discretion over enacting environmental interventions that can help reducing emissions, promoting sustainable development and boosting green innovation. There are various market-based instruments, such as cap-and-trade schemes, carbon taxes and green subsidies, that are effective tools in fighting climate change by creating mechanisms that realign incentives. These cannot, however, be implemented without effective governmental regulation and control.

Governments' incentives on protecting the environment is not necessarily aligned with that of the public. The literature suggests, for example, that politicians may be biased towards policies that serve the interest of the industry over the citizenry. For example, Buchanan and Tullock (1975) shows that when the industry is better organized than the general public, the instituted policy instruments align with firms' preferred choices. Therefore, policies targeting environmental protection may not serve the interests of the public. Hahn (1990) extends on this analysis and identifies

conditions under which incentive-based instruments can emerge while balancing the opposing interests of the industry and the environmentally conscious population.

Ultimately, the public wants policy proposals to be implemented and committed to in a longer-haul. Governments that do not maintain their proposed environmental strategies tend to face an increased pressure from the public. Environmental groups actively protest and, in some cases, go to court whenever governments seemingly violate their committed green policies. For example, James Thornton, founder of ClientEarth, has recently sued the UK government over violations of the air quality standards (Financial Times, 2019). Therefore, democratic governments are made accountable for their proposed policies which disincentives them deviating from their agenda by large.

Nonetheless, the public is rarely informed about the actual level of government's policy enforcement. Firstly, citizens may not have access to information on policy implementation and the uphold of commitments. Therefore, monitoring the government's policy actions is not always feasible. Secondly, voters may be inattentive to observe enforcement accurately. Getting information on the enforcement level of policies comes with considerable search costs that voters are usually unwilling to bear. Instead, the public is informed on green issues from the media which does not always convey unskewed information. Importantly, the media can have large influence on the public's considerations of environmental issues and their opinion on whether the government meets its policy agenda.

The aim of this thesis is to formally model and analyse the above issues using a game theoretic model of environmental policy making. I focus on politicians' incentives on setting environmental policy targets and their decision on enforcing these policies.

This paper is organized as follows. After a brief literature review in Section 2, I outline the mathematical formulation of the model beginning in Section 3. The model that I present captures a simplified representation of reality with two periods

separated by an election, two signals and two players: the median voter(s) and the incumbent politician.

At the beginning of the game, nature determines the type of the incumbent politician and players' discount factors which capture their relative valuation of future utility. In the first period, the incumbent politician decides on the level of enforcement of existing green standards and makes a policy proposition for the next period. Based on the observed enforcement level and policy target, the median voters decide on whether to reelect or not the incumbent politician. If the incumbent does not get reelected, a new politician gains power who is drawn from the population randomly. In both cases, the politician who gets elected decides on the second period policy implementation.

The median voters derive utility from the environmental quality and a capital good. Enforcement of green policies by the government has long-lasting effects, therefore, it improves both the present and future environmental quality. On the other hand, abatement initiatives have costs that decrease the provision of the capital good for a single period. Politicians are differentiated by their preferences over the environmental quality and the capital good. Specifically, the politician is either an environmentally conscious type who puts the same relative preference on environmental quality as the median voter, or an industrialist type who does not care about the environment. Both type of politicians want to get reelected, however, an environmentalist incumbent also derives utility from policies that increase social welfare. For simplicity, the model assumes that voters' and the environmentalist politician's discount factor is 1, therefore, they do not discount future utility.

The model also incorporates two elements present in the real world. Firstly, it captures that politicians face public tension when deviating from the green policies they committed to before the election. Secondly, the model has information asymmetry in the form of voters' inability to observe the politician's type and the actual level of policy enforcement. That is, voters have a prior belief on the probability

of having an environmentalist incumbent. Furthermore, voters observe the first period enforcement level with a noise. Therefore, with some probability they observe smaller or larger enforcement level than is actually enacted by the politician. When the distribution of the noise is right-skewed, I define it as a positive information skew. In the opposite case, negative information skew is present in the model.

In section 3.2, the paper examines the solution of the model under a full-information benchmark. In a full information setting, there is no uncertainty about the type of politician and the level of enforcement. Then, the model predicts that only an environmentalist politician gets reelected who fully enforces past standards and proposes green policies that coincide with voters' optimal policy target. She also sets the socially optimal enforcement level upon being elected. Importantly, this game with an environmentalist incumbent can be considered socially optimal as first-best policy is proposed, and the level of enforcement in both periods meet voters' optimal enforcement decision. Then, underenforcement is defined as the enforcement level observed in equilibrium which is lower than the socially optimal. Furthermore, overlegislation is observed when proposed standards exceed the socially optimal level. Overenforcement and underlegislation represent the opposite cases.

Section 4 introduces the information asymmetry to the model. There, I assume that voters do not have information on the type of incumbent politician and the exact first period enforcement level. They have prior belief on the probability of having an environmentalist incumbent; and the form and magnitude of the noise present in the enforcement signal is common knowledge. I identify equilibria in which voters use threshold strategies on the observed enforcement level and the policy proposal. Firstly, I consider the separating equilibrium of the game on the proposed environmental policy. In a separating equilibrium, the politician's type is fully revealed by the proposed policy agenda in the first period. The model suggests that an environmentalist politician is willing to overlegislate only for a small set

of parameter values to distinguish herself. That is because an environmentalist politician does not only value reelection, but also wants to set policies that result in outcomes close to the socially optimal. Therefore, when overlegislation is required to signal her type, under most parameter values she is better off proposing close-to-optimal policies instead. Furthermore, the equilibrium implies that overlegislation by an environmentalist results in second-period overenforcement.

Secondly, I analyze the pooling equilibria in which politicians choose the same level of policy target in their agenda. Then, proposed policy does not reveal any information on the politician's type. Instead, voters determine the probability of an environmentalist incumbent based on their prior belief and the observed policy enforcement signal. The pooling equilibrium shows that when the distribution of the noise is right skewed, in equilibrium the median voters reelect politician only when observing full-enforcement. Then, an incumbent expects that even when setting full-enforcement, with some positive probability she won't get reelected. This implies that the proposed policy level on which politicians pool is higher than the first-best level and so overlegislation is observed in equilibrium. Furthermore, the probability that an industrialist politician underenforces in the first period increases with the magnitude of a positive information skew. The intuition behind is that when voters observe higher enforcement levels more frequently, an industrialist politician is willing to sacrifice current consumption to increase enforcement level and thereby his probability of reelection.

When the distribution of the noise is left skewed, voters also reelect the politician when observing first period underenforcement and politicians pool on the socially optimal level of environmental target. Importantly, when an industrialist politician is also willing to fully enforce in the first period for large discount factors, equilibrium only exists if the magnitude of the skew is large enough. Therefore, unskewed information transmission on the level of policy enforcement can limit the existence of such pooling equilibrium.

In Section 5, I consider a modification of the model in which voters do not observe the policy proposition of the politician. Then, the median voters reelect politician based on the observed value of first period enforcement. Similarly to the pooling equilibria, with positive information skew voters reelect incumbent when observing full-enforcement. In the opposite case, they reelect when past standards are observed to be either under- or fully enforced. This specification shows that an environmentalist incumbent fully enforces in the first period, but may overlegislate standards depending on voters' equilibrium strategy on reelection. In contrast, an industrialist incumbent chooses first period enforcement level based on his discount factor and sets environmental target to zero. Upon getting reelected, he does not enforce any environmental legislation.

An important result of this modification is that the probability of an industrialist choosing either under-, or full-enforcement is higher, therefore, in equilibrium we observe an industrialist politician to be reelected more frequently. That is because an industrialist politician does not have to pledge future environmental policies which alters his incentives to forgo current consumption and increase his reelection probability. Furthermore, there is no separating equilibrium of this game in which voters would only reelect an environmentalist incumbent. This demonstrates welfare conclusions on the importance of clear communication of political agenda to the voters.

Section 6 elaborates on the robustness of my results to alternative specifications. Section 7 provides some evidence on the insights in real world elections, and discusses the difficulty of empirically detecting overlegislation. It also offers some recommendations that can improve policy making on environmental protection. Section 8 concludes.

2 Literature review

This thesis builds on the framework developed by Selden and Terrones (1993). Their model extends Rogoff (1990) who analyzes electoral outcomes under asymmetric voter information. The Rogoff model shows that an incumbent politician has an incentive to bias fiscal policy toward the provision of more readily observable consumption goods over hard-to-measure public investments. This helps the incumbent to signal competency and increase the probability of reelection.

Selden and Terrones (1993) complements the model by analyzing the provision and regulation of environmental quality in an electoral cycle under asymmetric information. Their paper presents two models with distinct assumptions that highlight the mechanisms behind the incentives to overlegislate yet underenforce environmental standards when information asymmetries are present. In the paper, politicians are differentiated by competency, and the optimal environmental strategy is achieved when voters observe the incumbent's ability. Under asymmetric information, however, an incumbent distorts his environmental policy to signal competency. In their first model, past environmental standards are binding for the present and the politician only decides on the level of future legislation. Furthermore, voters are able to observe both current and future environmental policies. In a separating equilibrium, this specification results in overlegislation by the competent incumbent to signal competency. In the second model, the politician has discretion over current environmental standards but voters cannot observe current and future environmental policies (they only observe current period consumption). In separating equilibrium, a competent incumbent provides more from the consumption good with the cost of downgrading current environmental standards to signal competency. Therefore, their results on the mechanisms behind overlegislation and underenforcement are obtained under different assumptions and in a separating equilibrium. My model adds to this framework by formalizing a unified model that captures both overlegislation and underenforcement under one set of assumptions,

furthermore, analyzes both the separating and pooling equilibra.

The importance of political agenda in democratic elections is analyzed in Colomer and Llavador (2012). Their paper presents a model of electoral competition focusing on the construction of political agenda. In the model, parties choose an issue and a policy proposition, thereby trying to raise political salience. The success of a political campaign depends both on voters' pre-campaign salience on issue and on voters' agreement on the proposed policy alternative to the issue. It shows that the issues which are considered priority by the majority of the voters may not receive salience in politician's campaign when there is no single policy proposal that can attain widespread public agreement. In the context of this thesis, it implies that thinking about environmental policy proposals on a single dimension may not be appropriate as it does not capture the public agreement about the best policy instrument on the issue.

