Taxes, Public Goods and Policies of (In)Competent Politicians *

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Abstract

This paper examines the equilibrium relationship between politics and the economy. I consider a repeated-election model with policy and office motivated politicians. The incumbent politician chooses a tax rate and oversees the activities of the private and public sectors. Politicians differ in their ability to increase the productivity of the private sector, and in their ability to transform tax revenues into public goods. Voters differ in their productivities and tastes. I solve for the stationary equilibrium of the model and show how each underlying characteristic of the heterogeneous agents affects: policy choices, voting behavior, the output of the private and public sectors, and welfare of different voters. In equilibrium, the politician's ability defines both her budget *and* political constraints; the combined effect of these constraints endogenously displaces competence as a valence issue. I also present a mechanism through which economic growth may foster the selection of better office holders.

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1 Introduction

A central goal of political economy is to understand the relationship between the political environment and the real economy. In order to explain economic policy, Persson and Tabellini (2000) highlight the importance of explicitly modeling the microfoundations of both economic behavior and political behavior, and the importance of taking a general equilibrium approach (economic and political outcomes should be mutually consistent). Several questions arise from the equilibrium relationship between politics and economics: How do politicians choose economic policies? How do economic policies affect economic decisions by individual agents, and what are their consequences for the aggregate economy? How do these consequences affect voters' preferences over policies (and over politicians), and how do they affect voting behavior and electoral outcome? Finally, how does this cycle influence choices by politicians in office? This paper examines all these questions.

In particular, this paper examines how the underlying characteristics (productivity and taste) of the heterogeneous agents (politicians and voters) affect political and economic behavior, and welfare of different voters. That is, the main goal of this paper is to advance the understanding of the microfoundaments of the general equilibrium involving politics and economics.

To do this, I develop a political economy model that incorporates a production economy into a repeated-election framework. In the model, politicians are both policy and office motivated: they care about holding office and which policy is implemented. There are two sectors —public and private— and politicians have heterogeneous preferences over the outcomes of each sector. Politicians also differ in their multidimensional *executive skill vector* — each politician has an inherent ability to increase the productivity of the private sector, and to transform tax revenues into public goods. Voters differ in their productivities and tastes. At the beginning of each period, the incumbent politician chooses a linear income tax rate, which distorts labor choices, and oversees the activities of the private and public sectors. In equilibrium, voters and politicians account for the incentive effects of taxes on the aggregate labor supply when evaluating different tax rates. At the end of each period, a majority-rule election takes place and voters choose whether to keep the incumbent or to elect an untried challenger. Voters observe the incumbent politician's performance in office. As a result, voters know more about the incumbent politician, and have less information about untried challengers.

Politicians cannot commit to policies, but they are electorally accountable for their actions in office — politicians are free to choose taxes, but they can be ousted from office by voters in the following election. This creates an important political agency problem: different politicians have different incentives to distort the economy in their own benefit, while different voters have different preferences over economic outcomes. The endogenous re-election constraints imposed by the electoral process, and the equilibrium choices of tax rates by politicians, are intricate functions of agents' characteristics.

I solve for the stationary equilibrium of the model and show that, although voters differ in multiple dimensions (productivity and taste), preferences over taxes and voting behavior can be represented by a unidimensional *social type*, which represents the individual-specific trade off between the private and public goods. Fixing a politician's skill vector, individuals with a lower social type prefer higher tax rates, while higher social type individuals prefer lower tax rates. The voter with the median social type is decisive: an incumbent politician is re-elected if and only if she is supported by the median voter.

Equilibrium is characterized by a series of cutoff functions. Politicians with sufficiently low skill vectors are never re-elected; they implement their preferred policy and are ousted from office. In the benchmark version of model, politicians with sufficiently high skill vectors are endogenously divided into three groups. Politicians with centrist social types — politicians with preferences over outcomes sufficiently similar to the median voter's preferences— can implement their preferred policy and be re-elected. Politicians with moderate types do not implement their preferred policy; they choose to compromise and implement a policy closer to the median voter's preferred policy, in order to win re-election. Politicians with extreme preferences implement their preferred tax rate and lose re-election.

How does a politician's ability affect her equilibrium behavior and the welfare of different voters? The behavior of politicians is defined by both economic considerations (the underlying trade off between the consumption of private and public goods) and political considerations (re-election implications of different tax rate choices). A politician's executive skill vector affects her budget constraint, i.e., her ability to transform tax revenues into public goods. It also affects her re-election constraint, since in equilibrium the decisive median voter grants more lenient re-election cutoffs to more able politicians. As a result, politicians with different abilities face different budget and political constraints. In a series of propositions, I describe the implications of the interaction between these two constraints, and show how important it is to consider the effects of ability on *both* constraints. In equilibrium, the magnitude and sign of the changes in policy choices as a function of politician's ability depend on which constraint dominates.

Proposition 1 describes how each executive skill dimension affects policy choices and welfare of different voters *when politicians are not constrained by re-election considerations* — centrist and extremist politicians. When the political constraint does not bind, a politician chooses the tax rate that maximizes her own preferences over outcomes, given her three-dimensional skill vector:

• *Public Sector Fixed Costs:* A politician's ability to reduce government waste (to lower government's fixed costs) does not affect the marginal trade off between private and public consumption. A politician who is better at lowering fixed costs provides more public goods without decreasing private good consumption, which benefits all voters.

• *Private Sector Productivity:* In contrast, a politician with a higher ability to improve private sector productivity faces a different marginal trade off between private and public consumption, and chooses to implement a lower income tax. However, I find that she does not decrease the amount of public goods provided — the income effect dominates the substitution effect between public and private goods. A higher consumption of public and private goods benefits all voters.

• *Public Sector Productivity:* Finally, a politician with higher ability to increase the marginal productivity of the public sector chooses to implement a higher income tax and provides more public goods. In this case, every individual consumes less private goods, due to the higher income tax and lower labor supply. Consequently, this change *benefits* voters who have relative preferences for public goods equal to or higher than the politician, but *hurts* voters who have sufficiently lower relative preferences for the public good.

Propositions 2 and 3 consider politicians *who are constrained by re-election considerations* — moderate politicians who must compromise in order to be re-elected. The politician's skill vector not only affects the marginal trade off between private and public goods, but also the re-election cutoff. In equilibrium, I prove that politicians with higher ability can implement more extreme policies and be re-elected. This change in the political constraint has important economic implications. First, consider moderate politicians with social types to the left of the median voter. In order to be re-elected, these left-moderate politicians need to implement taxes below their preferred (politically unconstrained) rates. More able left-moderate politicians can implement *higher* tax rates and be re-elected.

In particular, a left-moderate politician with a higher ability to influence the private sector productivity chooses to increase taxes so much that it *decreases* consumption of the private good. In this case, the effect of the change in the political constraint dominates the effect of the change in the budget constraint described by Proposition 1, which would point towards a decrease in tax rate and an increase in private consumption.

The political constraint change also has important welfare implications. We know from Proposition 1 that a politically unconstrained incumbent with higher ability to influence the private sector productivity delivers higher private and public consumption, which *benefits all voters*. In contrast, a more competent left-moderate politician, constrained by re-election considerations, offers more public goods, leaving the median voter *indifferent* to the loss of private consumption. Because voters trade off public and private consumption differently, the higher public good production and lower private consumption *benefits* all voters to the left of the median voter, but *hurts* all voters to the right — they value the public good relatively less.

The opposite is true for right-moderate politicians. Their re-election constraint binds, so they implement a tax rate above their bliss point. In equilibrium, more competent right-moderate politicians can implement lower tax rates and be re-elected. In particular, a right-moderate politician who is better at increasing the marginal productivity of the public sector chooses a tax rate so much lower that it decreases provision of the public good. The trade off between more private consumption and less public goods benefits all voters to the right of the median, but hurts all voters to the left.

Political constraints may also generate conflict between voters on the same side of the social type distribution. For example, consider a left-extremist politician with low skill who implements a high tax rate and loses re-election. A marginal increase in her ability results in a more lenient re-election cutoff. If she chooses to compromise to the new re-election cutoff (that is, to reduce her implemented tax rate to become left-moderate), then the moderation would decrease the expected discounted payoff of voters with social types sufficiently to the left of the politician. That is, sufficiently extreme voters prefer extreme politicians, even though these politicians lose re-election.

Finally, I extend the model and consider an exogenous rate of technological progress. Under some conditions on the parameters of the model, I solve for the stationary political equilibrium with productivity growth. I prove that the equilibrium in an economy with productivity growth is equivalent to the equilibrium in a similar economy without growth, but with more patient agents. The intuition behind this result is simple. If in the next period the economy will be twice as productive as today's economy, then voters and politicians will be more concern about future policy choices, since they will affect a larger economy. In particular, for the decisive median voter, having in the next period a politician who is more competent and implements a policy closer to the median voter's preferred policy is more important when the exogenous rate of productivity growth is larger.

The decisive median voter has the option of voting extremist, incompetent politicians out of office. Consequently, technological progress may increase the option value of replacing the incumbent politician for an untried challenger who *could* be more competent and have preferences closer to the median voter's preferences. If this is the case, then a higher rate of economic/productivity growth induces the decisive median voter to adopt more restrictive re-election cutoffs, so that re-elected politicians are expected to be more competent and implement policies closer to the median voter's preferred policy.

1.1 Related Literature

A broad literature studies different aspects of the interaction between politics and economics. An important branch of this literature studies how the political arena influences (and is influenced by) the government's fiscal policies. That is, it studies the connection between politics, the equilibrium choices of taxes, the level of income distribution, and the provision of public goods.

In the Ramsey approach to optimal taxation, a social planner (government) maximizes its objective function (social welfare), given that agents are in a competitive equilibrium, and given a restricted set of available distortionary tax instruments (usually linear taxes). The original approach assumes that the government can make binding policy choices, which potentially generates time inconsistency. The Ramsey approach was then extended to consider the case without commitment, as a game between the policymaker and the economic agents (see Golosov and Tsyvinski, 2008a,b). Another shortcoming of the original approach is the fact that, in practice, policies are not chosen by a benevolent government. Economic policies are an endogenous result of the political environment, in particular, the actions of heterogeneous, strategic politicians.

Londregan (2006) points out that restricted tax schemes have become a standard building block of more sophisticated models of economic activity and political decision making. In a classic paper, Meltzer and Richard (1981) build upon Romer (1975) and Roberts (1977) to study how different voting rules affect the equilibrium choice of a distortionary linear income tax. Rogoff and Sibert (1988), Rogoff (1990), and Krasa and Polborn (2009 and 2011) consider politicians with *heterogeneous ability* to produce a public good. Austen-Smith (2000) considers parties with *heterogeneous preferences* in terms of economic payoffs — each party seeks to promote the interests of the average member of the occupation it represents[1]. Acemoglu, Golosov, and Tsyvinski (2011) examine a taxation model with homogeneous politicians, and focus on the *political agency problem*[2] created by the rent-seeking behavior of self-interested politicians who cannot commit to policies

Other authors take a different approach, considering more general tax schemes, but simpler political environments. Acemoglu, Golosov, and Tsyvinski (2008 and 2010) have expanded the optimal non-linear taxation framework originated by Mirrlees (1971) to study dynamic non-linear taxation under political economy constraints. However, these models assume that politicians are homogeneous — they have the same ability to manage government activities, and the same preferences over policy outcomes.

This paper follows the first approach. I consider a distortionary linear income tax and focus on a sophisticated political environment, where strategic politicians have heterogeneous ability *and* heterogeneous preferences. Politicians cannot commit to policies, which creates

[1] Austen-Smith (2000) considers alternative collective decision schemes: proportional representation with legislative bargaining and simple majority rule with winner-take-all legislative decision making. Battaglini and Coate (2008) and Barseghyan, Battaglini and Coate (2010) also consider a political framework where policy decisions are made by a legislature.

[2] See also the earlier work on electoral accountability by Barro (1973) and Ferejohn (1986).

a political agency problem.

I incorporate a production economy into the repeated election framework introduced by Duggan (2000). Two important features of this framework are that the electorate knows more about an incumbent politician than an untried opponent, and that re-election considerations endogenously discipline the behavior of incumbent politicians. Duggan (2000) considers an one-dimensional policy space without valence. In equilibrium, cutoff rules characterize how the median voter selects between candidates, and the platforms that incumbents with different ideologies adopt. Bernhardt, Câmara and Squintani (2011) integrate valence to the model, and show how the endogenous cost of compromising and the re-election standard varies with valence levels, and derive the consequences for voter welfare. Banks and Duggan (2008) consider a multidimensional policy space without valence, where politicians have access to a common set of feasible policies. In contrast, my model examines a production economy where politicians have a heterogeneous multidimensional skill vector, and hence face a heterogeneous production possibility frontier.

My results are also related to the valence literature in political economy, originated by Stokes (1963). *Ceteris paribus*, a variable v represents a *valence issue* if the period utilities of all voters increase in v; variable y represents a *position issue* if period utilities of some voters increase in y, while period utilities of other voters decrease in y. However, Stokes (1992) points out that a valence issue can be displaced by a position issue if the public sees a trade off between two high-consensus goals. This is the case in my model: there is a trade off between private and public goods, and both the budget and the political constraints endogenously displace competence as a valence issue.

The paper is organized as follows. Section 2 presents the model. Section 3 characterizes the equilibrium. Section 4 details how the underlying characteristics of agents affect political and economic behavior, and the welfare of different voters. Section 5 extends the model. Section 6 concludes. An appendix contains all proofs.

