Political Competition and Climate Policy: A Dynamic Game of Pollution Control

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Abstract

In this paper, I analyze a dynamic game of political pollution control where two policy-motivated parties compete for votes through tax policies. Voters evaluate the direct effects of the tax policies and vote probabilistically. Depending on the voters' time horizon, the ambition of the green party's climate policy is drastically affected. If voters only consider one legislative period, the green party's climate policy is virtually indistinguishable from the brown party's to remain politically competitive. The brown party is barely affected by the political competition and can almost exactly implement its dictatorially preferred policy. Extending the voter's time horizon allows the green party to be more ambitious and forces the brown party to move closer to the median voter's preferred policy. I find that voters would need a time horizon close to ten legislative periods for the steady-state pollution stock to be lower than under random voting. This implies that for shorter time horizons the green party is better served not making the pollution issue a political campaign topic. Increased polarization in party objectives/beliefs decreases societal welfare and increases both the level and the volatility of steady-state pollution.

JEL Classification: C73, D72, Q54, Q58
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1 Introduction

Climate policy in many countries has proven to be inconsistent, oscillating between more ambitious targets under certain administrations and rollbacks or deregulation under others. These policy swings are partially driven by political party competition, reflecting different ideological stances on taxation, regulation, and the urgency of environmental protection. Such partisan dynamics, however, do not merely create short-term policy uncertainty; they can also shape the trajectory of pollution and emissions over a longer horizon. The scientific consensus acknowledges that anthropogenic climate change is a significant global threat requiring immediate action (Calvin et al., 2023). Despite this urgency, there is no clear agreement on the optimal climate policy, even under the idealized scenario of a social planner with full implementation power. In practice, however, climate policy is shaped by the political process, where disagreements between parties are even more pronounced than among experts.

Looking at recent history, the New York Times writes:

> Over four years, the Trump administration dismantled major climate policies and rolled back many more rules governing clean air, water, wildlife and toxic chemicals (Popovich et al., 2020).

And the Center for American Progress writes:

> From comprehensive legislation to ambitious executive action, the Biden administration has set the United States on a new course of climate action. Not only does this mark a profound break from the policies of the Trump administration, but it also amounts to more action on climate than any other administration in history (Higgins et al., 2024).

This variability is not limited to the most recent administrations.

In Figure 1, we see the actual and pledged CO2 emissions by US presidents and how these pledges differ across parties. Clearly, the political process significantly impacts the policies that are implemented.

Against this backdrop, this paper examines how political competition influences climate policy and pollution dynamics. Specifically, I present a dynamic model of party competition in which two policy-motivated parties set emissions taxes, vying for voter support over an endogenously evolving pollution stock. Voters differ in their susceptibility to pollution damages. The model thus shows how electoral incentives and forward-looking considerations interplay to produce emissions trajectories and

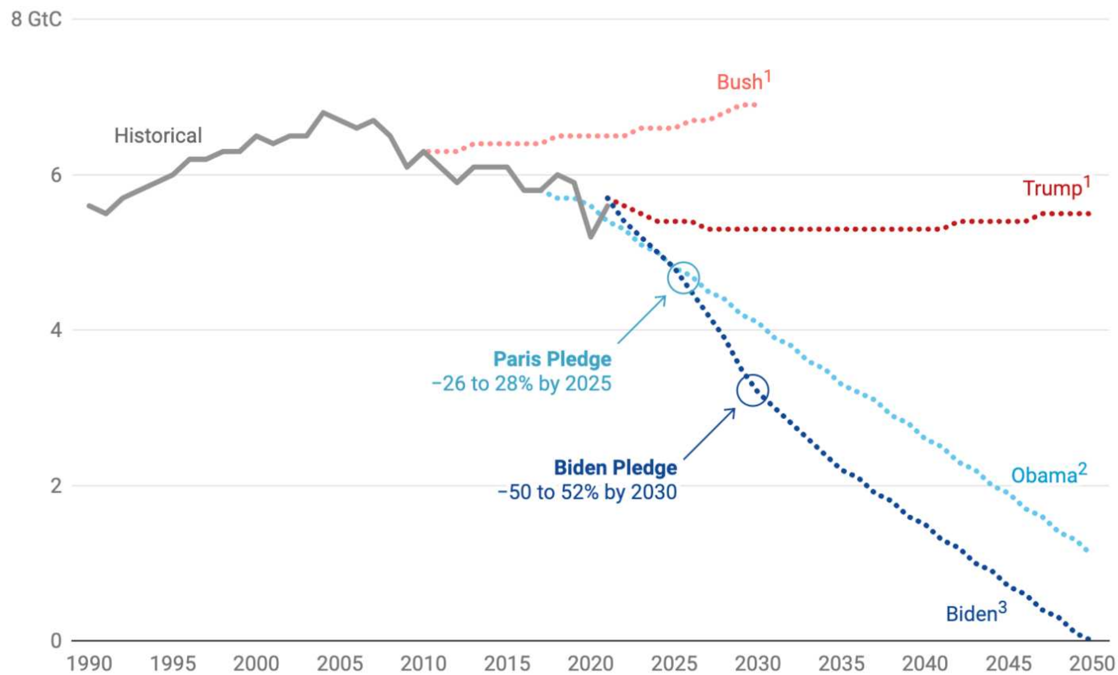

Figure 1: Historical U.S. annual greenhouse gas emissions and projections under different presidential administrations in gigatons of carbon dioxide equivalent, 1990–2050

welfare outcomes that deviate from a social planner's optimum.

Methodologically, I build on the literature of spatial and probabilistic voting models,following the seminal contributions of Hotelling (1929) and Downs (1957). Hotelling's (1929) seminal model of spatial competition noted the relevance to the political process and party competition. Downs (1957) expanded on this with his spatial voting model. This model, famously, predicts that parties will converge to the median voter's preferences. Contrary to this prediction, it is rarely seen that parties converge to the same policy position. Two adjustments to the model have been proposed to achieve equilibrium policy differentiation: policy-motivated parties and probabilistic voting (Calvert, 1985; Wittman, 1983). Alesina (1988) shows that with two parties (that are both policy- and office-motivated) with probabilistic voting and perfect commitment, equilibrium strategies will be distinct and in the open interval spanned by the two parties' ideal points. The author further considers a game in which the stage game is repeated infinitely often and shows that in this case equilibrium strategies converge to a point depending on the parties' bargaining power.

A large part of the literature on electoral competition focuses on static environments. A key aspect of policy-making is that the decisions (hopefully) affect the relevant state variables and thus a policy decision today will affect a party's situation in the following periods. One area where dynamic considerations have been studied is fiscal policy, where current policies affect future government budget constraints and thereby create a dynamic link between periods. Battaglini (2014) studies a dynamic model of electoral competition and fiscal policy with office-motivated parties in an environment with (potentially heterogeneous) electoral districts. He finds that how close the policy outcome is to Pareto efficiency depends on the degree of heterogeneity and the size of the electoral districts.