Finally, this thesis presents a two-dimensional signalling model which is infrequently applied in the literature. The two dimensions represent the two signals received by the voters: first period enforcement level and environmental policy proposal. Therefore, voters' strategy depends on the observed values of both signals. To my best knowledge, such multidimensional signalling specification has not been used to analyze problems on environmental legislation.

3 Model of environmental legislation

3.1 Setup

The model has two players, the median voter and a politician with two types: environmentalist or industrialist. The prior probability of observing either type is α and $1-\alpha$, respectively. An electoral cycle is divided into two periods: the beginning and the last-quarter of the cycle. At the beginning of each cycle, the incumbent politician decides on the level of abatement policy which is in effect until the third quarter of a cycle. Before the election, the politician decides on whether to abandon environmental standards, partially- or fully enforce the standards until the end of period. These actions are denoted by $a_1 = 0$, $a_1 = 0.5$ and $a_1 = 1$, respectively. At this stage, he also proposes next period abatement policy (a_2^*) that constitutes part of his political agenda. At the end of the political cycle, election takes places and voters decide on whether to reelect or not the incumbent politician. If the voters decide on not to reelect the politician, there is a draw from the population and with probability α an environmentalist, with probability $1-\alpha$ an industrialist politician gets elected. In both cases, the elected politician sets an environmental policy at the beginning of the next period that is in effect until the third quarter of the new electoral cycle. This action is denoted by a_2. My model considers only two periods: the period before and after the election. The timeline of the model is depicted below:

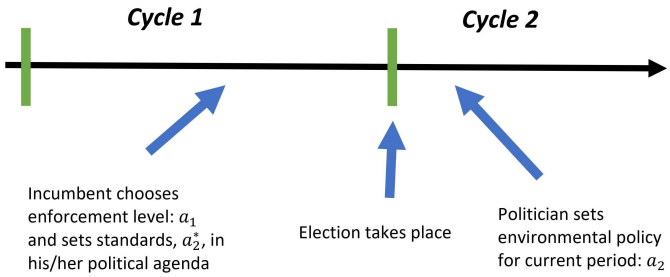

Figure 1: Timeline of the model

Median voters' two-period maximization problem can be expressed by the following functional form:

$$w^v = \sum_{t=1}^{2} [\beta x_t + (1-\beta)e_t] - (a_2 - a_2^*)^2$$

where x_t is a capital good, e_t is the environmental quality, a_2^* is the proposed- and a_2 is the enacted second-period environmental policy. Voters put relative weight β on the capital good and $1-\beta$ on environmental quality, which value is common knowledge. I assume that $\beta \in (0, 0.5)$ which means that the median voters value the environmental quality relatively higher than the perishable capital good. Therefore, at least half of the population has stronger preference for the former over the latter. While this might seem to be an unrealistic assumption, the Pew Research Center's report shows that 64% of the US population believes that environmental protection should be a top policy priority. Under this assumption, voters prefer full-enforcement in the first period, as will be shown later. In Section 6, I further argue that my results still hold when this assumption is relaxed. Additionally, voters' utility reflect that they derive disutility when there is gap between the proposed and the enacted second period policy.

Abatement decisions in both periods have direct effect on the capital good and the environmental quality. Specifically, with cost of abatement c and (for computational ease) quadratic abatement cost, the consumption good and the environmental quality can be expressed as: $x_t = 1 - ca_t^2$ and $e_t = \sum_{\tau=0}^{t} a_\tau$. Normalizing environmental quality before the first period to zero, in the two analyzed periods it can be expressed as: $e_1 = a_1$ and $e_2 = a_1 + a_2$. Lastly, c is assumed to be between 0 and 1 so that the provision of the consumption good does not fall below zero in the first period. Robustness to these specifications is discussed further in Section 6.

In the model, the politician can be one of two types: either environmentalist or industrialist. Environmentalist's payoff function depends the same way on the consumption good and environmental quality as the median voters' utility, while the industrialist only have preference for the former. Both type of politicians care about

the election, and they form expectations about the probability of being reelected. While the industrialist politician only derives utility in the second period when being reelected, an environmentalist politician also values socially optimal policy choices. The industrialist politician also discounts future utility with a discount factor, δ. Furthermore, politicians have to bear the cost of public pressure if they get reelected and deviate from the proposed environmental policy in their agenda. Therefore, the environmentalist and the industrialist politicians' payoff functions, respectively, can be expressed as:

$$w^{pe} = \beta(1 - ca_1^2) + (1 - \beta)e_1 + \beta(1 - ca_2^2) + (1 - \beta)e_2 - z_2[(a_2 - a_2^*)^2]$$
$$w^{pc} = 1 - ca_1^2 + \delta z_2[1 - ca_2^2 - (a_2 - a_2^*)^2]$$

where z_2 is an indicator function which takes the value 1 if being reelected and 0 otherwise; furthermore, δ is a discount factor which is a private information to the industrialist. For computational simplicity, I assume that δ follows a standard uniform distribution which is common knowledge. Importantly, if an incumbent does not get reelected, a newly elected politician is drawn from the population randomly and has the same preferences as above. Therefore, he must face the public tension when deviating from the incumbent's proposed policy.

In the first period the politician decides on the extent of enforcement of environmental standards. This is implemented by discretizing the choice set of politicians so that a_1 can take on values 0, 0.5 and 1 which represent discarding, partially-enforcing and fully-enforcing previously set environmental standards.

The final element of my model is the form of asymmetric information. The enforcement of environmental quality is imperfectly observed by the voters and assumed to follow the distribution:

$$a_1^* = max(min(\widetilde{a_1}, 1), 0)$$

$$\widetilde{a_1} = \begin{cases} a_1 & \text{with probability } \frac{1}{2} \\ a_1 + 0.5 & \text{with probability } \frac{1}{4} + \gamma \\ a_1 - 0.5 & \text{with probability } \frac{1}{4} - \gamma \end{cases}$$

where γ represents the extent of information skew and can take on values $\gamma \in (-\frac{1}{4}, \frac{1}{4})$. Therefore, $0 < \gamma$ implies positive information skew where observing higher enforcement is more prevalent, while $\gamma \leq 0$ depicts the opposite. Note that this specification also implies that voters cannot observe $a_1^* = -0.5$ and $a_1^* = 1.5$. The value of γ is a common knowledge, however, the realized value of a_1^* is determined by nature after the incumbent's action on a_1.

The following sections present the solution of the model under full- and asymmetric information. First, I consider the full information benchmark in which there is no uncertainty about the type of politician and the first period enforcement level. I use backward induction to solve for the enacted enforcement and the proposed environmental standard when facing different types of incumbents. Importantly, this game with an environmentalist incumbent can be considered socially optimal as first-best policy is proposed, and the level of enforcement in both periods meet voters' optimal enforcement decision.

In Section 4, I consider the asymmetric information case in which the politician's type is hidden from the median voters. The equilibrium concept I apply is Perfect-Bayesian. The Perfect-Bayesian equilibrium consists of a pair of strategies and beliefs (of voters) such that given belief, no player can improve her payoff at any stage in the game. Furthermore, beliefs are derived from strategies using Bayes rule wherever possible. That is, when voters observe signals on-path they use Bayesian updating to determine the probability of observing an environmentalist incumbent. Off-path signals, however, can lead to any beliefs.

In the first period, voters observe two signals from the politician's policy agenda, a_1^* and a_2^*, and decide on whether to reelect the incumbent by updating their beliefs on the probability of having an environmentalist politician. The median voters have

prior belief α on the probability of an environmentalist, and $1-\alpha$ on an industrialist politician. In this paper, I only consider equilibria in which a threshold strategy is applied: reelect when $\theta \leq a_2^*$ and $\Theta \leq a_1^*$. It is assumed that θ is a positive real number which an environmentalist politician (and for some values the industrialist politician) is willing to take. Furthermore, Θ is either 0.5 or 1 as reelecting incumbent with $a_1^* = 0$ is not optimal. Rational voters know that an environmentalist politician sets their preferred policy enforcement in the second period as their preferences match, therefore, voters would want to elect an environmentalist politician. Furthermore, an environmentalist incumbent wants to set enforcement to the highest possible level in the first period, $a_1 = 1$, and so in equilibrium voters do not observe $a_1^* = 0$ when having an environmentalist incumbent. (See Appendix 1 for reference) It also means that politician's type is revealed to be industrialist when observing $a_1^* = 0$.

I consider the separating and pooling equilibrium of the model based on the proposed environmental target. In the separating equilibrium, an industrialist incumbent is not willing to set $\theta_1 < a_2^*$ and reveals his type. In the pooling equilibrium, both type of politicians set $\theta_2 \leq a_2^*$ and voters update their beliefs based on the observed a_1^*. Therefore, θ_1 and θ_2 are the threshold values in voters' strategy in the separating and pooling equilibrium, respectively.

Solving the model under different specifications reveals whether in equilibrium underenforcement and overlegislation can be observed. Importantly, these two concepts are considered relative to the baseline welfare that would be achieved when voters can choose the level of enforcement in both periods and the environmental policy proposition before the election. This outcome is achieved, as argued in the following section, under full information when the incumbent is environmentalist.

3.2 Benchmark: solution under full information

In this section, I solve the model in a full information setting where the type of incumbent is known for the voters. Firstly, we must note that the election outcomes are determined by the preferences and strategy of the median voters.[1] Secondly, the model specification implies that voters would like to reelect an environmentalist politician as their preferences are closely aligned. The environmentalist politician and the median voters maximize the same utility function in the second period, therefore, voters' optimal strategy is to reelect an environmentalist incumbent who sets their preferred enforcement level in the second period. On the other hand, they want to vacate an industrialist politician because he would institute policies that favour the provision of the capital good against environmental quality. Voters are better off not reelecting an industrialist incumbent and having a draw in which the politician is environmentalist with probability α. Therefore, under full information an environmentalist incumbent will always, an industrialist incumbent will never be reelected.

Thirdly, under full information the environmentalist's expectation on the probability of reelection is one, thus, the utility function of voters matches the environmentalist's. It means that when voters do not face uncertainty about the type of politician and the incumbent is environmentalist, the optimization problem of the voters and the environmentalist politician coincide. In contrast, the industrialist incumbent knows that he won't get reelected and his optimization problem is reduced to choose a policy that maximizes his first period utility.

I define the socially optimal environmental policy as the one which is achieved when the incumbent is environmentalist. Then, voters' and politician's interests meet and the first-best level of enforcement and policy proposal are made. There-

[1]The idea that election outcomes are determined by the preferences of the median voter was outlined in Downs (1957). The paper formalized the median voter theorem which states that the electoral outcome in a democratic government with majority rule voting system is determined by the preferences of the median voter(s).

fore, the definition of the first-best policy target and enforcement level is equivalent to defining it as the policy voters would choose. Solving under these assumptions results in the first proposition of the paper.