2 The Model

Overview: I consider an infinitely-repeated election model in which a private good c and a public good g are produced each period. Voters differ in their individual ability α to produce the private good, and they differ with regard to their marginal utility β from consuming the public good. Politicians differ with regard to their preferences over the outcomes of the private and public sectors, and they differ in their executive skills, represented by the vector $\theta = (\theta_c, \theta_v, \theta_g)$. This vector captures the office holder's competence, her inherent ability to govern the private and public sectors, that is, to manage government resources and the economy. θ_c represents the politician's ability to increase the productivity of the private sector, while θ_v and θ_g represent the politician's ability to increase the output of the public sector (to transform tax revenues into public goods). θ_v represents a fixed cost (or waste) and θ_g a marginal productivity (or efficiency) dimension.

Each period the incumbent politician must (i) choose a linear income tax $\tau \in [0, 1]$, (ii) manage the production of the public good g, and (iii) oversee the private sector's production of good c. Each voter optimally chooses an effort level n to produce the private good, given his own characteristics, the set of observable characteristics of the incumbent politician, and the implemented tax rate. At the end of each period an election takes place, and voters decide whether to keep the incumbent or to elect an untried challenger.

Voters: There is a continuum of measure one of infinitely-lived voters. Each voter is endowed with an individual productivity parameter $\alpha \in A \equiv [\underline{\alpha}, \overline{\alpha}]$, $0 < \underline{\alpha} \leq \overline{\alpha} < \infty$, and an individual preference parameter $\beta \in B \equiv [\underline{\beta}, \overline{\beta}]$, $0 < \underline{\beta} \leq \overline{\beta} < \infty$. These characteristics are jointly distributed according to the twice differentiable c.d.f. $F(\alpha, \beta)$ with support $A \times B$. This distribution is common knowledge. Voters are heterogeneous: the set $A \times B$ has an interior point. Notice that my model incorporates homogeneous productivity or homogeneous preferences as special cases. Moreover, preference parameter β might be correlated with productivity α or not. No assumption on symmetry or single peakedness of the p.d.f. is imposed.

Voter Preferences: Per period utility is given by a function $u(c, g, n|\beta)$: each voter derives utility from the consumption of private good c, from the consumption of public good g provided by the government, and dislikes effort n. I consider preferences that take the form[3]

$$u(c, g, n|\beta) \quad = \quad c + \beta g - \mu \frac{n^\sigma}{\sigma}, \tag{1}$$

[3]One can extend the main results to preferences of the form $u(c, g, n|\beta) = \frac{c^{\sigma_1}}{\sigma_1} + \beta \frac{g^{\sigma_2}}{\sigma_2} - \mu \frac{n^{\sigma_3}}{\sigma_3}$, given the appropriate assumptions on the parameters.

where $\mu > 0$ and $\sigma > 0$ are common preference parameters, and β is the voter-specific marginal utility from the consumption of the public good[4]. If $\underline{\beta} = \overline{\beta} = 1$, then voters have the homogeneous utility function $u(c, g, n) = c + g - \mu \frac{n^\sigma}{\sigma}$. Voters discount the future by $\delta \in (0, 1)$.

Private Good: At each period, each voter must choose an effort level $n \geq 0$. A voter with individual productivity parameter α working n earns a pretax income $y = \theta_c \alpha n^\gamma$, where γ is an exogenous technology parameter, $0 < \gamma < \sigma$, and $\theta_c > 0$ represents the incumbent politician's ability to stimulate the economy and increase the private sector's productivity. That is, θ_c captures the politician's impact on the economy's Total Factor Productivity. For example, an incumbent politician could affect TFP through her ability to: manage infrastructure, regulate the private use of public resources, cut red-tape for businesses, etc.[5]

Given the linear income tax τ implemented by the incumbent and her ability θ_c, an individual with productivity α who chooses to work n consumes

$$c = (1 - \tau)y = (1 - \tau)\theta_c \alpha n^\gamma$$

units of the non-storable private good c (there are no savings).

Public Good: Given the implemented linear income tax τ and pretax income y of each voter, let Y represent the total pretax income of the economy. The government uses the total tax revenues τY to produce the public good g according to a given production technology, and the government's budget must balance each period— in this paper I abstract from savings to focus on the trade off between current consumption of private and public goods.

[4]The individual taste parameter β can represent selfish and altruistic motives. For example, consider g to be the government's provision of street lights. Voters that use the streets at night more often will tend to highly value this public good (will have a higher β). Moreover, some voters might have a high β not because they consume g directly, but because they care about the consumption of g by other citizens (they value street lights because they care about the safety of others using the streets at night).

[5]One can extend the main results to an economy with a stochastic Total Factor Productivity Z. Realized pretax income is $y = Z\alpha n^\gamma$, where $Z > 0$ is an increasing function of a random variable ζ and the politician's ability θ_c. A high-ability politician would then be able to reduce (increase) the likelihood of negative (positive) shocks in the economy (e.g., avoid financial crises by better auditing financial institutions), and/or would be able to reduce (increase) the negative (positive) effects of realized shocks (e.g., better manage government response to natural disasters).

I consider politicians who might differ in their ability to transform tax revenue into public goods in two dimensions: a fixed cost (or waste) dimension θ_v and a marginal productivity (or efficiency) dimension θ_g. Specifically, a politician with ability parameters $\theta_v \leq 0$ and $\theta_g > 0$ produces

$$g = \theta_v + \theta_g(\tau Y)^{\psi},$$

where $\psi \in (0,1]$ is an exogenous technology parameter common to all politicians. Hence, politicians with higher θ_v and/or θ_g can produce more public goods using the same tax revenues.[6] For example, a politician with higher executive skills (θ_v, θ_g) has stronger leadership abilities, is more efficient, and can better identify waste and cost saving opportunities. In the particular case where $\theta_v = 0$ and $\theta_g = 1$ for every politician, $\beta = 1$ for every voter, and $\psi = 1$, we can interpret τ and g as a standard system of income transfer between voters: income tax rate τ distorts labor choices, and g is a standard lump sum transfer. The more general formulation of my model allows us to consider a broader interpretation of g.

Politicians: There is a continuum of measure one of infinitely-lived politicians. Politicians are policy motivated — each politician is endowed with preferences over the outcomes in the private and public sectors.[7] The per period utility $\tilde{u}(i)$ of politician i (or her social objective function) captures her preferences over economic outcomes. $\tilde{u}(i)$ is given by the following weighted average of the per period utility of voters $(\alpha, \beta) \in A \times B$,

$$\tilde{u}(i) = \int_A \int_B u(c, g, n|\alpha, \beta) s_i(\alpha, \beta)\, d\alpha\, d\beta, \tag{2}$$

where $s_i(\alpha, \beta) \geq 0$ represents the relative weight that politician i attaches to the utility of voter (α, β). Therefore, the preferences over economic outcomes of a given politician i are captured by her social weight function $s_i : A \times B \to \mathbb{R}_+$, where $\int_A \int_B s_i(\alpha, \beta)\, d\alpha\, d\beta = 1$.

Standard optimal income tax problems consider politicians with homogeneous preferences — politicians (or simply the benevolent government) want to maximize a common social

[6] Krasa and Polborn (2009) consider a similar production technology. Rogoff and Sibert (1988) and Rogoff (1990) consider a public goods production technology with a *positive* shift parameter. My main results are not affected if θ_v takes on positive values.

[7] In section 5, I consider the case where politicians receive an ego rent each period in office, so that they are both policy and office motivated.

welfare function. My formulation allows us to consider the relevant case in which there is *disagreement* among politicians regarding their preferences over economic policies, because different politicians assign different weights to the utility of different voters. The flexibility of the social weight function s_i also allows us to consider many different underlying foundations for a politician's economic preferences. For example, a politician with a social weight function s_i equal to the probability density function of (α, β) in the population corresponds to a standard utilitarian social planner. Alternatively, some politicians might prefer policies that favor groups with lower ability α and higher preference β for public goods, while other politicians might prefer policies that favor voters with higher α and lower β. This could represent, for instance, the influences of interest groups closely related to that particular politician. As a final example, consider the limiting case, when s_i is degenerate and assigns all weight to some voter (α', β'), so that $\tilde{u}(i) = u(c, g, n|\alpha', \beta')$. This case corresponds to a standard citizen-candidate model.

Politicians discount the future by δ. Incumbent politician i chooses a policy that maximizes the expected discounted value of $\tilde{u}(i)$. Hence, the incumbent politician cares about the current and future implications of her policy, in particular, the re-election consequences of her actions when in office.

For politician i with social weight function s_i, define social preference parameters $\alpha_i \equiv [\int_A \int_B \alpha^{\frac{\sigma}{\sigma-\gamma}} s_i(\alpha, \beta)\, d\alpha\, d\beta]^{\frac{\sigma-\gamma}{\sigma}}$ and $\beta_i \equiv \int_A \int_B \beta s_i(\alpha, \beta)\, d\alpha\, d\beta$. It will become clear from equation (6) below that, under economic equilibrium (when each voter optimally chooses effort n), we can rewrite the per period utility of the politician as $\tilde{u}(i) = u(c, g, n|\alpha_i, \beta_i)$. Therefore, without loss of generality, the economic preferences of politician i (that is, her social weight function s_i) are fully captured by a two-dimensional vector (α_i, β_i): politician (α_i, β_i) receives a per period utility $u(\cdot)$ equal to that of a voter with ability α_i and preference parameter β_i.

Each politician i is then endowed with a pair of social preference parameters (α_i, β_i) and an executive skill vector $\theta = (\theta_c, \theta_v, \theta_g)$. These characteristics are jointly distributed according to the twice differentiable c.d.f. $H(\alpha_i, \beta_i, \theta)$ with support $A \times B \times \Theta$. Let $\Theta = [\underline{\theta}_c, \overline{\theta}_c] \times [\underline{\theta}_v, \overline{\theta}_v] \times [\underline{\theta}_g, \overline{\theta}_g]$, $0 < \underline{\theta}_c \leq \overline{\theta}_c < \infty$, $-\infty < \underline{\theta}_v \leq \overline{\theta}_v \leq 0$, and $0 < \underline{\theta}_g \leq \overline{\theta}_g < \infty$. Define the measure of executive skill heterogeneity $\Delta\theta = \max\{\overline{\theta}_c - \underline{\theta}_c, \overline{\theta}_v - \underline{\theta}_v, \overline{\theta}_g - \underline{\theta}_g\}$.

The cases where politicians have homogeneous ability in one, two, or all three dimensions are special cases of this model. Moreover, I do not assume that the probability distribution over politicians' social preference parameters (α_i, β_i) must be the same as the probability distribution over voters' characteristics (α, β). Hence, the model accounts for a possible selection effect — the social preference parameter distribution of politicians might be different than that of voters, e.g., due to self-selection of individuals into politics, or selection of candidates by political organizations. The model also allows for correlation between the different attributes of a politician. For example, it might be that, on average, politicians with higher preferences β_i for public goods are better at producing them (have a higher θ_g). No assumption on symmetry or single peakedness of the p.d.f. is imposed.

Social preference parameters (α_i, β_i) are private information to the politician. Executive skill vector θ is initially private information of a candidate before she holds office, but her performance in office reveals her ability to the electorate. Probability distribution $H(\cdot)$ is common knowledge.

Elections: I consider an infinitely repeated election framework similar to Bernhardt, Câmara and Squintani (2011), who integrate valence to the model of Duggan (2000).

At the beginning of period $t = 0$, a random politician drawn from $H(\alpha_i, \beta_i, \theta)$ is in office. At the end of each period $t \geq 0$, a majority-rule election takes place between the incumbent politician and a random challenger drawn from $H(\cdot)$. Voters know H but not the realized characteristics of the challenger; voters know ability θ and implemented policy τ for the incumbent, but not her social preference parameters (α_i, β_i).

I assume that voters adopt the weakly dominant strategy of voting for the candidate who they believe will provide them strictly higher discounted lifetime utility if elected—citizens vote sincerely. I assume that a voter who is indifferent between an incumbent and an untried challenger selects the incumbent (in equilibrium, a measure zero of voters is indifferent).

Timing: At the beginning of each period $t \geq 0$, an incumbent with social preference parameters (α_i, β_i) and executive skill vector θ chooses and implements a linear income tax $\tau \in [0, 1]$. Voters then observe θ and τ, but not (α_i, β_i). Each voter chooses an effort n, production takes place and voters pay taxes. The politician uses the tax revenue to produce the public good. Private and public goods are consumed, and voters and politicians realize their respective period-payoffs. A random challenger is then drawn from $H(\cdot)$ to compete against the incumbent politician.[8] A majority-rule election takes place: given the information about candidates, citizens vote for their preferred candidate (voters know H but not the realized characteristics of the challenger; voters know the ability θ and implemented policy τ of the incumbent). The winning politician assumes office and period $t+1$ starts.

3 Equilibrium

I focus on stationary, stage-undominated perfect Bayesian equilibrium (PBE). Voters choose effort n that maximizes expected discounted payoff, and vote for the candidate who they believe will provide them strictly higher discounted lifetime utility if elected. Incumbent politicians choose policies that maximize their expected discounted payoff.

3.1 Economic Equilibrium

At each period t, after observing an incumbent's executive skill vector θ and implemented tax τ, each voter (α, β) chooses effort $n \geq 0$ and consumption $c \geq 0$. The choices of n and c by any given infinitesimal voter do not affect aggregate tax revenues: the production choices of any given individual do not affect the amount g of public goods produced or the outcome of future elections. Therefore, each voter chooses n and c to maximize his period utility $u(\cdot)$ subject to his budget constraint,

$$\begin{aligned} \max_{n\geq 0, c\geq 0} \quad & c + \beta g - \mu \frac{n^\sigma}{\sigma} \\ \text{s.t.} \quad & c \leq (1-\tau)\theta_c \alpha n^\gamma. \end{aligned} \tag{3}$$

I show in the appendix that the optimal effort n^* is given by

$$n^*(\alpha, \tau, \theta) = \left[\frac{\gamma(1-\tau)\theta_c\alpha}{\mu}\right]^{\frac{1}{\sigma-\gamma}}.$$

[8] All qualitative results hold if, after adopting her policy, with probability $q \in [0, 1)$ the incumbent receives an exogenous shock and cannot run for re-election. One can interpret this re-election shock as an unanticipated retirement for health or family issues.