Beetsma et al. (2022) study the effect of increased fiscal transparency on public debt choice in a two-period model of fiscal policy with two political parties and homogeneous voters. Voters receive noisy signals about economic and political variables and reelect the incumbent if the voters' beliefs about the incumbent's competency exceed a threshold. In this paper, there is no direct competition between the parties as only the incumbent makes a policy decision. By choosing a higher public debt level in the first period, the incumbent can increase the probability of being reelected in the second period. However, opting for a high debt level also decreases the utility of the incumbent in case of reelection, as they prefer more even spending over the two periods. Not being reelected yields a large negative utility, such that being reelected is always preferred.

My main findings reveal several striking patterns. First, when voters are short-sighted (i.e., have very limited time horizons), the "green" party is forced to propose relatively weak emissions taxes to remain electorally competitive – resulting in higher long-run pollution levels. As voters become more forward-looking, both the green and the brown parties propose higher taxes, reducing long-run pollution. Second, the salience of the climate issue produces an intriguing paradox: if environmental policy does not matter to voters, the green party can actually propose more ambitious taxes without losing votes, thereby lowering pollution. Meanwhile, the brown party's tax proposal remains near its dictatorially preferred (lower) level. Third, greater political polarization increases the volatility of pollution stocks, as electoral cycles usher in sharp policy swings. Even though extending voter time horizons helps reduce overall pollution, it does not mitigate these fluctuations. Finally, a comparison of aggregate welfare outcomes shows that the political equilibrium often departs from what a social planner would achieve – especially if one of the parties is significantly more "brown" than the median voter. These results highlight how voter horizons, salience of climate issues, and party polarization jointly shape the level, path, and stability of pollution in a democratic setting.

This paper contributes to the literature by proposing a dynamic model of party competition with policy-motivated parties and probabilistic voting tailored to climate policy, providing insights into how evolving pollution stocks feed back into electoral strategies. I solve for the optimal strategies of the parties and the resulting state dynamics and analyze the welfare loss due to the political process.

The remainder of this paper is organized as follows: Section 2 details the model environment, including voter preferences, pollution dynamics, and party objectives. Section 3 presents the core results, along with comparative statics illustrating how time horizons, salience, and polarization shape equilibrium outcomes. Section 4 summarizes the main insights, reflects on potential policy implications, and suggests avenues for future research.

2 Model

2.1 Voter

I consider a discrete-time infinite-horizon model. A continuum of voters is characterized by a susceptibility to pollution damages γ_k. Pollution susceptibility is distributed according to a distribution function $F(\gamma)$. Consumers share a common benefits function giving benefits of emission consumption x_k net of emission taxes $\tau \geq 0$,

$$B(x_k) = \phi\left(x_k\right) - \tau x_k\,, \tag{1}$$

where $\phi\left(\cdot\right)$ is a concave function. Consumers vary in the costs of pollution

$$C_k(P) = \frac{\gamma_k}{2}P^2\,. \tag{2}$$

The utility of voter k is given by

$$U_k(x_k, P) = B(x_k) - C_k(P)\,. \tag{3}$$

Total emissions are given by $e = \int_0^1 x_k dk$ and pollution evolves according to

$$P_{t+1} = e_t + (1-\delta)P_t\,. \tag{4}$$

There are two policy-motivated parties $i \in \{1, 2\}$ that compete for votes. The parties are characterized by their own damage parameter Γ_i, which determines their ideal policy. You can think about this as parties representing a party base/activists. Let me denote by γ_{med} the median voter's susceptibility to pollution damages. In the following, I will assume that the parties are characterized by $\Gamma_1 < \gamma_{\text{med}} < \Gamma_2$. Party 1 can therefore be thought of as the brown party and Party 2 as the green party. Each period, one party is elected to form the government and can set a tax on emissions τ_t.

Per period, each voter chooses emissions given the current tax,

$$x_k = \arg\max_{x_k} U_k(x_k, P_t) \,. \tag{5}$$

As there is a continuum of voters, each voter has a negligible effect on the pollution level and voters will not consider the effect of their emissions on the pollution level. The optimal per period consumption taking taxes τ_t as given, solves

$$\max_{x_k} \phi\left(x_k\right) - \tau_t x_k - \frac{\gamma_k}{2} P_t^2 \,. \tag{6}$$

The first-order condition is

$$\phi'\left(x_k\right) - \tau_t \leq 0 \,, \tag{7}$$

which holds with equality if $x_k > 0$.

Thus, the optimal consumption is given by

$$x_k\left(\tau_t\right) = \max\left\{\left(\phi'\right)^{-1}\left(\tau_t\right), 0\right\} \,. \tag{8}$$

As the benefits of emissions are equal for all voters, optimal consumption is the same for all voters. This, together with the unit mass of voters, implies that aggregate emissions are equal to the optimal emissions level for each voter, i.e.

$$e(\tau) = x_k(\tau) \,.$$

Pollution dynamics as a function of the tax rate are given by

$$P_{t+1} = e\left(\tau_t\right) + (1-\delta) P_t \,. \tag{9}$$

For the rest of the paper, I will assume that the benefits function is given by the isoelastic utility function,

$$\phi(x) = \begin{cases} \frac{x^{1-\sigma}}{1-\sigma} & \text{if } \sigma \neq 1, \\ \log x & \text{if } \sigma = 1, \end{cases} \tag{10}$$

where $\sigma > 0$ is the parameter determining the intertemporal elasticity of substitution. A higher σ implies that voters are less willing to substitute consumption over time, i.e. prefer a smoother consumption path.

Aggregate emissions (and also optimal individual emissions consumption) are then given by

$$e(\tau) = \tau^{-1/\sigma} \tag{11}$$

Benefits as a function of taxes are then given by

$$\begin{aligned} b(\tau) = B(e(\tau)) &= \phi(e(\tau)) - \tau e(\tau) \\ &= \frac{\tau^{(\sigma-1)/\sigma}}{1-\sigma} - \tau^{(\sigma-1)/\sigma} \\ &= \frac{\sigma}{1-\sigma}\tau^{(\sigma-1)/\sigma} \\ &= -\frac{1}{\zeta}\tau^{\zeta}, \end{aligned} \tag{12}$$

where $\zeta = \frac{\sigma-1}{\sigma}$.

The intertemporal optimization problem of a dictatorial voter with γ_k is then given by

$$\max_{\{\tau_t\}} \sum_{t=0}^{\infty} \rho^t \left[-\frac{1}{\zeta}\tau_t^{\zeta} - \frac{\gamma_k}{2} P_t^2 \right], \tag{13}$$

subject to the pollution dynamics, $P_{t+1} = \tau^{\zeta-1} + (1-\delta)P_t$.