Proposition 1:

1. Under full information with an environmentalist incumbent, green standards are fully enforced in the first period, the proposed environmental policy is first-best and is enforced in the second period.

2. The first-best proposed environmental policy can be expressed as $\tilde{a_2}^* = \frac{1-\beta+\beta c-\beta^2 c}{2(\beta c+\beta^2 c^2)}$, and is decreasing in both costs (c) and the preference parameter (β).

Proof: See Appendix A.

An environmentalist politician chooses full-enforcement in the first period ($a_1 = 1$) and sets the socially optimal policy proposal $a_2^* = \tilde{a_2}^*$. Upon being reelected, she enforces the proposed policy standards at the beginning of the period ($a_2 = \tilde{a_2}^*$). Therefore, this is the socially optimal level of enforcement in the second period.

The first-best proposed environmental standard decreases in β and c, as depicted in the Figure 2 below. That is, when voters have stronger preference for the capital good and when enforcing environmental standards is costly, it is socially optimal to propose less ambitious green policies.

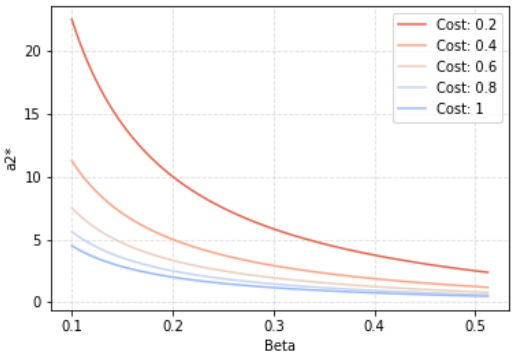

Figure 2: First-best $\tilde{a_2}^*$ under different costs

The outcome of the game under full information is as follows. Environmentalist politician gets reelected, environmental standards are fully enforced in the first period ($a_1 = 1$) and proposed first-best policy is enacted in the second period ($a_2^* = a_2 = \tilde{a_2}^*$). Industrialist incumbent does not get reelected, environmental standards are not enforced in the first period and second period policy is subject to the type of the newly elected politician. Notably, when the incumbent politician is environmentalist, the enacted policies match the median voters' utility maximizing decisions, therefore, can be considered as socially optimal.

4 Solution of the model

4.1 Least-cost separating equilibrium

This section presents the solution of the model when asymmetric information is present. Specifically, voters have prior expectation on the probability of the incumbent being environmentalist. Furthermore, the form and magnitude of the noise with which they observe first-period enforcement is common knowledge.

First, I consider the least-cost separating equilibrium of the model in which $\theta_1 < a_2^*$ is only set by an environmentalist politician. There are multiple separating equilibria which unveils politician's type on the observed a_2^*. The least-cost separating equilibrium results in the lowest utility cost to the voters. This is attained by the having the lowest possible θ in voters' strategy that separates the signals of the politicians. This specification results in the second proposition of this paper.

Proposition 2:

> There exists a separating equilibrium in which voters reelect when observing $a_1^* = 0.5$ or $a_1^* = 1$ and a_2^* is larger than the least-cost separating environmental target:
>
> $$\theta_1 = \sqrt{\frac{1+c}{c}}$$
>
> The least-cost separating environmental target decreases in c.

Proof: See Appendix B.

In a separating equilibrium, voters know that the type of the politician is revealed by the proposed environmental policy, a_2^*. When voters reelect incumbent for $\theta_1 < a_2^*$ and observe such a_2^* value, voters expectation on having an environmentalist incumbent is one. That is because they know that an industrialist politician would never propose a policy larger than θ_1. Therefore, the first period enforcement signal does not convey any further information on the type of politician and voters' optimal strategy is to reelect even if they observe underenforcement. In such case, voters

know that observing lower enforcement level is the result of the noise present in the model.

Next, we must analyze an environmentalist politician's optimal policy proposal. It is easy to see that when the socially optimal environmental policy is higher than the least-cost separating target ($\theta_1 < \tilde{a_2}^*$), an environmentalist politician proposes the first-best standard. That is because setting $\tilde{a_2}^*$ gets her reelected and also maximizes her two-period optimization problem. We can see from the graph below that this is the case when the cost and preference parameter, β, are small enough. Therefore, when the cost of enforcement is small and voters put relatively large weight on the environmental good, first-best policy is attained by an environmentalist politician. Then, the outcome of the model is the same as under full information.

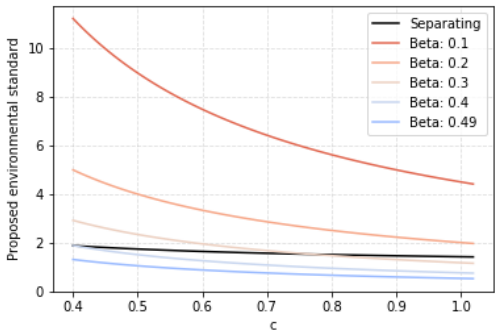

Figure 3: Separating θ_1 and first-best $\tilde{a_2}^*$ under different β

When θ_1 is larger than the first-best target, an environmentalist incumbent needs to deviate from her optimal strategy and set higher than optimal a_2^* to get reelected. That is, overlegislation is required to signal her type in equilibrium. Appendix A also shows that the environmentalist's optimal second period policy strictly increases in the first period proposed policy, therefore, overlegislation results in overenforcement in the second period relative to the socially optimal level. In the second period, the environmentalist's chosen enforcement level lies between the so-

cially optimal enforcement and the environmental target she proposed. If she set the first-best second period enforcement level, she would face public tension by not keeping to her promises. On the other hand, if she enforced the proposed environmental standards she would consume too little from the capital good. Therefore, an environmentalist politician balances between the opposing interests by moderately overenforcing standards.

When the least-cost separating policy is larger than the first-best environmental proposal, however, an environmentalist may be better off to deviate from the equilibrium strategy and set lower standards even though if it results in her not being reelected. Environmentalist politician does not only value reelection but derives utility from policies that are close to the socially optimal outcome. Appendix B presents the calculations on environmentalist's optimal a_2^* when deviating from the separating equilibrium strategy. Based on these calculations, Figure 4 shows the utility difference between setting the least cost separating θ_1 and her optimal a_2^* under deviation. When the environmentalist politician is better off deviating from the separating environmental policy, θ_1, the model does not have a separating equilibrium. In contrast, when deviation brings lower utility than signalling her type, the environmentalist proposes policies just above the separating target $\theta_1 < a_2^*$. Then, this constitutes and equilibrium in which an environmentalist politician overlegislates in the first-, and overenforces in the second period.

However, Figure 4 also shows that the existence of this equilibrium is limited to a small set of parameter values. From Figure 3, we could learn that the least-cost separating θ_1 is larger than the socially optimal policy when the abatement cost and the preference parameter are relatively large. For most of these values, however, deviating from the equilibrium brings higher utility to the environmentalist than setting the least cost separating θ_1.

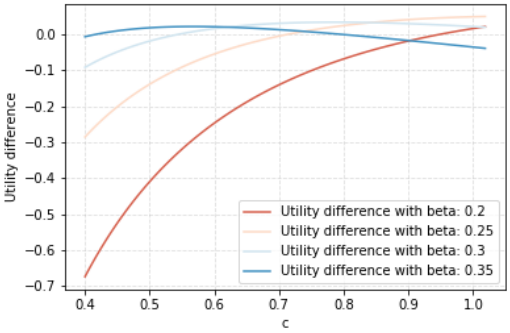

Figure 4: Utility difference between the separating equilibrium and under deviation

In summary, the outcome of the least-cost separating equilibrium is as follows. Voters form beliefs that the probability of having an environmentalist incumbent is one when observing $0.5 \leq a_1^*$ and $\theta_1 < a_2^*$, and zero otherwise. Then, an environmentalist politician fully enforces past standards in the first period. Furthermore, she sets a_2^* just above the least-cost separating target when θ_1 is larger than $\tilde{a_2}^*$ and brings her higher utility than under deviation. In the second period, she overenforces standards relative to the socially optimal. When $\theta_1 < \tilde{a_2}^*$, an environmentalist politician proposes the socially optimal $a_2^* = \tilde{a_2}^*$ and enforces these standards in the second period. In both cases, she gets reelected. Industrialist politician, in contrast, sets $a_1 = 0$ and $a_2^* \leq \theta_1$; he does not get reelected.

4.2 Pooling equilibria

When both politicians are willing to set $\theta_2 \leq a_2^*$ and the observed a_1^* does not reveal the politician's type, we must consider the pooling equilibrium of the game. That is, I analyze the case in which politicians set the same a_2^* in equilibrium but may set different a_1 depending on some parameter values. This constitutes a form of pooling equilibrium as voters observe a_1 with noise and cannot tell apart politicians based on the signal a_1^*. Note, however, that when the observed enforcement level is zero, politician's type is revealed to be industrialist. That is because an environmentalist

politician always chooses full-enforcement in the first period, and so in equilibrium voters do not observe $a_1^* = 0$ when having an environmentalist incumbent (See Appendix 1 for reference).

Therefore, a_2^* does not reveal any information on the politician's type but voters use Bayesian updating to determine the probability of having an environmentalist incumbent after observing a particular a_1^* signal. Then, the median voters reelect politician when the posterior belief of having an environmentalist politician is at least as large as the prior.

In this paper, I only consider the pooling equilibria in which the socially optimal environmental target is between voters' two threshold values: $\theta_2 \leq \tilde{a_2}^* \leq \theta_1$. The pooling equilibria for $\tilde{a_2}^* < \theta_2$ could also be analysed but it brings similar insights that we saw at the separating equilibrium: when equilibirium requires environmentalist to overlegislate, only a limited range of parameter values result in non-deviation. Additionally, the socially optimal environmental target cannot exceed voters' threshold value in the separating equilibrium. If it was not the case and the first-best policy was higher, $\theta_2 \leq \theta_1 < \tilde{a_2}^*$, we would arrive back to the separating equilibrium where an environmentalist politician distinguishes herself by setting $a_2^* = \tilde{a_2}^*$.