Individual pretax income and consumption of the private good are

$$
\begin{aligned}
y^*(\alpha,\tau,\theta) &= \theta_c \alpha n^\gamma \;=\; \theta_c \alpha \left[\frac{\gamma(1-\tau)\theta_c\alpha}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}}, \\
c^*(\alpha,\tau,\theta) &= (1-\tau) y \;=\; (1-\tau)\theta_c \alpha \left[\frac{\gamma(1-\tau)\theta_c\alpha}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}}.
\end{aligned}
$$

n^*, y^* and c^* are not affected by the amount g of public goods provided or the individual preference parameter β, and are zero if $\tau = 1$. When $\tau < 1$, optimal effort, income and private consumption are all strictly positive, strictly decreasing in τ, and strictly increasing in both the voter's productivity α and the politician's ability to influence marginal productivity of the private sector, θ_c.

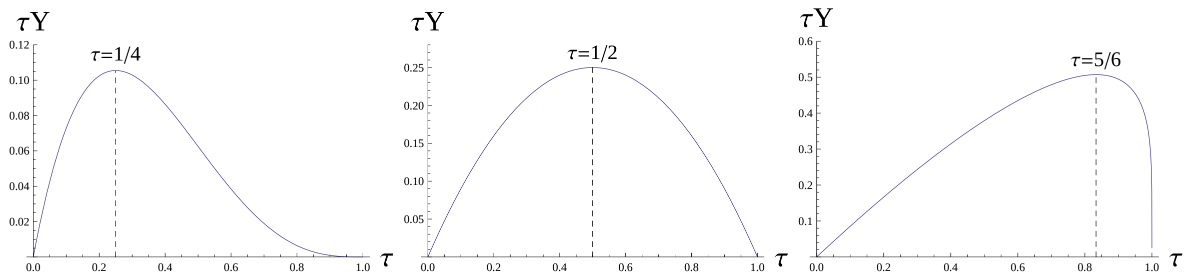
The resulting aggregate tax revenue τY is

$$
\begin{aligned}
\tau Y^*(\tau,\theta) &= \tau \int_{A\times B} y^*(\alpha,\tau,\theta)\; dF(\alpha,\beta) \\
&= \tau \int_{A\times B} \theta_c \alpha \left[\frac{\gamma(1-\tau)\theta_c\alpha}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}} dF(\alpha,\beta) \\
&= \tau\theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}} \int_{A\times B} \alpha^{\frac{\sigma}{\sigma-\gamma}} dF(\alpha,\beta) \\
&= \tau\theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}} \Omega, \qquad (4)
\end{aligned}
$$

where $\Omega \equiv \int_{A\times B} \alpha^{\frac{\sigma}{\sigma-\gamma}} dF(\alpha,\beta)$ is a measure of the aggregate ability endowment of the economy. There is a measure one of voters, so Ω is also the average value of $\alpha^{\frac{\sigma}{\sigma-\gamma}}$ in the population. Tax revenues are a strictly quasi-concave function of the tax rate. Revenues are zero if τ is either 0 or 1, reaching a maximum at $\tau = \frac{\sigma-\gamma}{\sigma}$. Hence, the tax revenue function resembles a Laffer Curve. Figure 1 depicts aggregate tax revenue as a function of tax rate, for different parameter values.

An incumbent politician with executive skill vector θ who implements tax rate τ uses the tax revenue to produce the following amount of public goods,

$$
\begin{aligned}
g^*(\tau,\theta) &= \theta_v + \theta_g \big[\tau Y^*(\tau,\theta)\big]^\psi \\
&= \theta_v + \theta_g \left[\tau\theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}} \Omega\right]^\psi.
\end{aligned}
$$



(a) $\gamma = 1$, $\sigma = 4/3$ (b) $\gamma = 1$, $\sigma = 2$ (c) $\gamma = 1/2$, $\sigma = 3$

Figure 1: Aggregate Tax Revenue as a function of tax rate τ, for $\theta_c = \Omega = \mu = 1$ and different values of (γ, σ).

3.2 Short-Run Preferences

The period utility of voters is affected by the policy choice τ and characteristics θ of the incumbent. Taxes and a politician's ability characteristics affect utility both directly by changing disposable income and public goods, and indirectly by changing the optimal effort choices of voters. Abusing notation, I use the previous results on c^*, g^* and n^* to rewrite the period utility (1) of a voter as a function of his characteristics (α, β), and the politician's policy choice τ and executive skill vector θ,

$$u(\alpha, \beta, \tau, \theta) = c^*(\alpha, \tau, \theta) + \beta g^*(\tau, \theta) - \mu \frac{n^*(\alpha, \tau, \theta)^\sigma}{\sigma} \tag{5}$$

$$= \beta \left\{ \theta_v + \theta_g \left[\tau \theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu} \right]^{\frac{\gamma}{\sigma-\gamma}} \Omega \right]^\psi \right\} + \mu \left[\frac{\sigma - \gamma}{\sigma\gamma} \right] \left[\frac{\gamma}{\mu}(1-\tau)\theta_c \alpha \right]^{\frac{\sigma}{\sigma-\gamma}}. \tag{6}$$

The first term $\beta\left\{\theta_v + \theta_g\left[\tau\theta_c\left[\frac{\gamma(1-\tau)\theta_c}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}}\Omega\right]^\psi\right\}$ represents voter's period payoff derived from the consumption of the public good. The second term $\mu\left[\frac{\sigma-\gamma}{\sigma\gamma}\right]\left[\frac{\gamma}{\mu}(1-\tau)\theta_c\alpha\right]^{\frac{\sigma}{\sigma-\gamma}}$ represents voter's net period payoff derived from the consumption of the private good, net of taxes and the cost of effort.

Taxes: Lemma 1 below characterizes the preferred tax rate τ^* of each voter (α, β), as a function of incumbent's executive skill vector θ.[9] In the Appendix I prove that $u(\alpha, \beta, \tau, \theta)$

[9] To simplify presentation of the optimal choice of τ, I allow g to take negative values when the optimal tax rate τ^* does not cover the fixed cost θ_v. If $\psi < 1$ and $\underline{\theta}_v < 0$ is sufficiently close to zero, then the optimal tax rate τ^* always yields a positive g. The main results hold when we constrain the equilibrium choices of τ to be sufficiently high that $g \geq 0$, or when we consider positive shift parameters ($\underline{\theta}_v \geq 0$) as in the public goods production technology of Rogoff and Sibert (1988) and Rogoff (1990).

is a strictly quasi-concave function of τ. When solutions are interior, the preferred short-run tax rate τ^* of voter (α, β) is given by the first-order condition

$$\beta \frac{\partial g^*(\tau, \theta)}{\partial \tau} \quad = \quad y^*(\alpha, \tau, \theta). \tag{7}$$

In the increasing segment of the Laffer Curve (when $\tau < \frac{\sigma-\gamma}{\sigma}$ so that $\frac{\partial g^*(\tau,\theta)}{\partial \tau} > 0$), voters face a trade off between the private and public sectors: an increase in taxes increases the amount of public good provided, but decreases labor supply and private consumption. That is, it increases the period payoff from the public good, and decreases the period net payoff from the private good.

Fixing preference parameter β for public goods, voters with higher individual productivity α desire lower taxes to support greater private good consumption. Fixing individual productivity α, voters with higher preference parameter β for public goods prefer higher taxes to support more public goods from the government. From equation (6) we can see that, given any tax rate choice, the relevant voter's characteristics are completely captured by the ratio $x = \frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$, which I call the voter's *social type* or simply the voter's type.[10] Social type x describes how voter's productivity α interacts with his preference β for public goods to influence how he trades off between private and public goods. Voters with higher social type x have stronger relative preferences for private goods, and hence prefer lower taxes: the optimal tax rate τ^* (or voter's bliss point) is a decreasing function of voter's social type x.

Lemma 1 *Given incumbent's executive skill vector $\theta \in \Theta$, there exists a unique tax rate $\tau^*(x, \theta)$ that maximizes the period utility of a voter $(\alpha, \beta) \in A \times B$ with **social type** $x = \frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$:*

- *If $\psi = 1$ and $x \geq \theta_g \Omega$, then $\tau^*(x, \theta) = 0$;*
- *Otherwise, $\tau^*(x, \theta)$ is the unique $\tau \in (0, \frac{(\sigma-\gamma)}{\sigma})$ that solves the following first-order condition*

$$\tau^{-(1-\psi)}(1-\tau)^{\frac{-\gamma(1-\psi)}{\sigma-\gamma}} - \frac{\gamma}{\sigma-\gamma}\tau^{\psi}(1-\tau)^{\frac{-(\sigma-\gamma\psi)}{\sigma-\gamma}} \quad = \quad \frac{\theta_c^{\frac{\sigma(1-\psi)}{\sigma-\gamma}}}{\psi \theta_g \Omega^{\psi}} \left[\frac{\gamma}{\mu}\right]^{\frac{\gamma(1-\psi)}{\sigma-\gamma}} x. \tag{8}$$

The bliss point $\tau^*(x, \theta)$ decreases in voter's social type x — strictly decreases if $\tau^*(x, \theta) > 0$.

[10] Since a politician with social preference parameters (α_i, β_i) has a period utility equivalent to that of voter (α_i, β_i), I also use $x_i = \frac{\alpha_i^{\frac{\sigma}{\sigma-\gamma}}}{\beta_i}$ to represent the social type of politician i.

Equation (8) details the first-order condition (7). The RHS of (8) is strictly positive, and independent of τ. The LHS of (8) strictly decreases in τ. Thus, an increase in the RHS decreases τ^*. The LHS of (8) becomes zero when tax revenues are maximized, $\tau = \frac{\sigma-\gamma}{\sigma}$. Therefore, optimal taxes τ^* are always strictly less[11] than $\frac{\sigma-\gamma}{\sigma}$. If $\psi < 1$, then τ^* is strictly positive for all voters. When $\psi < 1$, the marginal output of the public sector goes to infinity as the tax rate (and consequently the tax revenue) goes to zero. Hence, even the voter with the highest productivity α and lowest preference β for the public good would choose a strictly positive tax rate. When $\psi = 1$, optimal tax rate takes the simple form

$$\tau^*(x, \theta|\psi = 1) = \begin{cases} \left[1 - \frac{x}{\theta_g \Omega}\right] \cdot \left[\frac{\sigma}{\sigma-\gamma} - \frac{x}{\theta_g \Omega}\right]^{-1} & \text{if } x \leq \theta_g \Omega \\ 0 & \text{if } x > \theta_g \Omega. \end{cases}$$

Voters with social type $x = \frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$ greater than $\theta_g \Omega$ prefer zero taxes (voters with high productivity and/or low marginal utility from the public good).

Figure 2 depicts how the period utility of voters varies with the tax rate for different parameters. In contrast to standard valence models, period utility is usually an *asymmetric* function of policy around voter's bliss point, and utility might be convex when tax rates are higher than voter's bliss point.

Politician's Ability: The model gives rise to important new considerations regarding the interaction between the ability of politicians and voter preferences.

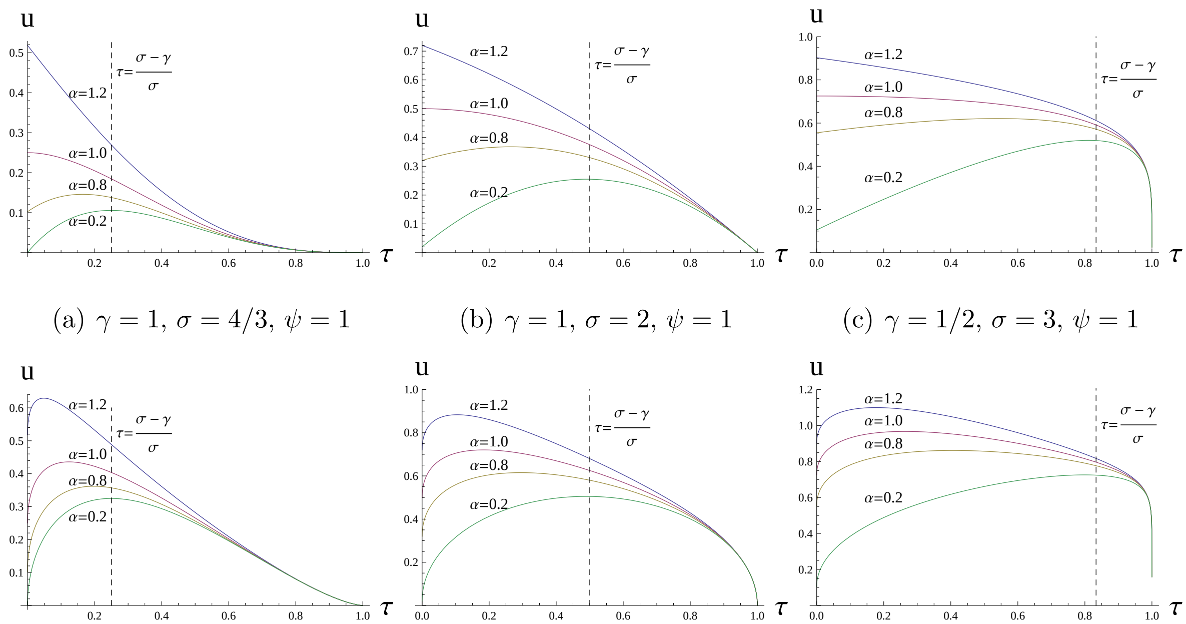
For a fixed tax rate τ, a marginal increase in the politician's executive skill dimension θ_v (ability to reduce government's fixed cost) increases the utility of each voter by β,

$$\frac{\partial u(\alpha, \beta, \tau, \theta)}{\partial \theta_v} = \beta.$$

When all voters have the same preference parameter β, this implies that the utility of *all* voters increase by the same amount, independently of the policy choice τ or individual productivity α. This is equivalent to the usual notion of additive valence in the voting literature.