The associated Bellman equation is

$$V_k(P) = \max_{\tau \in \mathcal{S}} \left\{ -\frac{1}{\zeta}\tau^{\zeta} - \frac{\gamma_k}{2}P^2 + \rho V_k\left(\tau^{\zeta-1} + (1-\delta)P\right) \right\}, \tag{14}$$

where $\mathcal{S}$ is the set of feasible tax rates, that ensure emissions consumption is non-negative and finite.

Differentiate the Bellman equation with respect to τ:

$$-\tau^{\zeta-1} - \rho\,(\zeta-1)\,\tau^{\zeta-2} V_k'(\tau^{\zeta-1} + (1-\delta)P) = 0\,. \tag{15}$$

Solving for τ:

$$\tau = -\,(\zeta-1)\,\rho V_k'(P')\,. \tag{16}$$

The envelope condition is:

$$V_k'(P) = -\gamma_k P + \rho(1-\delta)V_k'(P')\,. \tag{17}$$

Combining the envelope condition with the first-order condition, we get:

$$\tau = \frac{1-\zeta}{1-\delta}\left(\gamma_k P + V_k'(P)\right)\,. \tag{18}$$

The intertemporal elasticity of substitution (IES) $\frac{1}{\sigma} = 1-\zeta$ is directly related to the optimal tax rate. A higher IES implies a higher optimal tax rate, ceteris paribus.

The numerically found optimal rate can be seen in Figure 2.

2.2 Voting

I model voting as a discrete choice between two parties, where the probability of voting for party i is a function of the difference in (some measure of) utility between the two parties's policy proposals, i.e.

$$P_k^i\,(\tau_1, \tau_2; P) = \frac{e^{\xi W_k\left(\tau_i; P\right)}}{e^{\xi W_k\left(\tau_1; P\right)} + e^{\xi W_k\left(\tau_2; P\right)}}\,, \tag{19}$$

where ξ is the intensity of choice, determining how sensitive the choice probabilities are to differences in utility.

This is related to the binary Luce model (Luce, 1959), which is commonly used in the political science literature to model probabilistic voting behavior. In a Luce model, the choice probability is proportional to the utility the voter derives from the policy relative to the sum of the utilities of all policies. As the utility can be positive and negative, the denominator can be zero. Therefore, I follow the discrete choice literature and assume that the choice probabilities are given by the logit function, which ensures that the choice probabilities are always between 0 and 1.

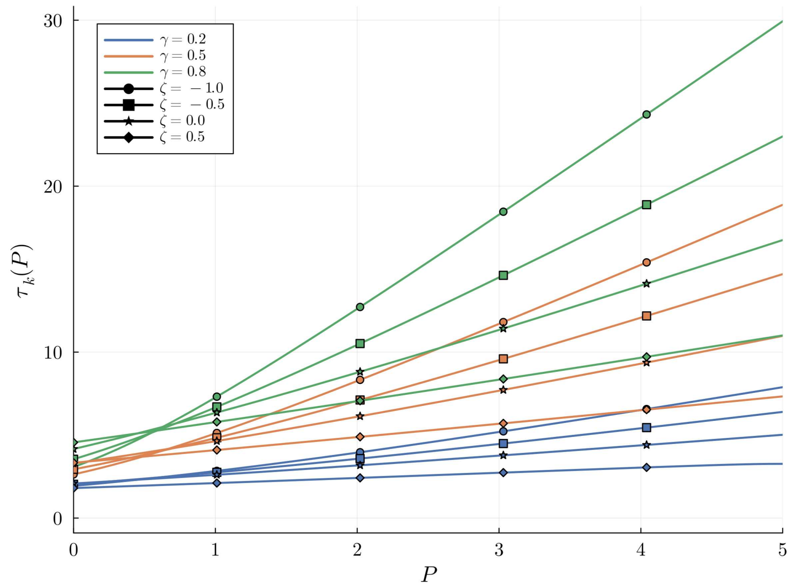

Figure 2: Optimal tax rate τ_k as a function of the pollution level P for different values of γ_k and ζ.

The probability that party i wins the election is given by

$$\begin{aligned}\theta_i\left(\tau_i, \tau_j; P\right) &= \int_{\gamma_{\min}}^{\gamma_{\max}} P_k^i\left(\tau_1, \tau_2; P\right) dF\left(\gamma_k\right) \\ &= \int_{\gamma_{\min}}^{\gamma_{\max}} \frac{1}{1+\exp\left(-\xi \Delta W_k^{ij}\right)} dF\left(\gamma_k\right) .\end{aligned} \tag{20}$$

Voter horizon

An important consideration is which utility voters should use when evaluating the proposed policies. Ideally, the voter would take into account the complete policy rule of the parties. This, however, is not feasible as the policy function of the parties is not known at this point and to calculate it, knowledge of the election probabilities is a prerequisite.

One option is to use the value function of a voter if she were able to act as a dictator and choose the policy unilaterally, as in Section 2.1. The problem with this approach is that when evaluating a particular policy proposal $\tau_{t,i}$, voters incorrectly assume that future policies will be chosen optimally (according to their preferences) forever after.

As a compromise, I consider a voter who takes into account the additional damages from emissions that will incur in the future up to h periods ahead, assuming the pollution level remains at the current level. The utility of a forward-looking voter is given by

$$\begin{aligned} W_k(\tau, P; h) =& b(\tau) - \frac{\gamma_k}{2}P^2 - \rho\frac{\gamma_k}{2}\sum_{t=0}^{h}\rho^t\left((1-\delta)^t e(\tau) + (1-\delta)P\right)^2 \\ =& b(\tau) - \frac{\gamma_k}{2}P^2 - \rho\frac{\gamma_k}{2}\left(\frac{1-\rho^{h+1}(1-\delta)^{2(h+1)}}{1-\rho(1-\delta)^2}e(\tau)^2\right. \\ &\left. +2(1-\delta)\frac{1-\rho^{h+1}(1-\delta)^{h+1}}{1-\rho(1-\delta)}e(\tau)P + \frac{1-\rho^{h+1}}{1-\rho}(1-\delta)^2P^2\right). \end{aligned} \tag{21}$$

Note that for $h = 0$ this corresponds to a voter who only cares about the direct effects of the policy proposal, i.e. emission utility today and resulting pollution damages tomorrow. As h approaches infinity, the voter becomes infinitely forward-looking but the expectations are incorrect, as the path of future pollution levels is unknown and depends both on future policy choices and election outcomes.