Then, in the pooling equilibrium voters form the following strategy and belief system. When observing $\theta_2 \leq a_2^* \leq \theta_1$, the belief on having an environmentalist politician is unchanged, therefore, reelection decision is based on the updated probability following the signal a_1^*. As argued before, the threshold on the observed a_1^* in voters' strategy can take on two values: either $\Theta = 0.5$ or $\Theta = 1$. Both values can constitute an equilibrium of the game under certain parameter restrictions. When observing $a_2^* < \theta_2$, the voters' belief on having an environmentalist incumbent is zero and so they never reelect politician. When observing $\theta_1 < a_2^*$, voters updated belief on the probability of an environmentalist incumbent is one and the incumbent gets reelected.

The actions and outcomes of the pooling equilibrium depend on the sign and magnitude of the information skew. When the information skew is negative, there is a pooling equilibrium in which voters reelect when observing either underenforcement or full-enforcement. When the information skew is positive, there is a pooling equilibrium in which voters reelect when observing full-enforcement. The main results on the pooling equilibria are summarized in Proposition 3 and 4.

Proposition 3:

1. With non-positive information skew $\gamma \leq 0$, voters reelect when observing either underenforcement or full-enforcement. Then, in equilibrium both type of politicians set the first-best policy target, $\tilde{a_2}^*$, which also equals voters' threshold value $\theta_2 = \tilde{a_2}^*$. In the second period, an environmentalist politician enforces first-best policy, while an industrialist politician underenforces standards.

2. Industrialist also underenforces in the first period when:

$$\min(1, \frac{0.25c}{(\frac{1}{2})U^*(\beta, c, \tilde{a_2})}) \leq \delta \leq \min(1, \frac{0.75c}{(\frac{1}{4} - \gamma)U^*(\beta, c, \tilde{a_2})})$$

   where $U^*(\beta, c, \tilde{a_2}^*) = 1 - (c + c^2)(\frac{\tilde{a_2}^*}{1+c})^2$ is the industrialist's second period utility upon being reelected and $\tilde{a_2}^*$ is the first-best environmental target on which politicians pool.

   The probability of underenforcement decreases in the magnitude of information skew.

3. When the industrialist is also willing to fully enforce in the first period for large δ, the magnitude of the negative information skew must be larger than 0.14 ($\gamma \leq -0.14$) to constitute an equilibrium.

Proof: See Appendix C.

The first result of Proposition 3 is rather intuitive. When there is a negative information skew, voters expect that with relatively high probability they observe underenforcement when an environmentalist incumbent instituted full-enforcement. Therefore, they are better off reelecting the politician also when observing underenforcement. Note, however, that when the negative information skew is small, there exists pooling equilibria in which voters reelect only when observing full-enforcement. Specific parameter restrictions are required for this to be an equilibrium. (See Appendix C for further reference)

Secondly, an environmentalist incumbent expects that she will get reelected in equilibrium when voters stick to their strategy. Based on our assumption that $\theta_2 \leq \tilde{a_2}^* \leq \theta_1$, environmentalist's optimal decision is to set the first-best level target, $a_2^* = \tilde{a_2}^*$, when her expectation of getting reelected is one. Furthermore, in a pooling equilibrium an industrialist incumbent wants to set the lowest possible a_2^* without revealing his type, therefore, he sets $a_2^* = \theta_2$. As politicians must pool on the same a_2^* to constitute an equilibrium, these imply that $a_2^* = \theta_2 = \tilde{a_2}^*$.

The second result of Proposition 3 determines the range of the discount factor for which the industrialist politician decides to underenforce in the first period. When the discount factor falls below the lower threshold, his optimal strategy is to discard past legislation (zero enforcement), while if it exceeds the upper threshold he decides on full-enforcement. The threshold values are also insightful: when an industrialist values future utility highly and wants to get reelected, he is willing to sacrifice current consumption and increase enforcement level. Interestingly, the probability of underenforcement decreases in the magnitude of information skew.

Furthermore, this pooling equilibrium reveals another important result. When an industrialist politician is also willing to fully enforce in the first period for large discount factors, equilibrium exists only if the magnitude of the skew is large enough. Therefore, unskewed information transmission on the level of policy enforcement can limit the existence of such pooling equilibrium.

Proposition 4:

1. With positive information skew $0 < \gamma$, voters reelect when observing full-enforcement. Then, in equilibrium both type of politicians propose higher than optimal policy, θ', which also equals voters' threshold value $\theta_2 = \theta'$. In the second period, an environmentalist politician overenforces, while an industrialist politician underenforces standards.

2. Industrialist also underenforces in the first period when:

$$\min(1, \frac{0.25c}{(\frac{1}{4}+\gamma)U(\beta,c,\theta')^*}) \leq \delta \leq \min(1, \frac{0.75c}{(\frac{1}{2})U(\beta,c,\theta')^*})$$

   where $U^*(\beta,c,\theta') = 1-(c+c^2)(\frac{\theta'}{1+c})^2$ is the industrialist's second period utility upon being reelected and θ' is the environmentalist's optimal policy target on which politicians pool.

   The probability of underenforcement increases in the magnitude of information skew.

Proof: See Appendix C.

First, I analyze the level of environmental policy on which politicians pool. Based on our assumption that $\theta_2 \leq \tilde{a_2}^* \leq \theta_1$, environmentalist's optimal decision is to set the first-best level policy when the probability of her being reelected is one. This is the case if voters reelect when observing either under- or full-enforcement. On the other hand, if voters reelect only when observing full-enforcement, the probability of reelection is $\frac{3}{4}+\gamma$ due to the noise present in the model. In that case, the environmentalist's optimal a_2^* is larger than the first-best. An environmentalist incumbent expects that with some probability an industrialist will be in power next period, who will lower the enforcement of proposed environmental standards. Therefore, the environmentalist incumbent's optimal strategy is to overlegislate environmental standards and set $a_2^* = \theta'$. As argued before, in a pooling equilibrium politicians must pool on the same a_2^* which implies that $a_2^* = \theta_2 = \theta'$.

Figure 5 depicts the environmentalist's optimal policy proposition as a function of γ and β for different α. Abatement cost is set to 0.5, but simulations show that the results hold for other cost parameters as well. If $\gamma = 0.25$, an environmentalist politician sets the first-best level environmental policy as it assures the reelection probability to be one. As the magnitude of the information skew decreases, the optimal policy gets higher. That is because with lower γ, the probability that an environmentalist politician gets reelected is lower. Similarly, her legislatory target is higher when the prior probability of reelecting an industrialist politician is higher. In short, an environmentalist politician overlegislates for all parameter values, as long as $\gamma < 0.25$.

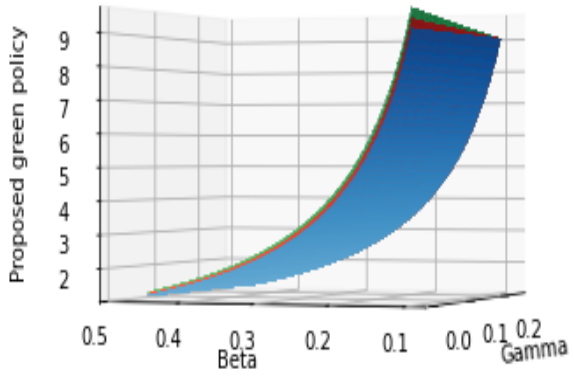

Figure 5: Proposed environmental policy with $\alpha = 0$ (green), $\alpha = 0.5$ (red) and $\alpha = 1$ (blue); abatement cost is c=0.5

Note, however, that this is a pooling equilibrium only when an industrialist politician is also willing to set the optimal policy of the environmentalist. While our assumptions guaranteed that both politicians are willing to pool on the socially optimal environmental target, this is not necessarily the case when pooling is required on a higher policy level. Therefore, the overlegislatory motives of the environmentalist should not be too large to constitute a pooling equilibrium.

Second, an industrialist politician uses a similar threshold strategy on the first period enforcement as in the pooling equilibrium with negative information skew.

When the discount factor falls below the lower threshold, his optimal strategy is to discard past legislation (zero enforcement), while if it exceeds the upper threshold he chooses full-enforcement. Comparing the threshold values in the two pooling equilibria, we can observe that the lower threshold in the second equilibrium (with positive information skew) is at least as large as in the first equilibrium (with negative information skew). Therefore, an industrialist chooses zero enforcement with higher probability when voters are strict and reelect only when observing full-enforcement. Moreover, in contrast to the first pooling equilibrium, the probability of underenforcement increases in the magnitude of information skew when positive information skew is present. That is because when voters observe higher enforcement levels more frequently, an industrialist politician is willing to sacrifice current consumption to increase enforcement level and thereby his probability of reelection.

In summary, the outcome of the equilibrium is as follows. With negative information skew, there exists a pooling equilibrium in which voters reelect when observing either under- or full-enforcement and politicians pool on θ_2 such that $\tilde{a_2}^* = \theta_2 \leq \theta_1$. An environmentalist politician always gets reelected and enforces the socially optimal standards in the second period.

With positive information skew, there exists a pooling equilibrium in which voters reelect only when observing full-enforcement and politicians pool on θ' such that $\tilde{a_2}^* < \theta' \leq \theta_1$. Therefore, politicians pool on an overly ambitious target level. An environmentalist politician is reelected with probability $\frac{3}{4} + \gamma$, and sets higher than optimal enforcement in the second period upon getting reelected.

With either positive or negative information skew, the industrialist politician decides on first period enforcement based on his discount factor. This, in turn, determines his reelection probability. In case he gets reelected, he underenforces environmental standards in the second period.

5 Solution of the model when political agenda is not observed

The previous sections assumed that politicians clearly communicate their policy targets to voters. Therefore, proposed political agenda could serve as the signal which either reveals politician's type in a separating equilibrium, or defines the level on which politicians pool their policy propositions. In this section, I compare the equilibrium outcomes when voters do not observe the proposed policy a_2^*. In terms of the model, it means that voters only observe a single signal: a_1^*. Solving this modified model leads to the final proposition of this thesis.

Proposition 5:

1. With non-positive information skew, voters reelect when observing either underenforcement or full-enforcement. Then, in equilibrium the industrialist politician underenforces standards when his subjective discount factor lies within the the range:
$$0.5c < \delta \leq \min(1, \frac{0.75c}{\frac{1}{4} - \gamma})$$

2. With positive information skew, equilibrium exists only when voters reelect observing full-enforcement. In equilibrium, the industrialist politician chooses to underenforce when:
$$\frac{0.25c}{\frac{1}{4} + \gamma} < \delta \leq \min(1, 1.5c)$$

3. With negative information skew when the industrialist is also willing to fully enforce for large δ, the magnitude of the information skew must be large enough to constitute an equilibrium.