A marginal increase in the politician's executive skill dimension θ_g (public sector produc-

[11]When $\tau < \frac{\sigma-\gamma}{\sigma}$, a marginal increase in taxes strictly decreases consumption of the private good and strictly increases consumption of the public good. When $\tau \geq \frac{\sigma-\gamma}{\sigma}$, a marginal increase in taxes strictly decreases the consumption of the private good, and does not increase the consumption of the public good.



(a) $\gamma = 1$, $\sigma = 4/3$, $\psi = 1$ (b) $\gamma = 1$, $\sigma = 2$, $\psi = 1$ (c) $\gamma = 1/2$, $\sigma = 3$, $\psi = 1$

(d) $\gamma=1$, $\sigma=4/3$, $\psi=1/2$ (e) $\gamma = 1$, $\sigma = 2$, $\psi = 1/2$ (f) $\gamma=1/2$, $\sigma=3$, $\psi=1/2$

Figure 2: Period utility as a function of tax rate τ, for $\theta_c = \Omega = \mu = \beta = \theta_g = 1$, $\theta_v = 0$, and different values of $(\gamma, \sigma, \psi, \alpha)$.

tivity) increases the utility of each voter by

$$\frac{\partial u(\alpha, \beta, \tau, \theta)}{\partial \theta_g} = \beta \left[\tau \theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu} \right]^{\frac{\gamma}{\sigma-\gamma}} \Omega \right]^{\psi}.$$

Here, however, the marginal increase depends on the policy choice τ. Intuitively, the utility of a voter increases faster as a function of θ_g when the politician is implementing intermediate values of tax τ that generate higher tax revenues. In other words, competence in managing public resources (higher θ_g) is more valuable when the politician runs a larger government. Moreover, the marginal effect of skill θ_g also depends on both the politician's skill θ_c (private sector productivity), and the macroeconomic variable Ω (the aggregate ability endowment of the economy).

The marginal effect of θ_c (private sector productivity) on the utility of voters is more intricate. It can be decomposed into two components,

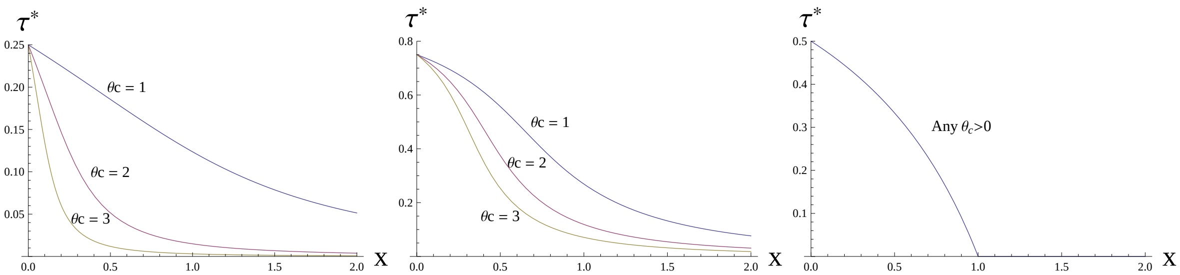
$$\frac{\partial u(\alpha, \beta, \tau, \theta)}{\partial \theta_c} = \frac{\psi\sigma}{\sigma-\gamma} \theta_c^{\frac{\psi\sigma}{\sigma-\gamma}-1} \beta \theta_g \left[\tau \left[\frac{\gamma(1-\tau)}{\mu} \right]^{\frac{\gamma}{\sigma-\gamma}} \Omega \right]^{\psi} + \frac{\sigma}{\sigma-\gamma} \theta_c^{\frac{\gamma}{\sigma-\gamma}} \mu \left[\frac{\sigma-\gamma}{\sigma\gamma} \right] \left[\frac{\gamma}{\mu}(1-\tau)\alpha \right]^{\frac{\sigma}{\sigma-\gamma}}.$$

The first component represents the impact of the private sector productivity on the amount of public goods provided. It increases the utility of *all* voters independently of voter's ability

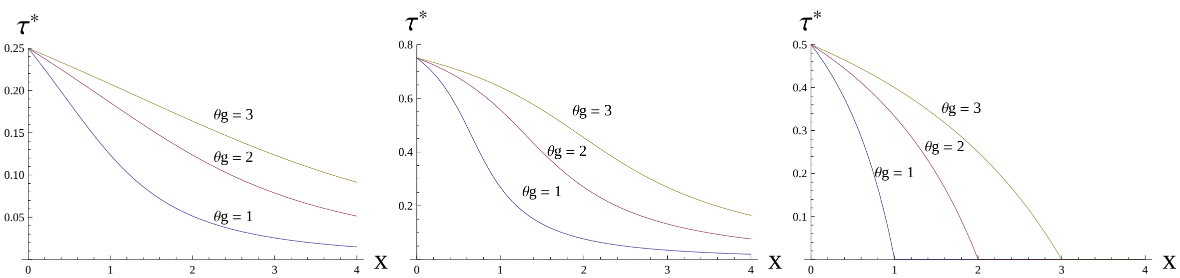
α, and depends on τ, θ_g, Ω, and β in a similar way as the marginal effect of θ_g (public sector productivity). The second component represents the impact of the private sector productivity on the net payoff from the private good. This marginal effect is now also a function of voter's productivity α. More productive individuals (with higher α) benefit *more* from an increase in θ_c than less productive individuals. Holding taxes constant, every voter values politicians who are more able to improve the productivity of the private sector; but this benefit increases with the voter's own productivity. Also, in sharp contrast to the other two ability dimensions (θ_v, θ_g), the marginal benefit of θ_c is a function of θ_c (utility is not linear in θ_c).

In summary, for any tax rate $\tau \in (0, 1)$, all three marginal effects are strictly positive. Therefore, each skill dimension $(\theta_c, \theta_v, \theta_g)$ is a valence dimension. However, in contrast to the standard additive-valence models, the marginal effect of each executive skill dimension on voter's utility is an intricate function of the voter's characteristics (α, β), policy choice τ, and macroeconomic variables, such as Ω.

A politician's ability affects not only the amount of public and private goods that can be produced by the economy, but also the trade off between private and public sectors. That is, what voters desire from the government varies with the incumbent's characteristics — preferences over policy τ depend on politician's executive skill vector θ. Figure 3 depicts the bliss point of voters with different types x, for different technology and ability parameters. As expected from the first-order condition (8), Figures 3(d), (e) and (f) show that voters prefer *higher* taxes when the incumbent is more competent at managing the public sector (higher θ_g). Note that as the politician's ability changes, the bliss points of different voters change at different rates. Also from (8), when $\psi < 1$, voters prefer *lower* tax rates when the incumbent is better at overseeing the private sector (higher θ_c), as shown by Figures 3(a) and (b). When $\psi = 1$, an increase in θ_c does not affect the *relative* values of the private and public goods, so that bliss points do not depend on θ_c—see Figure 3(c). Finally, the ability parameter θ_v does not affect the relative values of the private and public goods, hence it does not appear in condition (8) and does not affect bliss points.



(a) $\theta_g\!=\!1$, $\sigma\!=\!4/3$, $\psi\!=\!1/2$, $\gamma\!=\!1$ (b) $\theta_g\!=\!1$, $\sigma\!=\!2$, $\psi\!=\!1/2$, $\gamma\!=\!1/2$ (c) $\theta_g\!=\!1$, $\sigma\!=\!2$, $\psi\!=\!1$, $\gamma\!=\!1$



(d) $\theta_c\!=\!1$, $\sigma\!=\!4/3$, $\psi\!=\!1/2$, $\gamma\!=\!1$ (e) $\theta_c\!=\!1$, $\sigma\!=\!2$, $\psi\!=\!1/2$, $\gamma\!=\!1/2$ (f) $\theta_c\!=\!1$, $\sigma\!=\!2$, $\psi\!=\!1$, $\gamma\!=\!1$

Figure 3: Preferred tax rate $\tau^*(x,\theta)$, for $\Omega = \mu = 1$, and different values of $(\theta, \sigma, \psi, \gamma)$.

3.3 Political Equilibrium

In any stationary equilibrium, the discounted payoff that voter (α, β) expects from an untried challenger taking office at period $t+1$ is (see the Appendix for detailed discussion)

$$\overline{U}(\alpha,\beta) \;=\; E\left[\sum_{s=t+1}^{\infty} \delta^{s-(t+1)} u(\alpha,\beta,\tau_s,\theta_s)\right].$$

The discounted payoff that voter (α, β) expects from an incumbent with executive skill vector θ who implements tax rate τ and wins re-election is

$$U(\alpha,\beta,\tau,\theta) \;=\; \sum_{s=t+1}^{\infty} \delta^{s-(t+1)} u(\alpha,\beta,\tau,\theta) \;=\; \frac{1}{1-\delta} u(\alpha,\beta,\tau,\theta).$$

Therefore, at the end of period t, voter (α, β) votes to re-elect the incumbent if and only if $U(\alpha,\beta,\tau,\theta) \geq \overline{U}(\alpha,\beta)$.

Lemma 1 shows that the relevant parameter for preferences over taxes is the ratio $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$. Hence, to simplify presentation, for each voter (α, β) define his social type $x = \frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$, where $x \in X \equiv [\underline{x}, \overline{x}]$, $\underline{x} = \frac{\underline{\alpha}^{\frac{\sigma}{\sigma-\gamma}}}{\overline{\beta}}$, and $\overline{x} = \frac{\overline{\alpha}^{\frac{\sigma}{\sigma-\gamma}}}{\underline{\beta}}$. Using this change of variables, we can compute from $F(\alpha, \beta)$ the corresponding distribution $\tilde{F}(x)$ of x. Similarly, for each politician (α_i, β_i), define her social type $x_i = \frac{\alpha_i^{\frac{\sigma}{\sigma-\gamma}}}{\beta_i}$, and compute from $H(\alpha_i, \beta_i, \theta)$ the corresponding distribution $\tilde{H}(x_i, \theta)$. To simplify exposition, for the remaining of the paper I call x and x_i as the agent's social type, or simply the agent's type.

Let x_{med} be the median value of the distribution of voter preferences $\tilde{F}(x)$, and note that x_{med} is not necessarily equal to the median politician. Assume either $\psi < 1$ or $x_{med} < \underline{\theta}_g \Omega$, so that the median voter's preferred tax rate is strictly positive, $\tau^*(x_{med}, \theta) > 0$ for any $\theta \in \Theta$. The next theorem proves that the median voter x_{med} is decisive in every stationary PBE: the incumbent politician is re-elected if and only if she receives the support of the median voter. If $\Delta\theta$ (skill heterogeneity) is sufficiently small[12], then the outcome of each equilibrium is characterized by a non-empty set of viable executive skills $\Theta^* \subseteq \Theta$, two tax-cutoff functions $\underline{\tau}, \overline{\tau} : \Theta^* \to [0, 1]$, and four type-cutoff functions $c^L, w^L, w^R, c^R : \Theta^* \to X$.

Politicians with executive skill vector θ outside the viable set Θ^* are not re-elected. When $\theta \in \Theta \backslash \Theta^*$ (the set $\Theta \backslash \Theta^*$ might be empty), the politician's skill is so low that the median voter is not willing to re-elect her, even if she adopts the median voter's preferred policy $\tau^*(x_{med}, \theta)$. In this case, the politician adopts her preferred policy $\tau^*(x_i, \theta)$ and loses re-election.

When the politician has a viable skill $\theta \in \Theta^*$, then the equilibrium outcome is characterized by tax- and type-cutoff functions[13] $\underline{\tau}, \overline{\tau} : \Theta^* \to [0, 1]$ and $c^L, w^L, w^R, c^R : \Theta^* \to X$, where $\underline{\tau}(\theta) \leq \tau^*(x_{med}, \theta) \leq \overline{\tau}(\theta)$ and $\underline{x} \leq c^L(\theta) \leq w^L(\theta) \leq x_{med} \leq w^R(\theta) \leq c^R(\theta) \leq \overline{x}$. A politician with viable executive skill $\theta \in \Theta^*$ is re-elected if an only if she implements a tax rate τ sufficiently close to the median voter's preferred tax rate $\tau^*(x_{med}, \theta)$, that is, if and only if $\tau \in [\underline{\tau}(\theta), \overline{\tau}(\theta)]$. Politicians with ability θ and centrist social type $x_i \in [w^L(\theta), w^R(\theta)]$ adopt their preferred policy $\tau^*(x_i, \theta)$ and are re-elected. Politicians with ability θ and extreme social type $x_i \in [\underline{x}, c^L(\theta)] \cup [c^R(\theta), \overline{x}]$ adopt their preferred policy $\tau^*(x_i, \theta)$ and lose re-election. Politicians with ability θ and moderate social type $x_i \in (c^L(\theta), w^L(\theta))$ do not adopt their preferred policy $\tau^*(x_i, \theta)$, as they would then lose office. They compromise and adopt the highest tax rate that allows them to win re-election, $\overline{\tau}(\theta)$. Similarly, politicians with ability θ and moderate social type $x_i \in (w^R(\theta), c^R(\theta))$ compromise and adopt the lowest tax rate that allows them to win re-election, $\underline{\tau}(\theta)$. Figure 4 illustrates these cutoffs for a

[12] I drop this assumption in Section 5 and show that, in this case, two more cutoff functions characterize the behavior of viable politicians.