The limit $\lim_{h\to\infty} W_k(\tau, P; h)$ is not defined as the last term diverges, but we can consider the limit of the difference in utility between two policies. The difference for a finite h is given by

$$\begin{aligned} \Delta W_k^{ij}(P; h) = b(\tau_i) - b(\tau_j) - \rho\frac{\gamma_k}{2}&\left(\left(e(\tau_i)^2 - e(\tau_j)^2\right)\frac{1-\rho^{h+1}(1-\delta)^{2(h+1)}}{1-\rho(1-\delta)^2}\right. \\ &\left. +2\left(e(\tau_i) - e(\tau_j)\right)P(1-\delta)\frac{1-\rho^{h+1}(1-\delta)^{h+1}}{1-\rho(1-\delta)}\right). \end{aligned} \tag{22}$$

The derivation of the winning probabilities is given in the Appendix A.

2.3 Solution

Parties make their decisions at the beginning of a period. They face a tradeoff between implementing a policy that maximizes their intertemporal utility versus the policy that maximizes their winning probability. The value function of party i, suppressing arguments where not necessary, is given by

$$V_i(P) = \max_{\tau_i \in \mathcal{S}} \Big\{ \theta_i \Big(b(\tau_i) + \rho V_i \big(P'(\tau_i) \big) \Big) + (1-\theta_i) \Big(b\big(\tau_j\big) + \rho V_i \Big(P'\big(\tau_j\big) \Big) \Big) - \frac{\Gamma_i}{2} P^2 \Big\} . \tag{23}$$

The value function is unknown and depends on the Nash equilibrium strategies. Given a guess V_i^n for the value function, we can solve for the Nash equilibrium strategies using the first-order condition of the right-hand side of the Bellman equation.

This gives us best-response functions $\tau_i = \tau_i^n \left(\tau_j, P; V_i^n\right)$ for each party. We can then find the Nash equilibrium as the fixed point of the best-response functions. This gives policy functions

$$(\tau_1, \tau_2) = \left(\varphi_1^n \left(P; V_1^n\right), \varphi_2^n \left(P; V_2^n\right) \right) .$$

By plugging the Nash equilibrium strategies into the current guess of the value function, we obtain the updated value function

$$V_i^{n+1}(P) = \theta_i \left(\varphi_i^n, \varphi_j^n, P\right) \left[b\left(\varphi_i^n\right) + \rho V_i^n \left(P'(\varphi_i^n)\right) \right] + \left(1 - \theta_i \left(\varphi_i^n, \varphi_j^n, P\right)\right) \left[b\left(\varphi_j^n\right) + \rho V_i^n \left(P'(\varphi_j^n)\right) \right] - \frac{\Gamma_i}{2} P^2 . \tag{24}$$

This process can be iterated until convergence[1]

3 Numerical Results

In Figures 3 and 4 we see the policy functions for different voter time horizons. For myopic voters ($h = 0$) the green party has to propose a low tax policy close to the brown party's policy, which coincides with the policy the brown party would implement dictatorially, to retain some chance of being elected. As the time horizon

[1]Due to the complexity of the problem, small numerical errors build up as the iteration steps increase. To counteract this, I use smoothed best response functions $\tilde{\phi}_i^n$, when updating the value functions.

increases, the green party can propose a more ambitious tax policy and move closer to its dictatorially preferred policy. Also the brown party increases its tax policy as the voter time horizon increases as voters become more aware of future pollution damages.

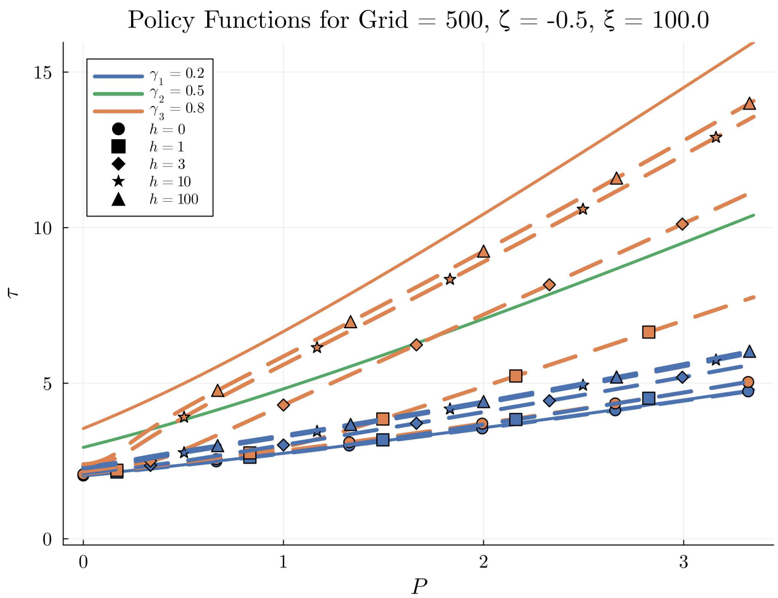

Figure 3: Policy functions for for isoelastic utility function with $\zeta = -0.5$ for different voter time horizons.

As a result of the higher equilibrium tax policies with far-sighted voters, long run pollution levels are lower the longer the voter time horizon, see Figures 5 and 6.

Compared to random voting, i.e. where voters do not consider the pollution tax and its consequences at all, the pollution stock is lower in the long run on average, if voter are sufficiently far-sighted.

3.1 Salience of Climate Issue

In Figures 7 and 9 we see that if voters are short-sighted, depending on the salience of the climate issue (ξ) the green party proposes a more or less strict tax policy. Interestingly, the less salient the climate issue is the higher the optimal tax policy from the perspective of the green party. This is because if the climate issue is not salient the voters do not consider the negative short-term effects of a higher tax when voting. The green party can then propose a higher tax policy without losing votes.

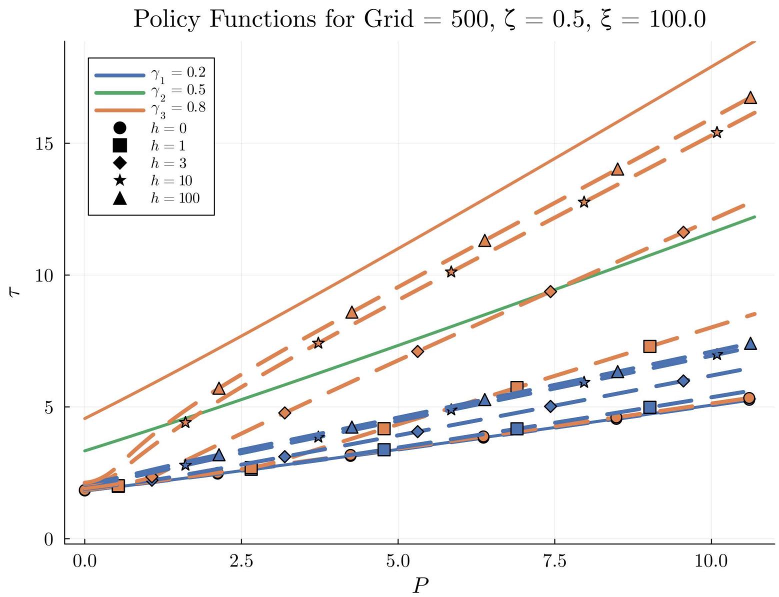

Figure 4: Policy functions for for isoelastic utility function with $\zeta = 0.5$ for different voter time horizons.