4. There are no parameter values β, γ and c that would make an industrialist choose $a_1 = 0$ for all δ. Therefore, there is no separating equilibrium in which voters reelect when $a_1^* = 1$ and industrialist always chooses $a_1 = 0$.

Proof: See Appendix D.

As the policy proposition of the incumbent is not public information and does not influence the outcome of the election, both types set their preferred policy targets. In case of an industrialist incumbent, his proposed policy is zero as setting positive target would only bring him disutility in the future. If he gets reelected, this also results in zero enforcement in the second period. When the incumbent is environmentalist, her optimal policy proposal depends on voters' equilibrium strategy. As seen in the pooling equilibrium case, her optimal target and second period enforcement is the socially optimal, $a_2 = a_2^* = \tilde{a_2}^*$, when she expects that her reelection probability is one. In contrast, if voters reelect only when observing full-enforcement, an environmentalist incumbent proposes a higher than optimal environmental policy, $a_2^* = \theta'$. This also results in overenforcement in the second period, in case she gets reelected.

Regarding first period enforcement level, an environmentalist politician fully enforces past standards as in the other equilibrium specifications. An industrialist, compared to the pooling equilibrium case, chooses underenforcement and full-enforcement for a larger set of discount factor values. The intuition behind is that as the industrialist politician does not have to pledge future environmental policies, his expectation on future utility when getting reelected is higher. This alters his incentives to forgo current consumption and increase his reelection probability by setting higher enforcement level. Therefore, when voters cannot observe the politician's policy agenda, the probability of reelecting an industrialist incumbent is higher. This implies that voters are better off when politicians clearly communicate their political agenda as it allows them to elect an environmentalist politician with higher probability.

Furthermore, while this specification does not allow pooling or separating on the proposed environmental policy, we can still specify a separating equilibrium in which voters would only reelect an environmentalist politician. That could only be

the case if voters reelected incumbent when the enforcement signal is $a_1^* = 1$ and if an industrialist politician chose $a_1 = 0$ for all values of his discount factor. Then, voters would never observe a full-enforcement signal by an industrialist politician and he would never get reelected. Proposition 5 shows, however, that there are no parameter values that would make the industrialist choose $a_1 = 0$ for any values of the discount factor. Therefore, in equilibrium an industrialist politician always gets reelected with some non-zero probability. This probability depends both on the parameters and the realized values of the discount factor and the noise term.

In summary, the outcome of the equilibrium is as follows. With negative information skew, voters reelect incumbent when observing either underenforcement or full-enforcement. Then, an environmentalist politician fully enforces standards in the first period, sets the socially optimal target level and enforces it in the second period upon being reelected.

With positive information skew, voters reelect incumbent when observing full-enforcement. Then, an environmentalist politician fully enforces and overlegislates standards in the first period, moreover, sets higher than optimal enforcement in the second period in case she gets reelected.

With either positive or negative information skew, an industrialist incumbent decides on first period enforcement based on his discount factor, which in turn determines his reelection probability. He sets zero environmental target and does not enforce policies in the second period upon being reelected.

6 Robustness checks

Alternative formulation of voters' utility function

In the model setup, I assumed that the median voters' two-period maximization problem takes the functional form:

$$w^v = \sum_{t=1}^{2} [\beta x_t + (1-\beta)e_t] - (a_2 - a_2^*)^2$$

This formulation guarantees that the preferences of the voters and an environmentalist incumbent under full information match.

However, it can be argued that the median voters do not care about whether a politician deviates from the proposed policy in the second period. They may only care about the provision of the capital and environmental good and do not derive disutility from the public tension that occurs when a politician deviates from the policy target. (Note, however, that politicians' utility function is unchanged, they derive disutility from public tension) In that case, voters' utility can be expressed as:

$$w^v = \sum_{t=1}^{2} [\beta x_t + (1-\beta)e_t]$$

Then, the policy proposal would not enter voters' utility function directly. In the first period, voters would still want to set the highest enforcement level, as shown in Appendix A. In the second period, however, their preferred enforcement level is:

$$a_2 = \frac{1-\beta}{2\beta c}$$

This formulation of the utility function would not affect my results significantly. Voters would still want to reelect an environmentalist politician in most cases as their preferences are more closely aligned to an environmentalist's preferences.

In some equilibria, however, if the incumbent's proposed policy is well above voters' preferred environmental target, voters may want to reelect an industrialist. As an environmentalist politician does care about deviating from the proposed policy, she prefers second period overenforcement when standards are overlegislated

before the election. (See Appendix A for reference) An industrialist, in contrast, would choose lower enforcement level in the second period that may be closer to voters' optimal policy. Therefore, when voters do not derive disutility from deviating the proposed policy, they may be better off with an industrialist politician who lowers enforcement sufficiently close to their preferred level.

Finally, the optimal policy proposal of an environmentalist incumbent and the voters would also differ in the model benchmark where no information asymmetry is present. Therefore, the definition of the socially optimal environmental legislation and enforcement need to be reconsidered.

Prior environmental quality and the effect of enforcement on past legislation

The model also made the assumption that prior to the first period the environmental quality is 0, and first period enforcement increases this level by either 0, 0.5 or 1. However, the model is robust to more realistic specifications as well.

Assume that during the previous electoral cycle, the environmental quality was e_0. This environmental quality results from the accumulation of the abatement initiatives by past legislators. Assume further that prior to the first period of the model, the incumbent politician legislated environmental standards a_0. In the first period, these standards are either abandoned $a_1 = 0$, underenforced $a_1 = 0.5$ or fully enforced $a_1 = 1$. Then, environmental quality after the first period can be expressed as:

$$e_1 = e_0 + a_0 * a_1$$

Furthermore, environmental quality after the election can be expressed as:

$$e_2 = e_0 + a_0 * a_1 + a_2$$

Setting $e_0 = 0$ and $a_0 = 1$, we get back to the expression of the environmental quality assumed in the model. In other cases, different e_0 values do not affect my

results as it enters the utility functions as a constant. When $a_0 \neq 1$ and is close to zero, the preferences of voters and the environmentalist politician is shifted towards the provision of the capital good in the first period. That is because abatement initiatives have the same cost on the provision of the capital good, however, the benefits of higher enforcement is diminished. On the other hand, having $a_0 \neq 1$ does not affect politicians' policy proposals and second period enforcement decisions. Therefore, my results are robust to this specification as long as a_0 is sufficiently greater than zero.

Limitations on the value of the preference parameter and the abatement cost

The model also relies on the assumption that the median voters value the provision of the environmental good higher than the perishable capital good; and that abatement cost cannot exceed one. While these are strong assumptions, it is certainly plausible to assume that the median voters prefer past legislated policies to be enforced in the present. When this holds, the above mentioned assumptions can be relaxed and the results of the full model are unaffected. Note, however, that this assumption may affect the fourth result of Proposition 5 in the model where political agenda is not observed. That is, the relaxed assumption can make an industrialist incumbent choose $a_1 = 0$ for all δ.

From Appendix A, we can derive the condition under which the median voters prefer past legislated policies to be enforced in the first period:

$$1 - \beta \geq 0.75c\beta \Leftrightarrow \frac{1-\beta}{\beta} \geq 0.75c$$

It is easy to see that under the model assumptions, this condition always holds. However, the range of β and c values that satisfy this equation is larger than under the model restrictions. This relaxed condition imposes an upper bound on the abatement cost that depend on the value of the preference parameter, β.

7 Evidence and policy implications

This thesis showed that overlegislation and underenforcement can be observed both in the pooling and separating equilibria of the model. Arguably, these biases exist in real world policy making as well.

Detecting overlegislation empirically, however, is a very difficult exercise. To define overlegislatory policies, one needs to find the socially optimal policy proposal first that would maximize society's welfare. Noneteless, this cannot be characterized for various reasons. Firstly, the importance of environmental problems is difficult to evaluate and is not well understood by most citizens. Furthermore, the effectiveness and benefits of environmental policies cannot be easily assessed as many of these are not reflected in marketed goods. Moreover, policy instruments may not have readily observable effects on the environment but increase environmental quality over the longer haul. Together, these imply that it is not possible to objectively evaluate whether policy propositions are optimal or overly ambitious.

In contrast, it is easier to identify cases when parties and politicians set environmental policies that are above their preferred level. The recent UK governmental elections, for example, provide some evidence on parties' overly ambitious environmental propositions. This is reflected by their sudden shift to support environmental initiatives without showing real commitment to their implementation. Specifically, the ruling conservative party's agenda in the most recent political campaign consisted of far greater environmental targets and policies than ever before. Proposed policies included 1 billion pounds for instituting electric vehicle charging stations and 800 million pounds for carbon capture and storage. The ruling party has also targeted to reach net zero carbon emissions by 2050. Opposing parties were also supportive of environmental protection measures. Notably, the Labor Party pledged 250 billion pounds to support the Green Transformation Fund. Furthermore, it targeted net zero emissions by 2030, while Liberal Democrats promised it by 2045 the latest. (Financial Times, 2019) Their manifestos show that parties have bias

towards ambitious, long-term targets instead of short-term policies and immediate actions.

The UK election provides a further example on politicians' motives to underenforce past standards. Specifically, it had been reported that Boris Johnson, prime minister of the UK, downgraded policies targeting environmental protection in his Brexit deal before the governmental elections. Thereby, he broke his pledge to stick with the environmental policies proposed by Theresa May and maintain the continent-wide standards legislated by the European Union. Therefore, the UK could renege on environmental standards to pursue trade deals with the US, in case no trade deal is agreed between the UK and the EU. (Euractiv, 2019; Financial Times, 2019)

This paper also highlights some mechanisms that lead to overlegislation and underenforcement. In particular, information asymmetry and differing political and public interests contribute to suboptimal equilibrium outcomes. However, there are various policy tools that can help governments dissolve information asymmetries and realign interests.

As suggested by the paper, social welfare is higher when the electorate is aware of the preferences of the incumbent politician and the enacted policy enforcement. Therefore, the polluting and the regulatory activities of governments should be more closely monitored by public organizations. Furthermore, democratic nations should strengthen institutions that inform voters about the enforcement of green standards. The media can help increase public awareness and inform citizens on the government's environmental policies. Free and unbiased media has an ultimate importance to convey the truthful information to the citizenry. This will allow people to better understand government's activities on environmental protection and incentivize politicians to enact welfare improving policies.