[13] The type-cutoff functions are similar to the cutoffs in Bernhardt, Câmara and Squintani (2011). Here, however, cutoffs are generically asymmetric, and equilibrium outcomes can be described by corner solutions.

given viable executive skill vector $\theta \in \Theta^*$.

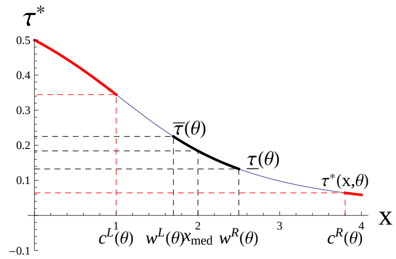


Figure 4: Equilibrium cutoffs for a given viable executive skill vector $\theta \in \Theta^*$.

Theorem 1 *Assume either $\psi < 1$ or $x_{med} < \underline{\theta}_g \Omega$. A stationary PBE exists. In every stationary PBE, the median voter x_{med} is decisive; if $\Delta\theta$ (skill heterogeneity) is sufficiently small, then the equilibrium outcome is characterized by a non-empty set of viable executive skills $\Theta^* \subseteq \Theta$, two tax-cutoff functions $\underline{\tau}, \overline{\tau} : \Theta^* \to [0, 1]$, and four type-cutoff functions $c^L, w^L, w^R, c^R : \Theta^* \to X$, where $\underline{\tau}(\theta) \leq \tau^*(x_{med}, \theta) \leq \overline{\tau}(\theta)$ and $\underline{x} \leq c^L(\theta) \leq w^L(\theta) \leq x_{med} \leq w^R(\theta) \leq c^R(\theta) \leq \overline{x}$. Using the preferred tax rate function $\tau^*(x_i, \theta)$ from Lemma 1, an incumbent politician with social type $x_i \in X$ and executive skill vector $\theta \in \Theta$ implements the following equilibrium tax rate τ^{Eq}:*

$$\tau^{Eq}(x_i, \theta) = \begin{cases} \tau^*(x_i, \theta) & \text{if } \theta \in \Theta \setminus \Theta^* \\ \tau^*(x_i, \theta) & \text{if } x_i \in [\underline{x}, c^L(\theta)] \cup [w^L(\theta), w^R(\theta)] \cup [c^R(\theta), \overline{x}] \text{ and } \theta \in \Theta^* \\ \overline{\tau}(\theta) & \text{if } x_i \in (c^L(\theta), w^L(\theta)) \text{ and } \theta \in \Theta^* \\ \underline{\tau}(\theta) & \text{if } x_i \in (w^R(\theta), c^R(\theta)) \text{ and } \theta \in \Theta^*. \end{cases}$$

An incumbent politician is re-elected if and only if she has a viable executive skill $\theta \in \Theta^*$ and implements a tax rate $\tau \in [\underline{\tau}(\theta), \overline{\tau}(\theta)]$.

4 Welfare

In this section I ask the questions: How are policy choices, voting behavior, the output of the private and public sectors, and welfare of different voters affected by the incumbent's different executive skill dimensions? In particular, who gains and who loses from improvements in a politician's ability?

An incumbent's ability affects both her budget constraint (her ability to transform tax revenues into public goods) and her political constraint (set of policies she must implement in order to be re-elected). I first consider centrist and extremist politicians. Their political constraint does not bind: politicians from both groups implement the tax rate $\tau^*(x, \theta)$ that maximizes their period utility, given their social type and executive skill vector. To focus on the equilibrium effect of each executive skill dimension, I compare two centrist (or two extremist) politicians (x_i, θ_i) and (x_j, θ_j) who have the same social type, $x_i = x_j$, but different executive skill vectors — θ_j is strictly greater than θ_i in one dimension, and equal to θ_i in the other two dimensions.

Suppose politician j is more competent at reducing government waste, that is, she has a higher θ_v. This fixed cost dimension does not affect tax or labor choices, but results in an increase in public good provision. The more competent politician j delivers more public goods, holding private consumption constant. This benefits all voters, in particular voters with high preference β for public goods. Now suppose instead that politician j is better at improving the productivity of the private sector (politician j has a higher θ_c than politician i, but same θ_v and θ_g). When the public sector exhibits decreasing returns to scale (when $\psi < 1$), the higher θ_c changes the trade off between private and public goods. An increase in θ_c decreases τ^* and increases labor supply and income. Hence, consumption of the private good is strictly higher when the more competent politician runs the government. The higher θ_c affects tax revenue and g^* positively by increasing private sector productivity, and negatively by decreasing the optimal tax rate. If the negative effect were to dominate, then a politician's higher ability to improve the productivity of the private sector would reduce provision of the public good. This would *decrease* the utility of voters with sufficiently low social type x (voters with low productivity α and high value β for the public good). However, I prove that the positive effect *always* dominates, so that g^* increases with θ_c. Consequently, all voters benefit from politician's higher executive skill θ_c.

Finally, suppose politician j is more efficient at transforming tax revenues into public goods (politician j has a higher θ_g than politician i, but same θ_v and θ_c). The higher θ_g changes the trade off between private and public goods. The more competent politician implements a higher tax rate and provides more public goods — both by the direct effect of θ_g on g^* and by the indirect effect of the tax increase. However, the increased tax rate reduces labor supply and the consumption of private goods. Consequently, there is a social type cutoff $\overline{y} > x_j$ such that: voters who sufficiently value the public good relative to the private good (voters with social types $x < \overline{y}$) become better off, while voters with social types $x > \overline{y}$ become worse off. That is, voters with social type sufficiently similar or lower than the politician's social type prefer the competent politician, while voters with social type sufficiently high prefer the incompetent politician. Proposition 1 summarizes these results.

Proposition 1 *Take any two centrist (or two extremist) politicians (x_i, θ_i) and (x_j, θ_j), such that $x_i = x_j$, θ_j is strictly greater than θ_i in one executive skill dimension, and θ_j is equal to θ_i in the other two dimensions.*

1. *Suppose politician j has a public sector fixed cost advantage, $\theta_{jv} > \theta_{iv}$ and $(\theta_{jc}, \theta_{jg}) = (\theta_{ic}, \theta_{ig})$. Both politicians implement the same tax rate and deliver the same amount of private consumption. Politician j provides more public goods; consequently, every voter prefers the more competent politician. That is, $\tau^{Eq}(x_j, \theta_j) = \tau^{Eq}(x_i, \theta_i)$, $g^*(\tau^{Eq}(x_j, \theta_j), \theta_j) > g^*(\tau^{Eq}(x_i, \theta_i), \theta_i)$, $c^*(\alpha, \tau^{Eq}(x_j, \theta_j), \theta_j) = c^*(\alpha, \tau^{Eq}(x_i, \theta_i), \theta_i)$; for every voter, $U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) > U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i)$.*

2. *Suppose politician j has a private sector advantage, $\theta_{jc} > \theta_{ic}$ and $(\theta_{jv}, \theta_{jg}) = (\theta_{iv}, \theta_{ig})$. The more competent politician implements a (weakly) lower tax rate, provides (weakly) more public goods, and delivers higher private consumption. Consequently, every voter prefers the more competent politician. That is, $\tau^{Eq}(x_j, \theta_j) \leq \tau^{Eq}(x_i, \theta_i)$, $g^*(\tau^{Eq}(x_j, \theta_j), \theta_j) \geq g^*(\tau^{Eq}(x_i, \theta_i), \theta_i)$, $c^*(\alpha, \tau^{Eq}(x_j, \theta_j), \theta_j) > c^*(\alpha, \tau^{Eq}(x_i, \theta_i), \theta_i)$; for every voter, $U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) > U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i)$. Further, all inequalities are strict for $\psi < 1$.*

3. *Suppose politician j has a public sector marginal productivity advantage, $\theta_{jg} > \theta_{ig}$ and $(\theta_{jv}, \theta_{jc}) = (\theta_{iv}, \theta_{ic})$. The more competent politician implements a (weakly) higher tax rate, provides (weakly) more public goods, and delivers (weakly) lower private consumption. Consequently, there is a social type cutoff $\overline{y} > x_i$ such that voters with social types $x < \overline{y}$ prefer the more competent politician, while voters with social types $x > \overline{y}$ prefer the less competent politician. That is, $\tau^{Eq}(x_j, \theta_j) \geq \tau^{Eq}(x_i, \theta_i)$, $g^*(\tau^{Eq}(x_j, \theta_j), \theta_j) \geq g^*(\tau^{Eq}(x_i, \theta_i), \theta_i)$, $c^*(\alpha, \tau^{Eq}(x_j, \theta_j), \theta_j) \leq c^*(\alpha, \tau^{Eq}(x_i, \theta_i), \theta_i)$. For each voter $(\alpha, \beta) \in$*

$A \times B$, if $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} < \overline{y}$ then $U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) \geq U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i)$; if $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} > \overline{y}$ then $U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) \leq U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i)$. Further, all inequalities are strict if $\tau^*(x_j, \theta_j) > 0$ (that is, if $\psi < 1$ or $x_j < \theta_{jg}\Omega$).

Hence, when incumbents are not constrained by electoral concerns, both ability dimensions θ_v and θ_c retain their basic valence properties: every voter prefers politicians who are more competent along these dimensions. However, voters with social types sufficiently above politician's social type x_i are worse off when the politician has a higher marginal productivity θ_g at providing the public good.

Before examining the choices of politically constrained incumbents, I present a result derived from the equilibrium behavior of voters. For politicians with viable executive skills, I find that incumbents with higher ability can take more extreme policies and win re-election.[14]

Lemma 2 *Take any viable politicians $\theta_i, \theta_j \in \Theta^*$ such that $\theta_j > \theta_i$. In equilibrium, the politician with higher executive skill vector θ_j can take more extreme policies and win re-election. That is, equilibrium tax-cutoff functions $\underline{\tau}$ and $\overline{\tau}$ are such that*

$$\underline{\tau}(\theta_j) \leq \underline{\tau}(\theta_i) \leq \tau^*(x_{med}, \theta_i) \leq \overline{\tau}(\theta_i) \leq \overline{\tau}(\theta_j).$$

Inequalities are strict when solutions are interior.

When politicians are constrained by re-election considerations, the equilibrium voting behavior described by Lemma 2 implies that the equilibrium effects of executive skill on policy choices might be quite different from these of Proposition 1. Proposition 2 describes how the executive skill vector of a left-moderate incumbent affects policy choices and the economy.

Proposition 2 *Take any two left-moderate politicians (x_i, θ_i) and (x_j, θ_j), such that $\theta_j > \theta_i$. That is, $\theta_i, \theta_j \in \Theta^*$, $x_i \in (c^L(\theta_i), w^L(\theta_i))$, and $x_j \in (c^L(\theta_j), w^L(\theta_j))$, where x_i need not equal x_j. Then when solutions are interior, the more competent politician j implements higher taxes, provides more public goods, and delivers less private consumption. That is, $\tau^{Eq}(x_j, \theta_j) > \tau^{Eq}(x_i, \theta_i)$, $g^*(\tau^{Eq}(x_j, \theta_j), \theta_j) > g^*(\tau^{Eq}(x_i, \theta_i), \theta_i)$, and $c^*(\alpha, \tau^{Eq}(x_j, \theta_j), \theta_j) < c^*(\alpha, \tau^{Eq}(x_i, \theta_i), \theta_i)$.*

[14] This result is similar to Proposition 1.1 in Bernhardt, Câmara and Squintani (2011).

From Lemma 1 and Proposition 1, the *preferred* tax rate τ^* of all voters and the *implemented* tax rate τ^{Eq} of politically unconstrained politicians are affected by each executive skill dimension as follows: they do not vary with the fixed cost dimension θ_v, they increase with marginal productivity θ_g, and they decrease with private sector productivity θ_c. In equilibrium, however, the *implemented* tax rate τ^{Eq} of left-moderate politicians increases with *each* dimension of the executive skill vector. This is so because the left-moderate politician implements a tax rate τ^{Eq} below her preferred tax rate τ^*, in order to guarantee re-election. Given her executive skill vector and the resulting government budget constraint, the incumbent politician would be willing to trade off less consumption of the private good c for more consumption of the public good g. However, the decisive median voter, who has a higher social type than the incumbent, is not willing to accept the change. When the left-moderate incumbent has a higher executive skill in *any* dimension, she faces a different budget constraint. The politician can trade off less consumption of the private good for more consumption of the public good, and still deliver at least the same payoff to the decisive median voter. That is, she can implement a higher tax rate (Lemma 2), closer to her preferred tax rate, and still win re-election. In particular, when the executive skill vector θ_i is equal to θ_j in all dimensions but θ_c, *the left-moderate politician with higher ability to improve the private sector productivity chooses a tax rate* τ^{Eq} *so much higher that it decreases the consumption of the private good by every voter.*

The change from the lower tax $\tau^{Eq}(x_i, \theta_i)$ to the higher tax $\tau^{Eq}(x_j, \theta_j)$ leaves the median voter indifferent. However, different voters trade off private goods for public goods differently. Voters with social type below the median voter are willing to trade off private consumption for public goods, so they strictly prefer the left-moderate politician with higher skills, charging higher taxes. Voters with social type above the median are hurt: they value g relatively less, and would prefer to keep their original consumption bundles.