The brown party, on the other hand, is barely affected by the salience of the climate issue. The optimal tax policy of the brown party is almost exactly the same as the policy they would implement dictatorially.

This is also visible in Figures 8 and 10. The pollution stock is lower when the climate issue is less salient, as the green party (paradoxically) gets voted more often.

3.2 Welfare analysis

To quantify the welfare losses due to the political process, I compare the voters' welfare in the party competition equilibrium to the welfare of the social planner's solution. The social planner's solution is the solution to the following optimization problem:

$$\max_{\tau} \int_0^1 \sum_{t=0}^{\infty} \rho^t \left[b\left(\tau\right) - \frac{\gamma_k}{2} P^2 \right] \, dF\left(\gamma_k\right) . \tag{25}$$

By switching the order of the sum and the integral we can see that the solution to this problem is equal to the median voter's ideal policy.

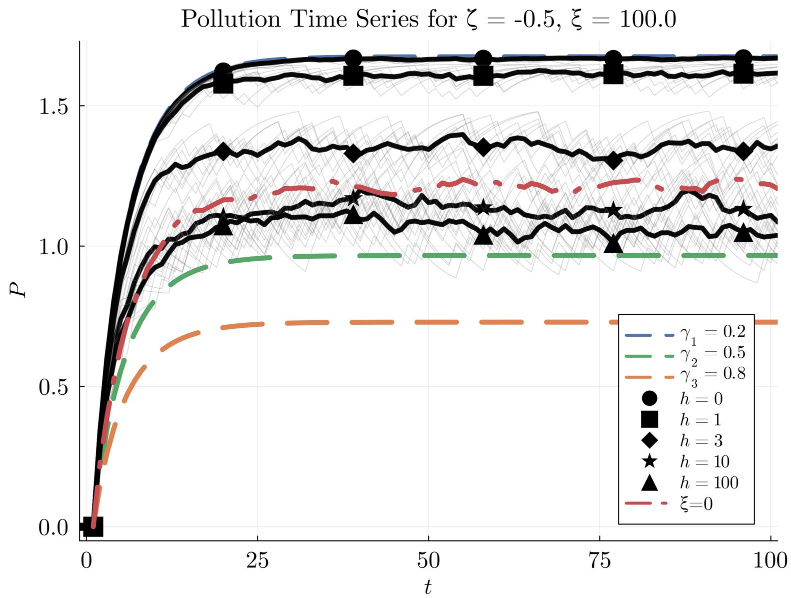

Figure 5: Sample paths of the pollution stock with isoelastic utility function with $\zeta = -0.5$ for different voter time horizons.

Let $\{\theta_t\}_{t=0}^{\infty}$ be a sequence of election outcomes, taking the value one if party one wins the election and zero otherwise. The realized aggregate welfare is then given by

$$V_{\text{agg}} = \int_0^1 \sum_{t=0}^{\infty} \rho^t \left[b\left(\theta_t \tau_1 (P_t) + (1 - \theta_t) \tau_2 (P_t)\right) - \frac{\gamma_k}{2} P_t^2 \right] dF(\gamma_k) \,. \tag{26}$$

Under the current assumptions we can switch the order of the integral and the sum and using that γ_k is uniformly distributed, we obtain

$$V_{\text{agg}} = \sum_{t=0}^{\infty} \rho^t \left[b\left(\theta_t \tau_1 (P_t) + (1 - \theta_t) \tau_2 (P_t)\right) - \frac{1}{4} P_t^2 \right] \,. \tag{27}$$

Thus, the aggregate welfare is given by the welfare of the median voter in the party competition equilibrium.

In Figure 11 we see that the welfare losses depend on the position of the parties relative to the median voter. If a center party and a green party are competing, the welfare losses are limited. However, if the center party and a brown party are competing, the welfare losses are more pronounced. Welfare losses are most pronounced

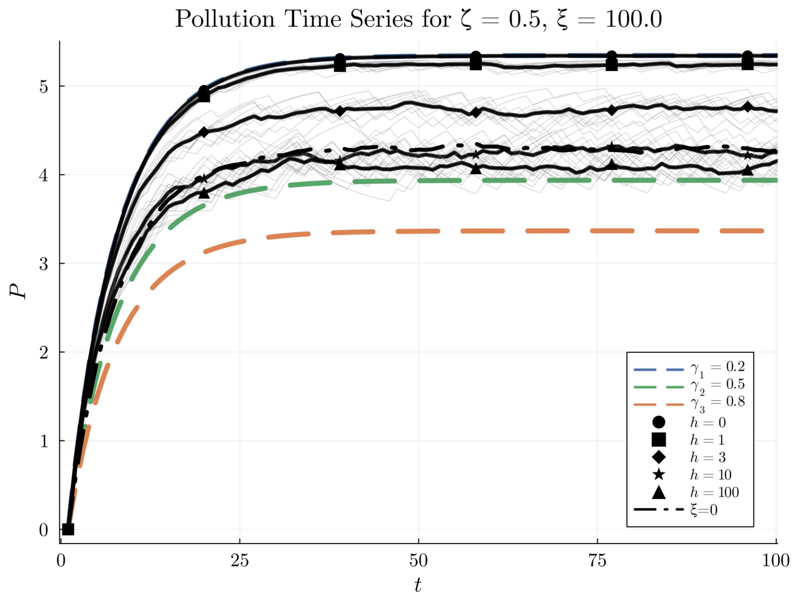

Figure 6: Sample paths of the pollution stock with isoelastic utility function with $\zeta = 0.5$ for different voter time horizons.