8 Concluding remarks

This thesis examined motives towards overlegislation and underenforcement of environmental standards in a democratic voting model. I identified that the socially optimal enforcement level and environmental proposition is achieved when there is no information asymmetry in the game.

The paper finds that when voters are uninformed about the type of politician and the actual enforcement level, overlegislation can be prevalent in both the separating and the pooling equilibria. Furthermore, I show that the overlegislatory motives of an environmentalist and industrialist politician differ. An environmentalist politician, who does not only care about getting reelected but also about having socially optimal outcomes, overlegislates standards in a pooling equilibrium to increase social welfare. In a separating equilibrium, she overlegislates to signal her type. In contrast, an industrialist politician who has preferences for the perishable capital good sets overly ambitious environmental policies to hide his type from the electorate.

Enforcement decisions of the politicians also differ. While an environmentalist politician never chooses enforcement level lower than the socially optimal, she may overenforce standards following an election. On the other hand, an industrialist politician decides on the enforcement level based on his relative valuation of the future. Upon getting reelected, he underenforces standards in all equilibrium specifications.

Finally, the overall effects of overlegislation and underenforcement on environmental quality is subject to further research. As shown in the paper, overlegislation by an environmentalist incumbent manifests itself into future overenforcement due to the public tension received when deviating from the policy proposition. Therefore, when an incumbent politician underenforces and overlegislates standards before a democratic election, he may overenforce standards upon getting reelected. Present underenforcement and future overenforcement have opposing impacts on

environmental quality and may balance out in the long term. Analyzing their net effect is an interesting empirical question for further research.

9 Appendix

9.1 Appendix A - Proof of Proposition 1.

To solve the model under full information, I use backward induction. In the second period an environmentalist politician maximises utility:

$$\max_{a_2} \beta(1 - ca_2^2) + (1 - \beta)(a_1 + a_2) - (a_2 - a_2^*)^2$$

which yields:

$$a_2 = \frac{2a_2^* + 1 - \beta}{2\beta c + 2}$$

Under full information, an environmentalist politician always gets reelected as her second period maximization problem matches that of the voters'. Then, in the first period an environmentalist does not face any uncertainty about reelection and maximizes:

$$\max_{a_1, a_2^*} \beta(1 - ca_1^2) + (1 - \beta)a_1 + \beta(1 - ca_2^2) + (1 - \beta)(a_1 + a_2) - (a_2 - a_2^*)^2$$

The choices of a_1 and a_2^* do not depend on each other so they can be considered separately. As a_1 can only take on values 0, 0.5 and 1, I consider the utility increase from each choices. Increasing a_1 from 0 to 0.5 increases utility if:

$$-0.25c\beta + 2 * 0.5(1 - \beta) \geq 0 \Leftrightarrow 1 - \beta \geq 0.25c\beta$$

Increasing a_1 from 0.5 to 1 increases utility if:

$$-0.75c\beta + 2 * 0.5(1 - \beta) \geq 0 \Leftrightarrow 1 - \beta \geq 0.75c\beta$$

Given the assumptions $\beta \in (0, 0.5)$ and $c \in (0, 1)$, both conditions hold so environmentalist sets full-enforcement in first period. Note that an environmentalist politician chooses full-enforcement in the first period even when she faces risk about the probability of reelection. Setting the highest possible first period enforcement level maximizes her reelection probability when voters have a threshold strategy and reelect for $\Theta \leq a_1^*$. Furthermore, setting the highest a_1 increases both current and

future utility. Therefore, an environmentalist politician chooses full-enforcement in the first period under both full- and asymmetric information.

Then, substituting in the optimal a_1 and a_2 into the optimization problem and maximizing with respect to a_2^* yields:

$$a_2^* = \frac{1 - \beta + \beta c - \beta^2 c}{2(\beta c + \beta^2 c^2)}$$

Substituting a_2^* into the optimal a_2 gives back a_2^*, indicating that the proposed environmental policy is enacted.

Industrialist incumbent, in contrast, does not get reelected as his preferences are biased towards the capital good. Therefore, industrialist's expectation on the probability of reelection is zero and he maximizes first period utility:

$$\max_{a_1, a_2^*} 1 - ca_1^2$$

which yields $a_1 = 0$ and $a_2^* \in \mathbb{R}^+$.

9.2 Appendix B - Proof of Proposition 2.

First, I solve for the industrialist optimal second period policy level. In the second period, industrialists solves:

$$\max_{a_2} 1 - ca_2^2 - (a_2 - a_2^*)^2$$

which yields:

$$a_2 = \frac{a_2^*}{1 + c}$$

Second, in a separating equilibrium an industrialist politician reveals his type by setting $a_2^* \leq \theta_1$. Therefore, the first period enforcement signal does not convey any further information on the type of politician and voters' optimal strategy is to reelect incumbent even if they observe underenforcement. Furthermore, it is easy to see that an industrialist politician wants to set the lowest possible a_2^* in equilibrium as higher a_2^* brings him greater disutility in the second period. Therefore, an

industrialist deviates the separating equilibrium when he sets a_2^* just above θ_1 to hide his type on the proposed policy.

Then, we must specify the industrialist's expected utility for each a_1 and a_2^* he may choose. Industrialist's utility when setting $a_1 = 0$ and $a_2^* \leq \theta_1$ is $U(a_1 = 0, a_2^* \leq \theta_1) = 1$ as he will not get reelected (when revealing type, his optimal strategy is to set $a_1 = 0$). If he sets a_2^* just above θ_1, the industrialist hides his type. Then, his probability of getting reelected is $E[z|a_1 = 0, \theta_1 < a_2^*] = \frac{1}{4} + \gamma$ when setting $a_1 = 0$, $E[z|a_1 = 0.5, \theta_1 < a_2^*] = \frac{3}{4} + \gamma$ when setting $a_1 = 0.5$ and $E[z|a_1 = 1, \theta_1 < a_2^*] = 1$ when setting $a_1 = 1$. Then, his utility when setting $a_1 = 0$ is $U(a_1 = 0, \theta_1 < a_2^*) = 1 + \delta(\frac{1}{4} + \gamma)[1 - (c + c^2)(\frac{\theta_1}{1+c})^2]$, when setting $a_1 = 0.5$ is $U(a_1 = 0.5, \theta_1 < a_2^*) = 1 - 0.25c + \delta(\frac{3}{4} + \gamma)[1 - (c + c^2)(\frac{\theta_1}{1+c})^2]$ and when setting $a_1 = 1$ is $U(a_1 = 1, \theta_1 < a_2^*) = 1 - c + \delta[1 - (c + c^2)(\frac{\theta_1}{1+c})^2]$. Then industrialist chooses to reveal his type in the separating equilibrium if (considering only positive θ_1):

$$\theta_1 > \sqrt{\tfrac{1+c}{c}} \text{ and } \theta_1 > \sqrt{max(0, \tfrac{1+c}{c} - \tfrac{0.25(1+c)}{\delta(\frac{3}{4}+\gamma)})} \text{ and } \theta_1 > \sqrt{max(0, \tfrac{1+c}{c} - \tfrac{1+c}{\delta})}$$

which holds for all δ when:

$$\theta_1 > \sqrt{\tfrac{1+c}{c}} \text{ and } \theta_1 > \sqrt{\tfrac{1+c}{c} - \tfrac{0.25(1+c)}{\frac{3}{4}+\gamma}} \text{ and } \theta_1 > \sqrt{\tfrac{1+c}{c} - (1+c)}$$

It is easy to see that the first constraint is the most strict so in a least cost separating equilibrium voters reelect when a_2^* is greater than:

$$\theta_1 = \sqrt{\frac{1+c}{c}}$$

Then, industrialist reveals his type by setting $a_2^* \leq \theta_1$. Furthermore, voters know that the incumbent is environmentalist when observing $\theta_1 < a_2^*$ and $a_1 = 0.5$ or 1.

Next, I analyze an environmentalist politician's optimal policy target. When $\theta_1 < \tilde{a_2}^*$, her optimal strategy is to set $a_2^* = \tilde{a_2}^*$. In the opposite case, least-cost separating equilibrium requires environmentalist to overlegislate. Then, her second period

utility can be expressed as:

$$U_2(\beta, c) = \beta(1 - ca_2^2) + (1 - \beta)(1 + a_2) - (a_2 - a_2^*)^2$$

where $a_2 = \frac{2a_2^* + 1 - \beta}{2\beta c + 2}$ and $a_2^* = \sqrt{\frac{1+c}{c}}$.

Nonetheless, she may deviate from proposed overlegislative equilibrium if deviation brings her higher utility. When deviating, she maximizes expected second period utility:

$$\max_{a_2^*} E[\beta(1 - ca_2^2) + (1 - \beta)(1 + a_2) - z_2(a_2 - a_2^*)^2]$$

which can be expressed as (noting that the probability of reelection under deviation is zero and the newly elected politician bears the disutility from public tension):

$$\max_{a_2^*} \alpha[\beta(1 - c(\frac{2a_2^* + 1 - \beta}{2\beta c + 2})^2) + (1 - \beta)(1 + \frac{2a_2^* + 1 - \beta}{2\beta c + 2})] +$$
$$(1 - \alpha)[\beta(1 - (\frac{a_2^*}{1 + c})^2) + (1 - \beta)(1 + \frac{a_2^*}{1 + c})]$$

solving for a_2^* yields:

$$a_2^* = \frac{\frac{\alpha(1-\beta)}{\beta c+1} + \frac{(1-\alpha)(1-\beta)}{1+c} - \frac{\alpha\beta c(1-\beta)}{(\beta c+1)^2}}{\frac{2\alpha\beta c}{(\beta c+1)^2} + \frac{2(1-\alpha)\beta c}{(1+c)^2}}$$

Substituting in the optimal a_2^* to her optimization problem gives expected future utility from deviating the least-cost separating equilibrium. Figure 4 shows that environmentalist chooses to stick with the least-cost separating strategy only for a limited set of parameter values.