Proposition 2 ***[Continued]*** *Every left-voter prefers a left-moderate politician with higher executive skill: for any* $(\alpha, \beta) \in A \times B$ *such that* $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} < x_{med}$,

$$U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) \quad > \quad U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i).$$

Every right-voter prefers a left-moderate politician with lower executive skill: for any $(\alpha, \beta) \in$

$A \times B$ such that $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} > x_{med}$,

$$U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) \quad < \quad U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i).$$

The results are reversed for right-moderate politicians. They need to implement tax rates τ^{Eq} above their preferred tax rate τ^* in order to be re-elected. They would like to trade off less public goods for more private consumption, but they are constrained by the fact that the decisive median voter, who has a lower social type, is not willing to accept the change. Therefore, right-moderate incumbents with higher executive skills use this advantage to decrease tax rates. In particular, when the executive skill vector θ_i is equal to θ_j in all dimensions but θ_g, *the right-moderate politician with higher marginal productivity to deliver public goods chooses a tax rate τ^{Eq} so much lower that it decreases the production of the public good*. Now right-voters benefit from the change, while left-voters are hurt.

Proposition 3 *Take any two right-moderate politicians (x_i, θ_i) and (x_j, θ_j), such that $\theta_j > \theta_i$. That it, $\theta_i, \theta_j \in \Theta^*$, $x_i \in (w^R(\theta_i), c^R(\theta_i))$, and $x_j \in (w^R(\theta_j), c^R(\theta_j))$, where x_i need not equal x_j. Then when solutions are interior, the more competent politician j implements lower taxes, provides less public goods, and delivers more private consumption. That is, $\tau^{Eq}(x_j, \theta_j) < \tau^{Eq}(x_i, \theta_i)$, $g^*(\tau^{Eq}(x_j, \theta_j), \theta_j) < g^*(\tau^{Eq}(x_i, \theta_i), \theta_i)$, and $c^*(\alpha, \tau^{Eq}(x_j, \theta_j), \theta_j) > c^*(\alpha, \tau^{Eq}(x_i, \theta_i), \theta_i)$.*

Every left-voter prefers a right-moderate politician with lower executive skill: for any $(\alpha, \beta) \in A \times B$ such that $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} < x_{med}$,

$$U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) \quad < \quad U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i).$$

Every right-voter prefers a right-moderate politician with higher executive skill: for any $(\alpha, \beta) \in A \times B$ such that $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} > x_{med}$,

$$U(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) \quad > \quad U(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i).$$

Re-election considerations generate endogenously a conflict between left and right-voters, regarding their preferences over the desired executive skill of moderate politicians. Higher ability allows moderate politicians to implement more extreme policies and win re-election. Consequently, left-voters prefer right-moderate politicians with lower ability in every dimension, while right-voters prefer incompetent left-moderate politicians.

We might also have endogenous conflict among left-voters regarding preferences over the ability of some left-politicians. An extreme-left politician (x_i, θ_i) implements her preferred policy $\tau^*(x_i, \theta_i) > \overline{\tau}(\theta_i)$ and loses re-election. She finds it too costly to compromise to the lower tax rate $\overline{\tau}(\theta_i)$ in order to be re-elected. However, if she had a higher executive skill $\theta_i' > \theta_i$, then she could be facing a strictly higher tax-cutoff $\overline{\tau}(\theta_i') > \overline{\tau}(\theta_i)$. If $\overline{\tau}(\theta_i')$ is sufficiently close to the politician's preferred tax rate, then she will no longer be an extremist — she will choose to compromise to $\overline{\tau}(\theta_i')$ in order to be re-elected. That is, a higher executive skill vector might lead an extremist politician to become a moderate politician. The less extreme policy by the left-politician may decrease the expected discounted payoff of voters sufficiently to the left of the politician — voters discount the future, and sufficiently extreme voters might prefer the incumbent to take an extreme position today and lose office, rather than compromise to a lower tax rate and be re-elected. A similar argument holds for right-politicians.

In summary, a voter's preference over the executive skill of a politician is a function of the voter's own social type and the politician's social type. Equilibrium considerations generate conflict across different voters with respect to their preferences over the ability of a politician. This conflict endogenously exhibits a single-crossing property: take any two politicians (x_i, θ_i) and (x_j, θ_j) with the same social type $x_i = x_j$ and different executive skill vectors, such that $\theta_j > \theta_i$. Either all voters prefer the more competent politician j, or there is a single cutoff $\overline{y} > x_i$ (or $\underline{y} < x_i$) such that partisan voters (voters in the same side of the cutoff as the politician) prefer the more competent politician, while non-partisan voters (voters in the opposite side of the cutoff) prefer the incompetent politician[15]. Combined, the results imply the following Corollary:

Corollary 1 *Take any two politicians (x_i, θ_i) and (x_j, θ_j), such that $x_i = x_j$ and $\theta_j >$*

[15]Gouret, Hollard and Rossignol (2011) consider an exogenous two-sided partisan (or intensity) valence structure. They conjecture that voters' utility function has an *exogenous* intensity valence term v. Voters with a preference parameter x sufficiently close to the politician's platform y (absolute distance $|x - y|$ less than an *exogenous* symmetric cutoff $K > 0$) benefit from a politician with higher intensity valence v, while all other voters lose. Competence in my model *endogenously* resembles an asymmetric, single-crossing partisan valence. Moreover, I explicitly model the microfoundations of the political-economic process that generates conflict across voters.

θ_i. Voters with social type x sufficiently close to politicians' social type x_i prefer the more competent politician j, while distant voters might prefer the less competent politician i.

5 Extensions of the Model

5.1 Ego Rents

The main results of the paper hold when politicians are both policy and office motivated. Suppose that, in addition to the per period utility $\tilde{u}(i)$ derived from her social objective function, a politician also receives an ego rent each period in office. One can then view politician i as a politician who wishes to represent the interests of voter (α_i, β_i) when in office, but who also values staying in office.

Observe that because a heterogeneous β_i results in a heterogeneous marginal rate of substitution between the private good and the public good across different politicians, it does matter for equilibrium characterization whether one defines ego rents in terms of units of private or public goods.

First consider an ego rent $\rho \geq 0$ measured in terms of public goods: a politician with social preference parameters (α_i, β_i) derives additional utility $\beta_i \rho$ for each period in office. In this case, the ratio $x_i = \frac{\alpha_i^{\frac{\sigma}{\sigma-\gamma}}}{\beta_i}$ remains sufficient to characterize the behavior of politicians and all previous results and equilibrium characterization hold. The main change is that politicians are now more willing to compromise. As a result, politicians face more strict re-election cutoffs.

Now consider an ego rent $\rho \geq 0$ measured in terms of private goods: a politician derives additional utility ρ for each period in office. Although the main results still hold, equilibrium characterization becomes more intricate because x_i is no longer sufficient to characterize the behavior of politician (α_i, β_i). Re-election cutoffs are still defined by functions of politician's ability: $\underline{\tau}(\theta)$, $\overline{\tau}(\theta)$, $w^R(\theta)$, and $w^L(\theta)$. Compromising cutoffs, however, now depend not only on the politician's ability θ but also her social preference parameters (α_i, β_i): $c^R(\alpha_i, \beta_i, \theta)$ and $c^L(\alpha_i, \beta_i, \theta)$. For example, keeping the ratio $x_i = \frac{\alpha_i^{\frac{\sigma}{\sigma-\gamma}}}{\beta_i}$ constant, a politician with a lower preference parameter β_i is more willing to compromise. This is because a smaller β_i implies that the marginal value of the private good is higher compared to the public good.

Therefore, a politician with lower β_i values ego rent ρ (measured in terms of the private good) relatively more, and she is more willing to compromise to remain in office.

Finally, if the executive skill set Θ has an interior point (politicians have heterogeneous ability), then equilibrium policies do not fully converge to the median voter's preferred policy, even when ego rents take an arbitrarily large value. Re-election cutoffs will be the exact median voter's preferred tax rate only for a measure zero of viable executive skills. That is, $w^L(\theta) = x_{med} = w^R(\theta)$ for a measure zero of executive skill vectors $\theta \in \Theta^*$. Politicians with lower (non-viable) executive skill vectors cannot be re-elected and implement their own preferred policy. Politicians with higher (viable) skills have more lenient re-election cutoffs, and are able to be re-elected with policies different than median voter's bliss point. When the discount rate δ is arbitrarily close to one, then the equilibrium policy of re-elected officials converges to the median voter's preferred policy, but the equilibrium policy of a first-term untried candidate does not.

5.2 Large Executive Skill Heterogeneity

When the executive skill heterogeneity $\Delta\theta$ is large, new cutoff functions are required to characterize the equilibrium behavior of politicians. Besides the three basic groups of viable politicians (centrists, moderates and extremists), a fourth group of drop-out politicians may arise: politicians who chose not to run for re-election, even though they would have won re-election. This can happen, for example, when the incumbent politician is very competent at helping the private sector (high θ_c), but very incompetent at running the public sector (low θ_v and θ_g). If the politician has a high relative value for the public good (low social type x_i) and the decisive median voter has a high relative value for the private good (high social type x_{med}), then the politician could implement her preferred policy (given her low ability to run the public sector and high ability to help the private sector) and win re-election. However, this is not individually rational: the politician prefers not to run. She prefers to be replaced by an untried politician who might have a high ability to run the public sector. The set of drop-out politicians is empty when the politician's personal benefit from holding office (ego rent ρ) is sufficiently high, or when skill heterogeneity across politicians ($\Delta\theta$) is sufficiently low. It would be interesting to study the endogenous selection of individuals into politics (self-selection and actions of political groups), given the novel incentive considerations highlighted by my model.

5.3 Productivity Growth

This section considers the effects of an exogenous rate of technological progress. At each period t, pretax income is now given by

$$y = \Phi_t \theta_c \alpha n^{\gamma}. \tag{9}$$

The new term $\Phi_t > 0$ represents the level of productivity (technology) of the economy, that is, the Total Factor Productivity. As before, θ_c captures the politician's impact on the economy's TFP, and α captures the voter's productivity parameter. Technology evolves at a constant exogenous rate of technical progress $\phi \geq 0$,

$$\Phi_{t+1} = (1+\phi)\Phi_t. \tag{10}$$

Therefore, the model used in Section 2 assumes $\phi = 0$ and normalizes $\Phi_t = 1$.

In general, changes in the *level* of the total factor productivity Φ_t would result in changes in the trade off between the private and the public goods. Consequently, short-run preferences over taxes, re-election cutoffs, and equilibrium behavior of politicians would all be non-stationary functions of the state variable Φ_t. Solving for a non-stationary political equilibrium is outside the scope of this paper. However, by including the following two assumptions, we can eliminate the *level* effect of the total factor productivity Φ_t, and focus on the effects of the *growth rate* ϕ: Assume that

(A1) The public good production function is linear in tax revenues ($\psi = 1$);

(A2) Politicians are homogeneous in the public good fixed cost dimension ($\underline{\theta}_v = \overline{\theta}_v$).

Assumption (A1) implies that the short-run preferences over taxes described by Lemma 1 are not a function of the TFP level. Assumption (A2) eliminates heterogeneity with respect to fixed costs — otherwise, as productivity grows, a politician's ability to deliver a lower fixed cost becomes less important. That is, when the economy has a low productivity level, a politician who has a fixed cost close to zero has a significant political advantage over a politician with a high fixed cost — they face very different re-election constraints. When the economy has a high productivity level (holding fixed costs constant), the fixed cost difference between the politicians is less important, and they face similar re-elections constraints[16].

The next proposition solves for the stationary political equilibrium with productivity growth. It shows that the political equilibrium in an economy with productivity growth is equivalent to the political equilibrium in a similar economy without growth, but with more patient agents.

Proposition 4 *Assume (A1), (A2), and* $\delta(1+\phi)^{\frac{\sigma}{(\sigma-\gamma)}} < 1$. *Given discount factor* δ *and growth rate* ϕ*, a stationary political equilibrium in an economy with growth exists. This stationary political equilibrium is the same equilibrium described by Theorem 1 in an alternative economy with the same parameters, but no growth and a higher discount factor* $\delta' = \delta(1+\phi)^{\frac{\sigma}{(\sigma-\gamma)}}$.

The intuition behind this result is simple. If in the next period the economy will be twice as productive as today's economy, then voters and politicians will be more concern about future policy choices, since they will affect a larger economy. In particular, for the decisive median voter, having in the next period a politician who is more competent and implements a policy closer to the median voter's preferred policy is more important when the exogenous rate of productivity growth ϕ is larger.

The decisive median voter has the option of voting extremist, incompetent politicians out of office. Consequently, technological progress may increase the option value of replacing the incumbent politician with an untried challenger who *could* be more competent and have preferences closer to the median voter's preferences. If this is the case, then a higher rate of economic/productivity growth induces the decisive median voter to adopt more restrictive re-election cutoffs, so that re-elected politicians are expected to be *more competent* and implement policies *closer* to the median voter's preferred policy[17].

[16] Alternatively, we can continue to allow heterogenous fixed costs across politicians, but assume that the fixed cost of each politicians grows as follows: $\theta_{v,t+1} = (1+\phi)^{\frac{\sigma}{\sigma-\gamma}}\theta_{v,t}$

[17] It is difficult to sign the change in the expected probability of re-election of an untried candidate, as a function of the technological progress. If it is the case that the re-election rate of politicians with lower ability decreases while the re-election rate of politicians with higher ability increases, then the aggregate effect depends on the parameters of the model.

6 Conclusion

This paper develops a model to examine the equilibrium relationship between politics and the economy. It incorporates a production economy into a repeated-election framework, and considers politicians with heterogenous preferences *and* heterogeneous abilities.

The model allows us to examine how the underlying characteristics (productivity and taste) of the heterogeneous agents (politicians and voters) affect political and economic behavior, and welfare of different voters. That is, it advances the understanding of the microfoundaments of the general equilibrium involving politics and economics.

In equilibrium, it is crucial to consider both the budget and the political constraints of an incumbent politician, when defining how a politician's ability affects her policy choices and voters' welfare. The combined effect of these constraints endogenously displaces competence as a valence issue.