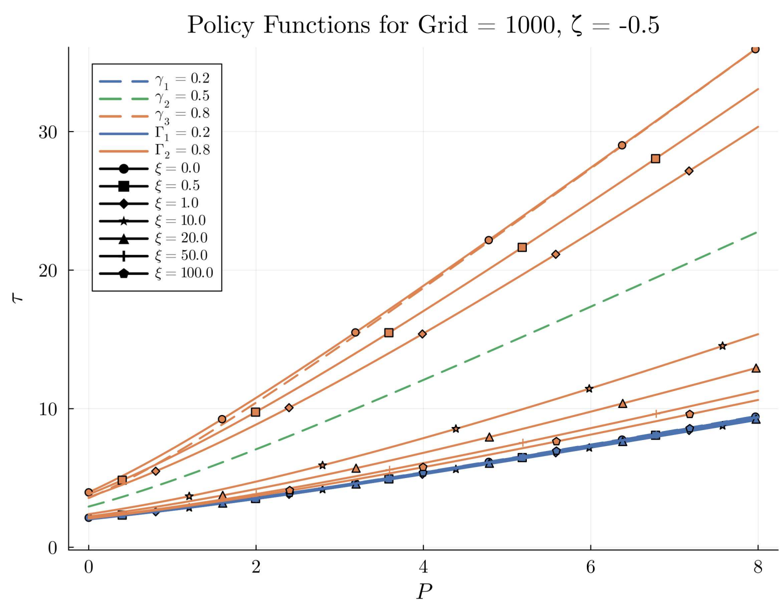

Figure 7: Policy functions for for isoelastic utility function with $\zeta = -0.5$.

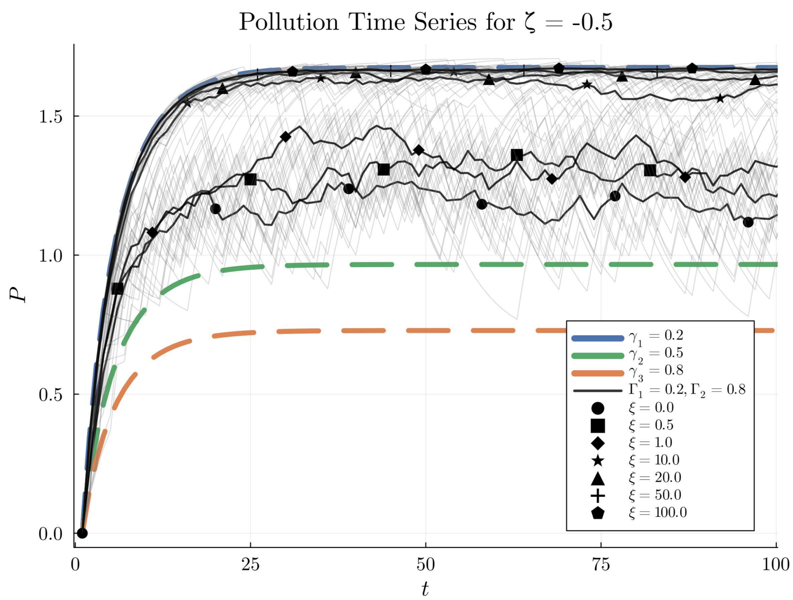

Figure 8: Sample paths of the pollution stock with isoelastic utility function with $\zeta = -0.5$.

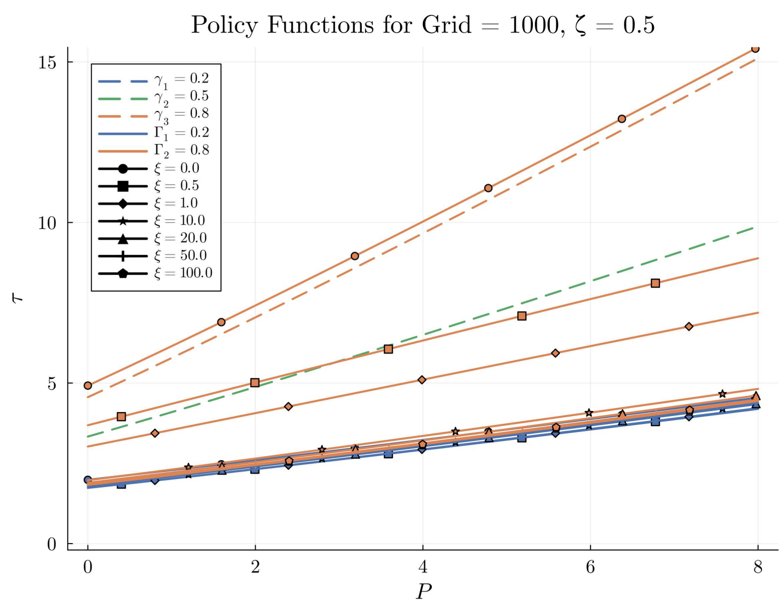

Figure 9: Policy functions for for isoelastic utility function with $\zeta = 0.5$.

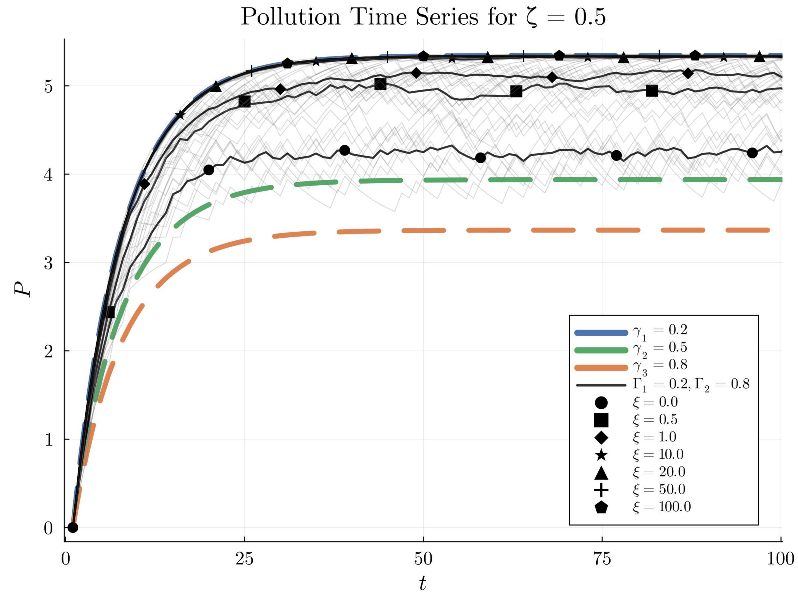

Figure 10: Sample paths of the pollution stock with isoelastic utility function with $\zeta = 0.5$.

if parties positions coincide and are far removed from the median voter, since then voters cannot leverage the different parties' policies to their advantage. For shorter time horizons, the welfare losses are more pronounced. This is because voters are more myopic and prefer the browner party's policy, since it leads to higher consumption levels. Note also that if one party is close to the median voter and the other is far greener, society is slightly better off if voters have a shorter time horizon. This is because the shorter the time horizon, the more the relatively browner party is voted. If the browner party is close to the median voter and the greener party is further away, the browner party corresponds more closely to the median voter's (and thus society's) ideal policy and thus if it is voted more often, society is better off.