9.3 Appendix C - Proof of Propositions 3. and 4.

For the industrialist to be willing to set a particular a_2^*, his future utility in case of being elected must be at least zero. Therefore it must be the case that:

$$1 - ca_2^2 - (a_2 - a_2^*)^2 = 1 - (c + c^2)(\frac{a_2^*}{1 + c})^2 \geq 0$$

which gives the condition:

$$a_2^* \leq \sqrt{\frac{1 + c}{c}} = \theta_1$$

To simplify notations, let's denote his second period utility as:

$$U(\beta, c, a_2^*)^* = 1 - (c + c^2)(\frac{a_2^*}{1+c})^2$$

Now, assume voters' strategy on a_2^* is to reelect incumbent when $\theta_2 \leq a_2^*$ with $\theta_2 \leq \theta_1$. As an industrialist politician wants to set the least possible a_2^* without revealing his type, his optimal strategy is to set $a_2^* = \theta_2$. That is because higher a_2^* would only bring him disutility in the future.

Next, I analyze the optimal policy proposition of the environmentalist politician. Importantly, in this analysis I assume that her optimal environmental target is at least as large as θ_2, the threshold value of voters' reelection decision. Environmentalist incumbent sets her optimal a_2^* obtained by:

$$\max_{a_1, a_2^*} \beta(1 - ca_1^2) + (1-\beta)a_1 + \beta(1 - ca_2^2) + (1-\beta)(a_1 + a_2) - z(a_2 - a_2^*)^2$$

The optimal a_1 is again 1 as it increases her utility and maximizes her reelection probability. Furthermore, she forms expectation on the future utility based on her expectation on the probability of reelection.

When voters reelect for both $a_1^* = 0.5$ and $a_1^* = 1$, the probability of an environmentalist getting reelected is one. Then, her maximization problem is the same as under full information so first-best level policy is chosen. As in a pooling equilibrium both type of politicians set the same a_2^*, the pooling equilibrium of this game is when $a_2^* = \theta_2 = \tilde{a_2}^*$.

In a pooling equilibrium, where voters only reelect when observing full- enforcement, however, the probability of reelection is $\frac{3}{4} + \gamma$. Then, an environmentalist incumbent maximizes expected second period utility:

$$\max_{a_2^*} E[\beta(1 - ca_2^2) + (1-\beta)(a_1 + a_2) - z(a_2 - a_2^*)^2]$$

which equals (noting that optimal $a_1 = 1$):

$$\max_{a_2^*}(\frac{3}{4} + \gamma + (\frac{1}{4} - \gamma)\alpha)[\beta(1 - c(\frac{2a_2^* + 1 - \beta}{2\beta c + 2})^2) + (1-\beta)(1 + \frac{2a_2^* + 1 - \beta}{2\beta c + 2})] +$$
$$(\frac{1}{4} - \gamma)(1-\alpha)[\beta(1 - c(\frac{a_2^*}{1+c})^2) + (1-\beta)(1 + \frac{a_2^*}{1+c})] - (\frac{3}{4} + \gamma)(a_2 - a_2^*)^2$$

solving for a_2^* yields:

$$a_2^* = \theta' = \frac{(\frac{3}{4}+\gamma+(\frac{1}{4}-\gamma)\alpha)\frac{1-\beta}{(\beta c+1)^2}+(\frac{1}{4}-\gamma)(1-\alpha)\frac{1-\beta}{1+c}+(\frac{3}{4}+\gamma)\frac{(1-\beta)\beta c}{(\beta c+1)^2}}{(\frac{3}{4}+\gamma+(\frac{1}{4}-\gamma)\alpha)\frac{2\beta c}{(\beta c+1)^2}+(\frac{1}{4}-\gamma)(1-\alpha)\frac{2\beta c}{(1+c)^2}+(\frac{3}{4}+\gamma)2(\frac{\beta c}{\beta c+1})^2}$$

It can be shown, as depicted on Figure 5, that this is at least as large as the first-best policy so environmentalist politician overlegislates prior to the election ($\tilde{a_2}^* \leq \theta'$). As in a pooling equilibrium both type of politicians set the same a_2^*, the pooling equilibrium of the game is when $a_2^* = \theta_2 = \theta'$.

Then, politicians propose the same environmental standard in equilibrium, a_2^*, and voters decide on reelection based on their updated beliefs observing a_1^*. Voters have two potential equilibrium strategies on the observed a_1^*. In the first strategy, voters reelect when $a_1^* = 1$ observed. In the second strategy, voters reelect when either $a_1^* = 1$ or $a_1^* = 0.5$ observed. For each strategy the voters may have, it is necessary to consider the optimal strategy of the industrialists politician on a_1 and voters' updated beliefs following the the signal a_1^*.

9.3.1 Voter strategy I: reelect when observing full-enforcement

First, I consider the voters' strategy in which they reelect an incumbent when observing full-enforcement. I check the optimal strategy of the industrialist on a_1 and whether voters have incentive to deviate from the proposed strategy.

If an industrialist incumbent sets $a_1 = 0$, he won't get reelected so his utility is $U(a_1 = 0, a_2^* = \theta_2) = 1$. If he sets $a_1 = 0.5$ then the probability of reelection is $E[z|a_1 = 0.5, a_2^* = \theta_2] = \frac{1}{4} + \gamma$ and his utility is $U(a_1 = 0.5, a_2^* = \theta_2) = 1 - 0.25c + \delta(\frac{1}{4}+\gamma)U(\beta, c, \theta_2)^*$. If he chooses $a_1 = 1$ then the probability of reelection is $E[z|a_1 = 1, a_2^* = \theta_2] = \frac{3}{4} + \gamma$ and his utility is $U(a_1 = 1, a_2^* = \theta_2) = 1 - c + \delta(\frac{3}{4}+\gamma)U(\beta, c, \theta_2)^*$. Then, industrialist chooses $a_1 = 0$ if:

$$\delta \leq \frac{0.25c}{(\frac{1}{4}+\gamma)U(\beta,c,\theta_2)^*} = \delta^* \text{ and } \delta \leq \frac{c}{(\frac{3}{4}+\gamma)U(\beta,c,\theta_2)^*} = \delta^{**}$$

chooses $a_1 = 0.5$ if:

$$\delta \geq \frac{0.25c}{(\frac{1}{4}+\gamma)U(\beta,c,\theta_2)^*} = \delta^* \text{ and } \delta \leq \frac{0.75c}{(\frac{1}{2})U(\beta,c,\theta_2)^*} = \delta^{***}$$

and chooses $a_1 = 1$ if:

$$\delta \geq \frac{0.75c}{(\frac{1}{2})U(\beta,c,\theta_2)^*} = \delta^{***} \text{ and } \delta \geq \frac{c}{(\frac{3}{4}+\gamma)U(\beta,c,\theta_2)^*} = \delta^{**}$$

There are three cases:

1. $\gamma > -\frac{1}{12}$: $\delta^* < \delta^{**} < \delta^{***} \Rightarrow \delta^*$ and δ^{***} are possible threshold values.
2. $\gamma < -\frac{1}{12}$: $\delta^{***} < \delta^{**} < \delta^* \Rightarrow \delta^{**}$ is a possible threshold value and $a_1 = 0.5$ never chosen.
3. $\gamma = -\frac{1}{12}$: $\delta^* = \delta^{**} = \delta^{***} \Rightarrow \delta^* = \delta^{**} = \delta^{***}$ is possible threshold value and $a_1 = 0.5$ chosen only when $\delta = \delta^*$

Within each case, I consider separate subcases depending on the values of δ^*, δ^{**} and δ^{***}. For each subcase, I check whether voters have incentive to deviate from the proposed equilibrium strategy.

Case 1: $\gamma > -\frac{1}{12}$

Subcase 1: $\delta^*, \delta^{***} \leq 1$

Observing $e_1^* = 1$ voters reelect if posterior at least as large as prior:

$$\frac{\alpha(\frac{3}{4}+\gamma)}{\alpha(\frac{3}{4}+\gamma) + (1-\alpha)[(\frac{3}{4}+\gamma)(1-\delta^{***}) + (\frac{1}{4}+\gamma)(\delta^{***}-\delta^*)]} \geq \alpha$$

which gives $\frac{1}{2}\delta^{***} + (\frac{1}{4}+\gamma)\delta^* \geq 0$. Given the values δ and γ can take, this condition always holds. Observing $e_1^* = 0.5$ voters do not reelect if posterior is smaller than prior:

$$\frac{\alpha(\frac{1}{4}-\gamma)}{\alpha(\frac{1}{4}-\gamma) + (1-\alpha)[(\frac{1}{4}+\gamma)\delta^* + \frac{1}{2}(\delta^{***}-\delta^*) + (\frac{1}{4}-\gamma)(1-\delta^{***})]} < \alpha$$

which holds for $\gamma < \frac{-4-\sqrt{13}}{12}$ and $\frac{-4+\sqrt{13}}{12} < \gamma$. Given our assumption on the values γ can take, it must be the case that $\frac{-4+\sqrt{13}}{12} \approx -0.033 < \gamma$. Therefore, this is an equilibrium for $-0.033 < \gamma$.

Subcase 2: $\delta^* \leq 1$ and $\delta^{***} > 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4}+\gamma)}{\alpha(\frac{3}{4}+\gamma) + (1-\alpha)[(\frac{1}{4}+\gamma)(1-\delta^*)]} \geq \alpha$$

giving $\frac{1}{2} + (\frac{1}{4} + \gamma)\delta^* \geq 0$ which always holds. Observing $e_1^* = 0.5$ voters do not reelect if:

$$\frac{\alpha(\frac{1}{4} - \gamma)}{\alpha(\frac{1}{4} - \gamma) + (1 - \alpha)[(\frac{1}{4} + \gamma)\delta^* + \frac{1}{2}(1 - \delta^*)]} < \alpha$$

which gives $\delta^* < \frac{\frac{1}{4}+\gamma}{\frac{1}{4}-\gamma}$. This holds for all $\gamma > 0$ and may also hold for some $-\frac{1}{12} \leq \gamma \leq 0$ depending on parameter values β and c.

Subcase 3: $\delta^*, \delta^{***} > 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4} + \gamma)}{\alpha(\frac{3}{4} + \gamma) + (1 - \alpha)[0]} \geq \alpha$$

giving $\alpha \leq 1$ which always holds. Observing $e_1^* = 0.5$ voters do not reelect if:

$$\frac{\alpha(\frac{1}{4} - \gamma)}{\alpha(\frac{1}{4} - \gamma) + (1 - \alpha)(\frac{1}{4} + \gamma)} < \alpha$$

which gives $0 < \gamma$. Then, this is an equilibrium for any $0 < \gamma$.