The rich — yet tractable — model developed by this paper should be a valuable framework to examine other relevant questions related to economic policies of heterogeneous politicians. For example, one could consider the political *and* economic implications of the actions of interest groups and political parties (e.g., endogenous selection of candidates with different abilities).

This paper focus on stationary equilibria. It also considers an *exogenous* rate of productivity growth, while maintaining the stationary political equilibrium structure. In order to consider *endogenous* productivity growth and capital accumulation, one needs to solve for non-stationary political equilibria. That is, re-election cutoffs and equilibrium behavior of politicians are functions of the current state of the economy. This extension of the model is important and should be pursued by future research. It would allow us to examine questions such as how heterogeneous politicians affect the growth rate of the economy, and how economic shocks affect the behavior of heterogenous politicians.

A Proofs

A.1 Economic Equilibrium

Substitute $c = (1-\tau)\theta_c \alpha n^\gamma$ into the utility function to rewrite the voter's problem (3) as

$$\max_{n\geq 0} \left\{ (1-\tau)\theta_c \alpha n^\gamma + \beta g - \mu \frac{n^\sigma}{\sigma} \right\}.$$

Given τ, g and θ, the voter's first-order conditions can be written as

$$n^{\sigma-1}\Big[\gamma(1-\tau)\theta_c \alpha n^{\gamma-\sigma} - \mu\Big].$$

Since $\sigma > \gamma$, period utility $u(\alpha, \beta, \tau, \theta)$ is a strictly quasi-concave function of effort n. The unique optimal effort is

$$n^*(\alpha, \tau, \theta) \;=\; \left[\frac{\gamma(1-\tau)\theta_c \alpha}{\mu}\right]^{\frac{1}{\sigma-\gamma}}.$$

Tax elasticity of labor supply is

$$\epsilon_{n,\tau} = \frac{\partial n^*(\alpha,\tau,\theta)}{\partial \tau}\frac{\tau}{n^*(\alpha,\tau,\theta)} \;=\; \frac{-\tau}{(\sigma-\gamma)(1-\tau)}.$$

Individual pretax income is then

$$y^*(\alpha,\tau,\theta) = \theta_c \alpha n^*(\alpha,\tau,\theta)^\gamma \;=\; \theta_c \alpha \left[\frac{\gamma(1-\tau)\theta_c \alpha}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}}.$$

The tax elasticity of pretax income is proportional to the tax elasticity of labor supply,

$$\epsilon_{y,\tau} = \frac{\partial y^*(\alpha,\tau,\theta)}{\partial \tau}\frac{\tau}{y^*(\alpha,\tau,\theta)} \;=\; \frac{-\gamma\tau}{(\sigma-\gamma)(1-\tau)} = \gamma\epsilon_{n,\tau}.$$

Note that $\epsilon_{y,\tau}$ strictly decreases with τ (pretax income becomes more elastic as taxes increase). Pretax income is inelastic ($|\epsilon_{y,\tau}| < 1$) when $\tau < \frac{\sigma-\gamma}{\sigma}$, and elastic ($|\epsilon_{y,\tau}| > 1$) when $\tau > \frac{\sigma-\gamma}{\sigma}$.

Using equation (4), the tax elasticity of aggregate tax revenues is

$$\epsilon_{\tau Y^*,\tau} = \frac{\partial \tau Y^*(\tau,\theta)}{\partial \tau}\frac{\tau}{\tau Y^*(\tau,\theta)} \;=\; 1 - \frac{\gamma\tau}{(\sigma-\gamma)(1-\tau)} = 1 + \epsilon_{y,\tau}. \tag{11}$$

Therefore, the tax revenue function resembles a Laffer Curve: revenues increase ($\epsilon_{\tau Y^*,\tau} > 0$) when pretax income is inelastic, and decrease ($\epsilon_{\tau Y^*,\tau} < 0$) when pretax income is elastic. Revenues reach a maximum at $\tau = \frac{\sigma-\gamma}{\sigma}$.

A.2 Short-Run Preferences

Proof: [**Lemma 1**] I first show that the per period utility (5) is a strictly quasi-concave function of tax rate τ. Abusing notation, rewrite per period utility (5) as

$$u(\alpha,\beta,\tau,\theta) \;=\; (1-\tau)\theta_c\alpha n^*(\alpha,\tau,\theta)^\gamma + \beta g^*(\tau,\theta) - \mu\frac{n^*(\alpha,\tau,\theta)^\sigma}{\sigma}.$$

Using the envelope theorem, the first derivative with respect to taxes is

$$\begin{aligned}\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial\tau} &= -\theta_c\alpha n^*(\alpha,\tau,\theta)^\gamma + \beta\frac{\partial g^*(\tau,\theta)}{\partial\tau}\\ &= -y^*(\alpha,\tau,\theta) + \beta\frac{\partial g^*(\tau,\theta)}{\partial\tau}. \qquad (12)\end{aligned}$$

To simplify presentation, divide and multiply (12) by the aggregate pretax income $Y^*(\tau,\theta)$,

$$\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial\tau} \;=\; Y^*(\tau,\theta)\left[\frac{\beta}{Y^*(\tau,\theta)}\frac{\partial g^*(\tau,\theta)}{\partial\tau} - \frac{y^*(\alpha,\tau,\theta)}{Y^*(\tau,\theta)}\right]. \qquad (13)$$

Aggregate pretax income $Y^*(\tau,\theta)$ is strictly positive for any tax $\tau<1$. Thus, the derivate $\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial\tau}$ has the same sign as the term in brackets. For any $\tau<1$, the last term equals a strictly positive constant,

$$\frac{y^*(\alpha,\tau,\theta)}{Y^*(\tau,\theta)} \;=\; \frac{\alpha^{\frac{\sigma}{(\sigma-\gamma)}}}{\int_{A\times B}\alpha'^{\frac{\sigma}{(\sigma-\gamma)}}dF(\alpha',\beta)} \equiv \frac{\alpha^{\frac{\sigma}{(\sigma-\gamma)}}}{\Omega},$$

where $\Omega \equiv \int_{A\times B}\alpha'^{\frac{\sigma}{(\sigma-\gamma)}}dF(\alpha',\beta)$ is a measure of the aggregate ability endowment of the economy. The ratio $\frac{\alpha^{\frac{\sigma}{(\sigma-\gamma)}}}{\Omega}$ captures the relative share of the total income that an individual with ability α obtains in economic equilibrium.

After some algebra, we can use equation (11) to rewrite the second term $\frac{\beta}{Y^*(\tau,\theta)}\frac{\partial g^*(\tau,\theta)}{\partial\tau}$ as

$$\frac{\beta}{Y^*(\tau,\theta)}\frac{\partial g^*(\tau,\theta)}{\partial\tau} \;=\; \beta\psi\theta_g\frac{\epsilon_{\tau Y^*,\tau}}{[\tau Y^*(\tau,\theta)]^{1-\psi}}$$

The term captures the marginal change in public good consumption relative to the aggregate pretax income of the economy. From (11), public good consumption decreases in the decreasing segment of the Laffer Curve. That is, $\frac{\partial g^*(\tau,\theta)}{\partial\tau}<0$ when $\tau>\frac{\sigma-\gamma}{\sigma}$. Therefore, $\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial\tau}<0$ when $\tau\geq\frac{\sigma-\gamma}{\sigma}$.

When $\tau<\frac{\sigma-\gamma}{\sigma}$, equation (11) implies that tax elasticity of aggregate tax revenues $\epsilon_{\tau Y^*,\tau}$ is positive and strictly decreasing in tax rate τ. Therefore, either $\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial\tau}<0$ for every

$\tau \in [0,1]$, or there is a tax rate τ^* such that $\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial \tau} > 0$ for any $\tau < \tau^*$, and $\frac{\partial u(\alpha,\beta,\tau,\theta)}{\partial \tau} < 0$ for any $\tau > \tau^*$.

Consequently, $u(\alpha, \beta, \tau, \theta)$ is a strictly quasi-concave function of τ. When solutions are interior, we can solve for the unique tax rate τ^* that maximizes $u(\cdot)$ by considering the first-order condition derived from (12),

$$\beta \frac{\partial g^*(\tau, \theta)}{\partial \tau} = y^*(\alpha, \tau, \theta).$$

Rewrite the condition to obtain

$$\tau^{-(1-\psi)}(1-\tau)^{\frac{-\gamma(1-\psi)}{\sigma-\gamma}} - \frac{\gamma}{\sigma-\gamma}\tau^{\psi}(1-\tau)^{\frac{-(\sigma-\gamma\psi)}{\sigma-\gamma}} = \frac{\theta_c^{\frac{\sigma(1-\psi)}{\sigma-\gamma}}}{\psi\theta_g\Omega^{\psi}}\left[\frac{\gamma}{\mu}\right]^{\frac{\gamma(1-\psi)}{\sigma-\gamma}}\left[\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}\right]. \tag{14}$$

The RHS of (14) is strictly positive, and it is not a function of τ. The RHS is a function of $x \equiv \frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$; that is, x is sufficient to define τ^*, we do not need to know the specific values of α and β. The LHS of (14) strictly decreases in τ. Moreover, the LHS is strictly negative for any $\tau > \frac{\sigma-\gamma}{\sigma}$ (that is, the LHS is negative when taxes exceed the tax level that maximizes tax revenues). This implies that optimal tax τ^* is always strictly below $\frac{\sigma-\gamma}{\sigma}$. If $\psi < 1$, then the LHS goes to infinity as τ goes to zero, hence solutions are interior and given by the first-order condition (14). If $\psi = 1$, then the RHS simplifies to $\frac{1}{\theta_g\Omega}\left[\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}\right]$, and the LHS goes to one as taxes go to zero. The optimal tax rate is then zero if the RHS is one or greater, that is, if $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} \geq \theta_g\Omega$. Otherwise, τ^* is characterized by first-order condition (14). ■

A.3 Political Equilibrium

Proof: [**Theorem 1**] This paper focus on beliefs and strategies that are stationary along the equilibrium path. There is a broad set of out-of-equilibrium beliefs that support the equilibrium path. In essence, all we need are beliefs that a incumbent with ability θ who locates more extremely than the equilibrium re-election cutoffs at some date t will never locate more moderately than the re-election cutoffs in the future.

I first show that if a stationary equilibrium exists, then it must take the form described by the theorem. I then show that an equilibrium exists.

Suppose a stationary equilibrium exists. The discounted payoff that voter (α, β) expects from an incumbent with executive skill vector θ who implements tax rate τ in period t and is able to win re-election is

$$U(\alpha,\beta,\tau,\theta) \;=\; \sum_{s=t+1}^{\infty} \delta^{s-(t+1)} u(\alpha,\beta,\tau,\theta) \;=\; \frac{1}{1-\delta} u(\alpha,\beta,\tau,\theta).$$

From period utility (6), define

$$\Lambda_A(\tau,\theta) \;\equiv\; \theta_v + \theta_g \left[\tau\theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}} \Omega\right]^{\psi}, \tag{15}$$

$$\Lambda_B(\tau,\theta) \;\equiv\; \mu\left[\frac{\sigma-\gamma}{\sigma\gamma}\right]\left[\frac{\gamma}{\mu}(1-\tau)\theta_c\right]^{\frac{\sigma}{\sigma-\gamma}}. \tag{16}$$

$\Lambda_A(\tau,\theta)$ is the amount of public goods consumed; $\Lambda_B(\tau,\theta)$ is the amount of private goods consumed, net of the cost of effort (cost measured in units of c). Rewrite

$$U(\alpha,\beta,\tau,\theta) \;=\; \frac{1}{1-\delta}\left[\beta\Lambda_A(\tau,\theta) + \Lambda_B(\tau,\theta)\alpha^{\frac{\sigma}{\sigma-\gamma}}\right].$$

In any stationary equilibrium, the discounted payoff that voter (α,β) expects from an untried challenger taking office at period $t+1$ is

$$\begin{aligned} \overline{U}(\alpha,\beta) \;&=\; E\left[\sum_{s=t+1}^{\infty} \delta^{s-(t+1)} u(\alpha,\beta,\tau_s,\theta_s)\right] \\ &=\; E\left[\sum_{s=t+1}^{\infty} \delta^{s-(t+1)} \left(\beta\Lambda_A(\tau_s,\theta_s) + \Lambda_B(\tau_s,\theta_s)\alpha^{\frac{\sigma}{\sigma-\gamma}}\right)\right]. \end{aligned}$$

Abusing notation, define

$$E[\Lambda_A] \;\equiv\; E\left[\sum_{s=t+1}^{\infty} \delta^{s-(t+1)} \Lambda_A(\tau_s,\theta_s)\right], \tag{17}$$

$$E[\Lambda_B] \;\equiv\; E\left[\sum_{s=t+1}^{\infty} \delta^{s-(t+1)} \Lambda_B(\tau_s,\theta_s)\right]. \tag{18}$$

$E[\Lambda_A]$ is the expected discounted amount of the public goods that will be consumed in equilibrium; $\Lambda_B(\tau,\theta)$ is the expected discounted amount of the private goods that will be consumed in equilibrium, net of the cost of effort. Rewrite

$$\overline{U}(\alpha,\beta) \;=\; \beta E[\Lambda_A] + E[\Lambda_B]\alpha^{\frac{\sigma}{\sigma-\gamma}}.$$

Therefore, at the end of period t, voter (α,β) votes to re-elect the incumbent if and only if

$$\begin{aligned} U(\alpha,\beta,\tau,\theta) \;&\geq\; \overline{U}(\alpha,\beta) \\ \Leftrightarrow \frac{1}{1-\delta}\left[\Lambda_A(\tau,\theta) + \Lambda_B(\tau,\theta)\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}\right] \;&\geq\; E[\Lambda_A] + E[\Lambda_B]\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}. \end{aligned} \tag{19}$$