3.3 Political volatility of pollution

In Figures 12 and 13, we see that an increase in polarization leads to both an increase in the median pollution stock level and an increase in the variance of the pollution stock. The increase in median pollution is becoming less pronounced as the voter time horizon increases, but the increase in variance is not.

In Figure 14, we see that the standard deviation of the pollution stock is relatively

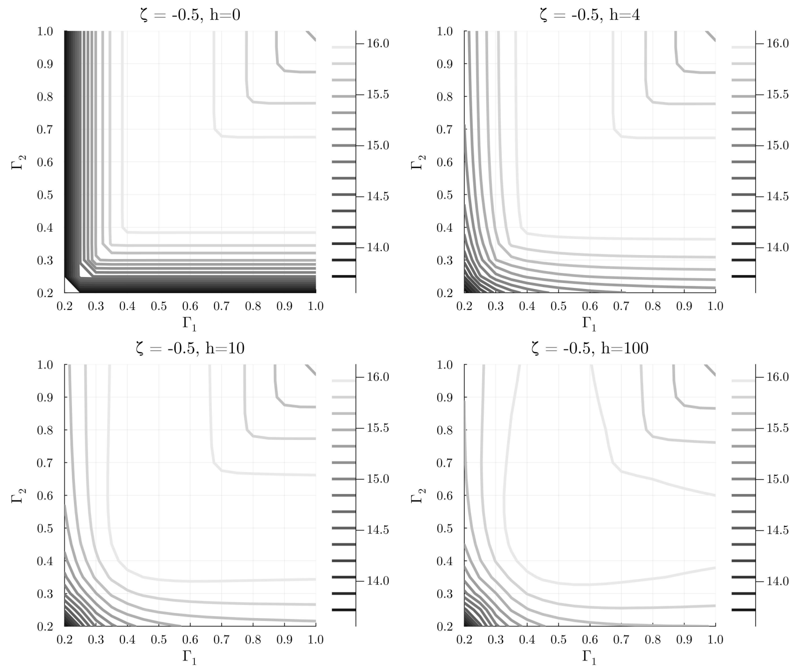

Figure 11: Welfare comparison for isoelastic utility function with $\zeta = -0.5$, $\xi = 100$ and various time horizons.

constant across time horizons and increases almost linearly with the level of polarization (except for $h = 0$). Thus, while a longer voter time horizon may reduce the median pollution stock level, it does not reduce the volatility of the pollution stock. So, while extending voter time horizons addresses some of the inefficiencies in the societally sub-optimally high pollution levels, it does not adequately address the instability in environmental outcomes driven by political cycles. Institutional interventions, such as bipartisan agreements on baseline environmental standards or mechanisms to smooth policy transitions between administrations, could provide pathways to mitigate volatility. Further research could explore the effectiveness of such interventions, particularly in highly polarized systems.

4 Conclusion

In this paper, I analyze a game of political pollution where two policy-motivated parties compete for votes through (perfectly committable) tax policies. Voters evaluate the accumulated effects of the current emissions under the proposed tax policies

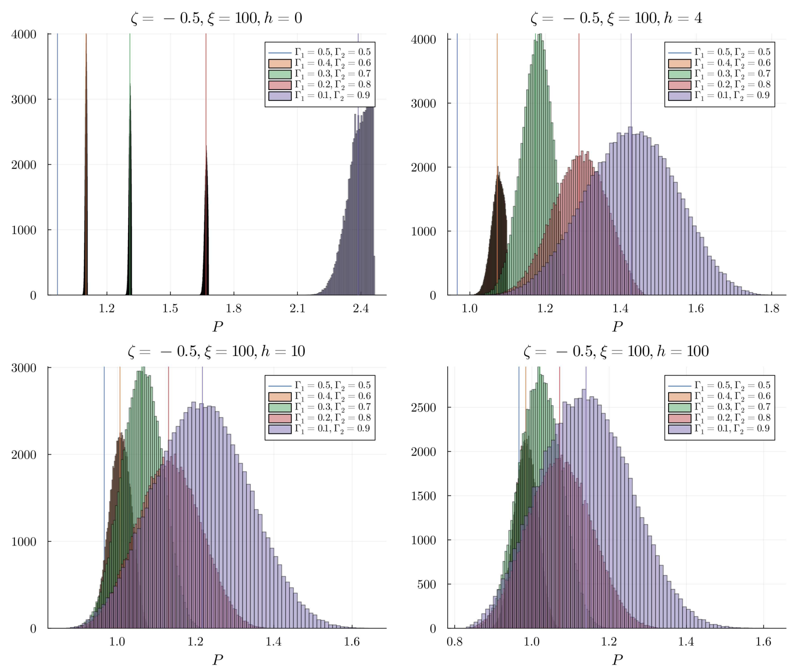

Figure 12: Histogram of the pollution stock after a 100 period burn-in period for various levels of political polarization and voter time horizons.

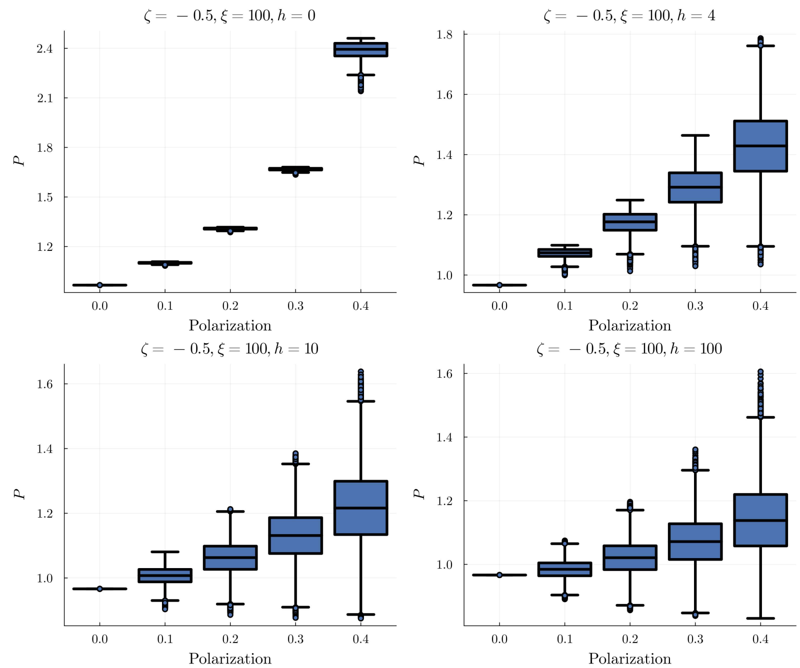

Figure 13: Boxplot of the pollution stock after a 100 period burn-in period for various levels of political polarization and voter time horizons.

up to some (possibly infinite) time horizon, assuming the current pollution stock remains constant and vote probabilistically. I focus on how voter time horizons and issue salience influence the strategies of policy-motivated parties. My findings reveal several key insights into the interplay between electoral considerations and environmental outcomes.