Case 2: $\gamma < -\frac{1}{12}$

Subcase 1: $\delta^{**} \leq 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4} + \gamma)}{\alpha(\frac{3}{4} + \gamma) + (1 - \alpha)(\frac{3}{4} + \gamma)(1 - \delta^{**})} \geq \alpha$$

giving $0 \leq \delta^{**}$ which always holds. Observing $e_1^* = 0.5$ voters do not reelect if:

$$\frac{\alpha(\frac{1}{4} - \gamma)}{\alpha(\frac{1}{4} - \gamma) + (1 - \alpha)[(\frac{1}{4} + \gamma)\delta^{**} + (\frac{1}{4} - \gamma)(1 - \delta^{**})]} < \alpha$$

which gives $0 < \gamma$. This contradicts with out initial assumption that $\gamma < -\frac{1}{12}$ so this cannot be an equilibrium.

Subcase 2: $\delta^{**} > 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4} + \gamma)}{\alpha(\frac{3}{4} + \gamma) + (1 - \alpha)[0]} \geq \alpha$$

giving $\alpha \leq 1$ which always holds. Observing $e_1^* = 0.5$ voters do not reelect if:

$$\frac{\alpha(\frac{1}{4} - \gamma)}{\alpha(\frac{1}{4} - \gamma) + (1 - \alpha)(\frac{1}{4} + \gamma)} < \alpha$$

which gives $0 < \gamma$. This contradicts with out initial assumption that $\gamma < -\frac{1}{12}$ so this cannot be an equilibrium.

Case 3: $\gamma = -\frac{1}{12}$

Given that δ is a continuous random variable, the probability that $\delta = \delta^*$ is zero, so this case can be analyzed as Case 2. Therefore, no equilibrium either.

9.3.2 Voter strategy II: reelect when observing under- or full-enforcement

Now assume that voters reelect when observing $a_1^* = 0.5$ or $a_1^* = 1$. Again, first I consider the industrialist's utility and strategy. If he chooses $a_1 = 0$ then the probability of reelection is $E[z|a_1 = 0, a_2^* = \theta_2] = \frac{1}{4} + \gamma$ and his utility is $U(a_1 = 0, a_2^* = \theta_2) = 1 + \delta(\frac{1}{4} + \gamma)U(\beta, c, \theta_2)^*$ If he chooses $a_1 = 0.5$ then the probability of reelection is $E[z|a_1 = 0.5, a_2^* = \theta_2] = \frac{3}{4} + \gamma$ and his utility is $U(a_1 = 0.5, a_2^* = \theta_2) = 1 - 0.25c + \delta(\frac{3}{4} + \gamma)U(\beta, c, \theta_2)^*$ If he chooses $a_1 = 1$ then the probability of reelection is $E[z|a_1 = 1, a_2^* = \theta_2] = 1$ and his utility is $U(a_1 = 1, a_2^* = \theta_2) = 1 - c + \delta U(\beta, c, \theta_2)^*$ Then, the industrialist chooses $a_1 = 0$ if:

$$\delta \leq \frac{0.25c}{(\frac{1}{2})U(\beta,c,\theta_2)^*} = \delta^* \text{ and } \delta \leq \frac{c}{(\frac{3}{4}-\gamma)U(\beta,c,\theta_2)^*} = \delta^{**}$$

As for all parameter values $\delta^* < \delta^{**}$, the industrialist chooses $a_1 = 0$ if $\delta \leq \delta^*$. Next, the industrialist chooses $a_1 = 0.5$ if:

$$\delta \geq \frac{0.25c}{(\frac{1}{2})U(\beta,c,\theta_2)^*} = \delta^* \text{ and } \delta \leq \frac{0.75c}{(\frac{1}{4}-\gamma)U(\beta,c,\theta_2)^*} = \delta^{***}$$

It is easy to show that for all parameter values $\delta^* < \delta^{***}$, so industrialist chooses $a_1 = 0.5$ if $\delta^* \leq \delta \leq \delta^{***}$. Finally, the industrialist chooses $a_1 = 1$ if $\delta^{***} \leq \delta$. This can be easily derived using the previous two cases. Therefore, δ^* and δ^{***} constitute cutoff values for the industrialist's strategy. We must consider 3 separate cases depending on the values of δ^* and δ^{***}.

Case 1: $\delta^*, \delta^{***} \leq 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4} + \gamma)}{\alpha(\frac{3}{4} + \gamma) + (1 - \alpha)[(\frac{3}{4} + \gamma)(1 - \delta^{***}) + (\frac{1}{4} + \gamma)(\delta^{***} - \delta^*)]} \geq \alpha$$

which gives $(\frac{1}{4}+\gamma)\delta^* + \frac{1}{2}\delta^{***} \geq 0$ so is always true. Observing $e_1^* = 0.5$ voters reelect if:

$$\frac{\alpha(\frac{1}{4}-\gamma)}{\alpha(\frac{1}{4}-\gamma)+(1-\alpha)[(\frac{1}{4}+\gamma)\delta^*+(\frac{1}{2})(\delta^{***}-\delta^*)+(\frac{1}{4}-\gamma)(1-\delta^{***})]} \geq \alpha$$

which holds for $\gamma \leq \frac{4-\sqrt{21}}{4}$ and $\frac{4+\sqrt{21}}{4} \leq \gamma$. Given our assumption on the values γ can take, it must be the case that $\gamma \leq \frac{4-\sqrt{21}}{4} \approx -0.146$. Therefore, this only constitutes an equilibrium if there is sufficiently large negative information skew in the model.

Case 2: $\delta^* \leq 1, \delta^{***} > 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4}+\gamma)}{\alpha(\frac{3}{4}+\gamma)+(1-\alpha)[(\frac{1}{4}+\gamma)(1-\delta^*)]} \geq \alpha$$

which gives $\frac{1}{2} + \delta^*(\frac{1}{4}+\gamma) \geq 0$ so is always true. Observing $e_1^* = 0.5$ voters reelect if:

$$\frac{\alpha(\frac{1}{4}-\gamma)}{\alpha(\frac{1}{4}-\gamma)+(1-\alpha)[(\frac{1}{4}+\gamma)\delta^*+(\frac{1}{2})(1-\delta^*)]} \geq \alpha$$

which holds for $\delta^* \geq \frac{\frac{1}{4}+\gamma}{\frac{1}{4}-\gamma}$. This holds only for some negative γ depending on parameter values β and c.

Case 3: $\delta^*, \delta^{***} > 1$

Observing $e_1^* = 1$ voters reelect if:

$$\frac{\alpha(\frac{3}{4}+\gamma)}{\alpha(\frac{3}{4}+\gamma)+(1-\alpha)[0]} \geq \alpha$$

giving $\alpha \leq 1$ which always holds. Observing $e_1^* = 0.5$ voters reelect if:

$$\frac{\alpha(\frac{1}{4}-\gamma)}{\alpha(\frac{1}{4}-\gamma)+(1-\alpha)(\frac{1}{4}+\gamma)} \geq \alpha$$

which gives $\gamma \leq 0$. Then, this is an equilibrium for any $\gamma \leq 0$.

Finally, I analyze second period enforcement by both type of politicians. When politicians pool on the socially optimal environmental proposition, an environmental politician enforces standards while an industrialist politician underenforces standards in the second period. (See appendix A and B for reference) In a pooling

equilibrium where the proposed policy is above the socially optimal, an environmentalist politician overenforces and an industrialist politician underenforces standards in the second period. Appendix A shows that an environmentalist politician's second period enforcement strictly increases in the proposed policy, a_2^*. Therefore, with overlegislation in the first period she overenforces in the second. An industrialist politician, in contrast, underenforces in the second period for any parameter values. The following graph depicts industrialist's second period legislation and the first-best policy enforcement. As can be seen from the graph, industrialist underenforces for all parameter values - β, γ and α. On the graph, abatement cost is assumed to be 0.5 and α is set to 0 (brown surface), 0.5 (red surface) and 1 (green surface). Simulations show that the results are robust to other parameter values as well.

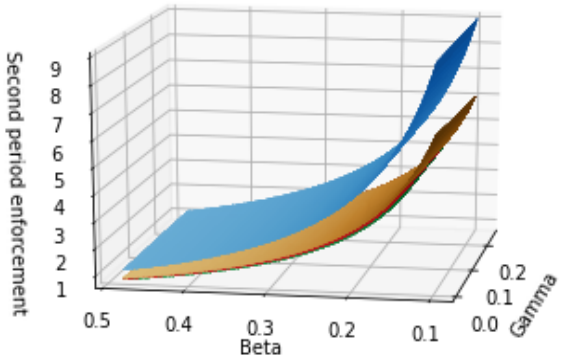

Figure 6: Second period enforcement with $\alpha = 0$ (brown), $\alpha = 0.5$ (red) and $\alpha = 1$ (green) and the socially optimal level (blue)

9.4 Appendix D - Proof of Proposition 5.

The modified model can be analyzed similarly to the pooling equilibrium case. Firstly, an environmentalist politician's strategy is the same as in the pooling equilibrium of the full model. That is because setting the highest first-period enforcement level maximizes her reelection probability and increases utility in both periods.

Furthermore, as the proposed policy is not observed by the voters, an environmentalist sets a_2^* optimally just as in the pooling equilibrium specification. Secondly, voters can have two strategies and they reelect either when observing full-enforcement; or when observing underenforcement or full-enforcement. Their equilibrium strategy depends on the sign and magnitude of the information skew, as in the pooling equilibrium case.

Thirdly, an industrialist politician's optimal strategy is to set $a_2^* = a_2 = 0$ as it does not influence reelection probability and maximizes second period utility. Then, if he gets reelected he can guarantee himself a utility of one in the second period. Therefore, he applies the same threshold strategy on a_1 as in the pooling case, except that his future utility is $U(\beta, c)^* = 1$. (See Appendix C for reference)

Furthermore, we may also define a separating equilibrium in which voters reelect when observing $a_1^* = 1$ and industrialist chooses $a_1 = 0$ for all δ. Appendix C shows that voters reelect incumbent when observing full-enforcement if $0 < \gamma$, assuming incumbent chooses $a_1 = 0$ for all δ. (See Appendix C, Case 1, Subcase 3 for reference) Furthermore, incumbent chooses zero enforcement for all δ if:

$$1 < \frac{0.25c}{\frac{1}{4} + \gamma} = \delta^*$$

that is:

$$\gamma < \frac{1}{4}(c - 1)$$

Given the restriction on the value of the abatement cost, this holds only for negative γ. Then, voters would also want to reelect when observing underenforcement for $\gamma \leq 0$. Therefore, there is no separating equilibrium when politician's agenda is hidden from the voters.

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