First, the limited time horizons of voters significantly constrain the green party's ability to advocate for ambitious climate policies. When voters prioritize short-term effects, the green party must align its policies closely with those of the brown party to remain politically viable, often at the expense of long-term environmental quality. Conversely, as voter horizons extend, the green party's policies become more progressive, and the brown party adjusts its strategies to remain competitive. This dynamic underscores the critical role of voter education and awareness in shaping the political feasibility of sustainable environmental policies.

Second, the salience of environmental issues produces counterintuitive effects. When the climate issue is less salient, voters are less reactive to immediate costs associated with higher emissions taxes, enabling the green party to pursue more robust policies

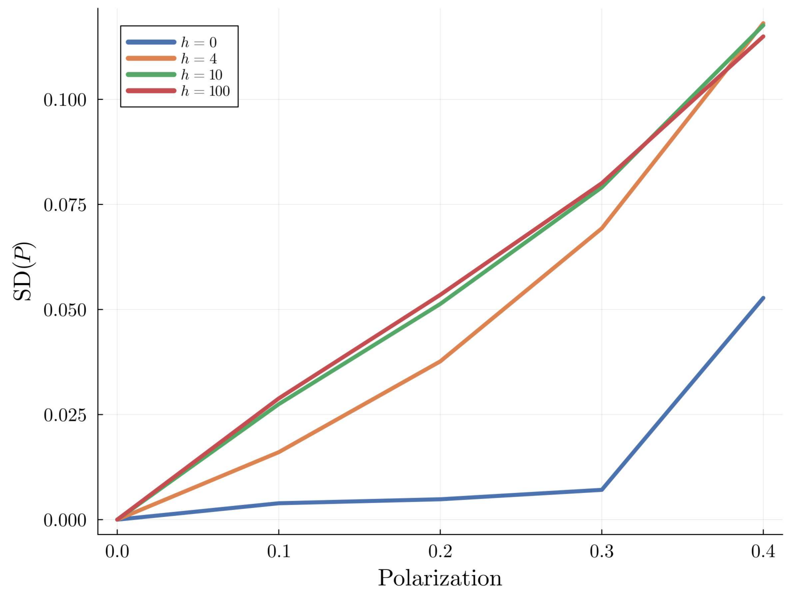

Figure 14: Standard deviation of the pollution stock after a 100 period burn-in period for various levels of political polarization and voter time horizons.

without eroding its electoral base. This paradox highlights the complexities of issue salience in electoral dynamics and its implications for policy outcomes.

Lastly, increased political polarization exacerbates both the level and volatility of pollution stocks. Higher polarization amplifies the divergence in party platforms, leading to more pronounced swings in policy implementation, depending on electoral outcomes. While longer voter horizons mitigate the average pollution levels, they fail to stabilize the system's inherent volatility, emphasizing the dual challenge of addressing polarization and fostering forward-looking voter behavior.

These findings contribute to our understanding of the political economy of climate policy, illustrating the tension between democratic processes and the urgency of environmental sustainability. Future research could explore mechanisms to align electoral incentives with long-term environmental goals, such as fostering bipartisan agreements or enhancing voter engagement on intergenerational issues. By illuminating the structural factors driving suboptimal environmental outcomes, this study aims to inform both theoretical advancements and practical policy interventions in the realm of political competition and environmental governance.

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A Election Probabilities

Plugging in the functional form of b and e we get

$$\Delta W_k^{ij}(P;h) = \frac{1}{\zeta}\left(\tau_j^{\zeta} - \tau_i^{\zeta}\right) - \rho\frac{\gamma_k}{2}\left(\frac{1-\rho^{h+1}(1-\delta)^{2(h+1)}}{1-\rho(1-\delta)^2}\left(\tau_i^{2(\zeta-1)} - \tau_j^{2(\zeta-1)}\right)\right.$$
$$\left. +2\frac{1-\Big(\rho(1-\delta)\Big)^{h+1}}{1-\rho(1-\delta)}(1-\delta)\,P\left(\tau_i^{\zeta-1} - \tau_j^{\zeta-1}\right)\right). \tag{28}$$

This expression is linear in γ_k and can be written as $\Delta W_k^{ij} = X + \gamma_k Y$, where $X = \frac{1}{\zeta}\left(\tau_j^{\zeta} - \tau_i^{\zeta}\right)$ and

$$Y(h) = -\frac{\rho}{2}\left[\frac{1-\rho^{h+1}(1-\delta)^{2(h+1)}}{1-\rho(1-\delta)^2}\left(\tau_i^{2(\zeta-1)} - \tau_j^{2(\zeta-1)}\right)\right.$$
$$\left. +2\frac{1-\Big(\rho(1-\delta)\Big)^{h+1}}{1-\rho(1-\delta)}(1-\delta)\,P\left(\tau_i^{\zeta-1} - \tau_j^{\zeta-1}\right)\right]. \tag{29}$$

Note that X is independent of the time horizon as it only relates to the difference in immediate benefits. The term Y is the difference in the future damages that will be incurred as a result of the policy.

Substituting $\Delta W_k^{ij} = X + Y\,\gamma_k$ into the probability that party i wins the election, Equation (20) and assuming that $\gamma_k \sim \text{Unif}[0,1]$, the overall probability that party i wins is:

$$\theta_i = \int_0^1 \frac{1}{1+\exp\Big(-\xi\,(X + Y\,\gamma_k)\Big)}\,d\gamma_k. \tag{30}$$

Let $u = \xi\,(X + Y\,\gamma_k)$, so:

$$\gamma_k = \frac{u - \xi\,X}{\xi\,Y}, \tag{31}$$

$$d\gamma_k = \frac{1}{\xi\,Y}\,du. \tag{32}$$

Adjusting the limits of integration:

$$u_{\min} = \xi X\,, \tag{33}$$
$$u_{\max} = \xi(X+Y)\,. \tag{34}$$

The integral becomes:

$$\theta_i = \frac{1}{\xi Y}\int_{u_{\min}}^{u_{\max}} \frac{1}{1+e^{-u}}\,du. \tag{35}$$

The integral of the logistic function is:

$$\int \frac{1}{1+e^{-u}}\,du = \ln\left(1+e^{u}\right) + C. \tag{36}$$

Therefore:

$$\begin{aligned}\theta_i &= \frac{1}{\xi Y}\left[\ln\left(1+e^{u}\right)\right]_{u_{\min}}^{u_{\max}} \\ &= \frac{1}{\xi Y}\left(\ln\left(1+e^{\xi\,(X+Y)}\right) - \ln\left(1+e^{\xi\,X}\right)\right).\end{aligned} \tag{37}$$