Together (19) and Lemma 1 imply that the relevant parameter for preferences over taxes and voting behavior is the ratio $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$. Hence, to simplify presentation, for each voter (α, β) define his social type $x = \frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta}$, where $x \in X \equiv [\underline{x}, \overline{x}]$, $\underline{x} = \frac{\underline{\alpha}^{\frac{\sigma}{\sigma-\gamma}}}{\overline{\beta}}$, and $\overline{x} = \frac{\overline{\alpha}^{\frac{\sigma}{\sigma-\gamma}}}{\underline{\beta}}$. Using this change of variables, we can compute from $F(\alpha, \beta)$ the corresponding distribution $\tilde{F}(x)$ of x. Similarly, for each politician (α_i, β_i) define her social type $x_i = \frac{\alpha_i^{\frac{\sigma}{\sigma-\gamma}}}{\beta_i}$, and compute from $H(\alpha_i, \beta_i, \theta)$ the corresponding distribution $\tilde{H}(x_i, \theta)$. Let x_{med} be the median value of the distribution of voter preferences $\tilde{F}(x)$. Without loss of generality, rewrite expected discounted payoffs

$$\begin{aligned} U(x, \tau, \theta) &= \frac{1}{1-\delta}\Bigg[\Lambda_A(\tau, \theta) + \Lambda_B(\tau, \theta)x\Bigg], \\ \overline{U}(x) &= E[\Lambda_A] + E[\Lambda_B]x. \end{aligned}$$

The expected discounted payoff from electing and untried candidate is characterized by the two endogenous expectations $E[\Lambda_A]$ and $E[\Lambda_B]$ (that are *not* a function of x) and x. Suppose $E[\Lambda_A]$ and $E[\Lambda_B]$ form an equilibrium. Then at any period t, voter x votes to re-elect an incumbent with ability θ that implements policy τ if and only if $U(x, \tau, \theta) \geq \overline{U}(x)$. Define $\mathbf{S}_x$ as the retrospective set of voter x: the set of pairs (τ, θ) of an incumbent that x would re-elect over a random challenger,

$$\mathbf{S}_x = \left\{(\tau, \theta) | U(x, \tau, \theta) - \overline{U}(x) \geq 0\right\}.$$

The next lemma characterizes the win set and proves that an incumbent wins re-election if and only if she receives the vote from the median voter x_{med}.

Lemma A. 1 *The median voter x_{med} is decisive: an incumbent with executive skill vector θ who implements policy τ is re-elected if and only if $(\tau, \theta) \in \mathbf{S}_{x_{med}}$. The retrospective set $\mathbf{S}_{x_{med}}$ is characterized by a non-empty set of viable executive skill vectors $\Theta^* \subseteq \Theta$ and two tax-cutoff functions $\underline{\tau}, \overline{\tau} : \Theta^* \to [0, 1]$, where $\underline{\tau}(\theta) \leq \tau^*(x_{med}, \theta) \leq \overline{\tau}(\theta)$. A politician with skill vector $\theta \in \Theta$ is re-elected if and only if $\theta \in \Theta^*$ and she implements a tax $\tau \in [\underline{\tau}(\theta), \overline{\tau}(\theta)]$.*

Proof: Take any $(\tau, \theta) \in \mathbf{S}_{x_{med}}$. By definition, $U(x_{med}, \tau, \theta) - \overline{U}(x_{med}) \geq 0$, that is,

$$\begin{aligned} \frac{1}{1-\delta}\Bigg[\Lambda_A(\theta, \tau) + \Lambda_B(\theta, \tau)x_{med}\Bigg] - E[\Lambda_A] - E[\Lambda_B]x_{med} &\geq 0, \\ \frac{\Lambda_A(\tau, \theta)}{1-\delta} - E[\Lambda_A] + \left[\frac{\Lambda_B(\tau, \theta)}{1-\delta} - E[\Lambda_B]\right]x_{med} &\geq 0. \end{aligned}$$

If $\frac{\Lambda_B(\tau,\theta)}{1-\delta} \geq E[\Lambda_B]$, then for every social type $x \geq x_{med}$ we have

$$\frac{\Lambda_A(\tau,\theta)}{1-\delta} - E[\Lambda_A] + \left[\frac{\Lambda_B(\tau,\theta)}{1-\delta} - E[\Lambda_B]\right]x \quad \geq \quad 0.$$

That is, $(\tau,\theta) \in \mathbf{S}_x$ for every $x \in [x_{med}, \bar{x}]$. At least half of the voters (the median and those voters with social types above the median) vote to re-elect the incumbent, and she wins. Similarly, if $\frac{\Lambda_B(\tau,\theta)}{1-\delta} \leq E[\Lambda_B]$ then at least half of the voters (the median and those below the median) vote to re-elect the incumbent, and she wins.

Now take any $(\tau,\theta) \notin \mathbf{S}_{x_{med}}$. By definition, $U(x_{med},\tau,\theta) - \overline{U}(x_{med}) < 0$, that is,

$$\frac{\Lambda_A(\tau,\theta)}{1-\delta} - E[\Lambda_A] + \left[\frac{\Lambda_B(\tau,\theta)}{1-\delta} - E[\Lambda_B]\right]x_{med} \quad < \quad 0.$$

If $\frac{\Lambda_B(\tau,\theta)}{1-\delta} \leq E[\Lambda_B]$, then for every social type $x \geq x_{med}$ we have

$$\frac{\Lambda_A(\tau,\theta)}{1-\delta} - E[\Lambda_A] + \left[\frac{\Lambda_B(\tau,\theta)}{1-\delta} - E[\Lambda_B]\right]x \quad < \quad 0.$$

That is, $(\theta,\tau) \notin \mathbf{S}_x$ for every $x \in [x_{med}, \bar{x}]$. At least half of the voters (the median and those voters with social types above the median) vote for the challenger, and the incumbent loses. Similarly, if $\frac{\Lambda_B(\tau,\theta)}{1-\delta} \geq E[\Lambda_B]$ then at least half of the voters (the median and those below the median) vote for the challenger, and the incumbent loses.

Hence, to characterize the win set, it suffices to characterize the retrospective set of the median voter. Given skill vector θ, the median voter's period utility $u(x_{med},\tau,\theta)$ is maximized at $\tau^*(x_{med},\theta)$. Therefore, $U(x_{med},\tau^*(x_{med},\theta),\theta) \geq U(x_{med},\tau,\theta)$ for all $\tau \in [0,1]$ and $\theta \in \Theta$. Moreover, we assumed either $\psi < 1$ or $x_{med} < \underline{\theta}_g\Omega$, which implies that $\tau^*(x_{med},\theta) > 0$ and $U(x_{med},\tau^*(x_{med},\theta),\theta)$ strictly increases in any dimension of θ.

Define the viable executive skill set $\Theta^* = \{\theta \in \Theta | U(x_{med},\tau^*(x_{med},\theta),\theta) - \overline{U}(x_{med}) \geq 0\}$. Politicians with non-viable skill vectors $\theta \in \Theta \setminus \Theta^*$ are not able to win re-election, even when they implement median voter's preferred policy. Therefore, they implement their preferred policy $\tau^*(x_i,\theta)$ and are ousted from office.

Now take any viable executive skill vector $\theta \in \Theta^*$. $U(x_{med},\tau,\theta)$ strictly decreases as τ moves away from $\tau^*(x_{med},\theta)$. Hence, we can compute the highest tax $\overline{\tau}(\theta) \in [\tau^*(x_{med},\theta),1]$ such that $U(x_{med},\overline{\tau}(\theta),\theta) \geq \overline{U}(x_{med})$, and lowest tax $\underline{\tau}(\theta) \in [0,\tau^*(x_{med},\theta)]$ such that $U(x_{med},\underline{\tau}(\theta),\theta) \geq \overline{U}(x_{med})$. Politician $\theta \in \Theta^*$ is re-elected if and only if she implements tax rate $\tau \in [\underline{\tau}(\theta),\overline{\tau}(\theta)]$.

By contradiction, suppose Θ^* is empty in equilibrium. Then every politician implements her preferred policy and losses re-election, which implies that a politician with sufficiently high skill $\theta \in \Theta$ could be re-elected by implementing the median voter's preferred policy, a contradiction. $\blacksquare$

For viable politicians $\theta \in \Theta^*$, define the type-cutoff functions $w^L : \Theta^* \to [\underline{x}, x_{med}]$ and $w^R : \Theta^* \to [x_{med}, \overline{x}]$ as follows. The politician with lowest social type x_i that can implement her preferred policy and be re-elected is $w^L(\theta) = \{\min x_i \in X | \tau^*(x_i, \theta) \leq \overline{\tau}(\theta)\}$. The politician with highest type x_i that can implement her preferred policy and be re-elected is $w^R(\theta) = \{\max x_i \in X | \tau^*(x_i, \theta) \geq \underline{\tau}(\theta)\}$. A politician with ability $\theta \in \Theta^*$ and type $x_i \in [w^L(\theta), w^R(\theta)]$ can implement her preferred policy $\tau^*(x_i, \theta)$ and be re-elected.

I now characterize the optimal decision of viable politicians with social types $x_i \notin [w^L(\theta), w^R(\theta)]$. A politician with ability $\theta \in \Theta^*$ will *lose* re-election if she adopts policy $\tau < \underline{\tau}(\theta)$ or $\tau > \overline{\tau}(\theta)$. For a politician with type $x_i < w^L(\theta)$, the value of adopting her own preferred policy and losing re-election to an untried challenger is

$$u(x_i, \tau^*(x_i, \theta), \theta) + \delta \overline{U}(x_i).$$

The value of adopting the highest tax $\overline{\tau}(\theta)$ that allows her to win re-election is

$$U(x_i, \overline{\tau}(\theta), \theta).$$

The incumbent will optimally choose to compromise to win re-election when

$$U(x_i, \overline{\tau}(\theta), \theta) \quad > \quad u(x_i, \tau^*(x_i, \theta), \theta) + \delta \overline{U}(x_i).$$

Similarly, an incumbent with ability θ and type $x_i > w^R(\theta)$ will compromise an implement policy $\underline{\tau}(\theta)$ if and only if

$$U(x_i, \underline{\tau}(\theta), \theta) \quad > \quad u(x_i, \tau^*(x_i, \theta), \theta) + \delta \overline{U}(x_i).$$

The next lemma characterizes the compromise sets.

Lemma A. 2 *For politicians with viable executive skill vectors $\theta \in \Theta^*$, compromise sets are defined by type-cutoff functions $c^L : \Theta^* \to [\underline{x}, w^L(\theta)]$ and $c^R : \Theta^* \to [w^R(\theta), \overline{x}]$ such that*

$$\underline{x} \leq c^L(\theta) \leq w^L(\theta) \leq x_{med} \leq w^R(\theta) \leq c^R(\theta) \leq \overline{x}.$$

A politician with ability $\theta \in \Theta^*$ and social type $x_i \in (c^L(\theta), w^L(\theta))$ compromises by adopting the highest tax $\overline{\tau}(\theta)$ that allows her to win re-election. A politician with ability $\theta \in \Theta^*$ and social type $x_i \in (w^R(\theta), c^R(\theta))$ compromises by adopting the lowest tax $\underline{\tau}(\theta)$ that allows her to win re-election. Politicians with ability $\theta \in \Theta^*$ and extreme social type $x_i \notin (c^L(\theta), c^R(\theta))$ adopt their preferred policy $\tau^*(x_i, \theta)$ and lose re-election.

Proof: For an incumbent with executive skill vector $\theta \in \Theta^*$ and social type $x_i \leq w^L(\theta)$, define $\Psi^L(x_i, \theta)$ to be the net value of compromising to $\overline{\tau}(\theta)$,

$$\Psi^L(x_i, \theta) = U(x_i, \overline{\tau}(\theta), \theta) - u(x_i, \tau^*(x_i, \theta), \theta) - \delta\overline{U}(x_i).$$

In any equilibrium, $U(x_i, \tau^*(x_i, \theta), \theta) > U(x_i)$ as long as $\Delta\theta$ is sufficiently small (I discuss the case where $\Delta\theta$ is large in Section 5). Therefore, at the cutoff $x_i = w^L(\theta)$ we have $\Psi^L(w^L(\theta), \theta) > 0$. We need to show that for any x_i below the cutoff, $x_i \in [\underline{x}, w^L(\theta)]$, the continuous function $\Psi^L(x_i, \theta)$ crosses zero at most once. This will be the case if $\Psi^L(x_i, \theta)$ is a concave function of x_i. Rewrite

$$\begin{aligned}\Psi^L(x_i, \theta) \quad = \quad & \frac{1}{1-\delta}\big[\Lambda_A(\overline{\tau}(\theta), \theta) + \Lambda_B(\overline{\tau}(\theta), \theta)x_i\big] \\ & -\big[\Lambda_A(\tau^*(x_i, \theta), \theta) + \Lambda_B(\tau^*(x_i, \theta), \theta)x_i\big] - \delta\big[E[\Lambda_A] + E[\Lambda_B]x_i\big].\end{aligned}$$

Taking the derivative with respect to x_i and using the envelope theorem,

$$\frac{\partial\Psi^L(x_i, \theta)}{\partial x_i} \quad = \quad \frac{\Lambda_B(\overline{\tau}(\theta), \theta)}{1-\delta} - \Lambda_B(\tau^*(x_i, \theta), \theta) - \delta E[\Lambda_B].$$

The first and last terms are not a function of x_i. From Lemma 1, the optimal tax rate $\tau^*(x_i, \theta)$ decreases in x_i (strictly decreases if $\tau^*(x_i, \theta) > 0$, which holds when $\psi < 1$ or $x_i < \theta_g\Omega$). From definition (16), $\Lambda_B(\tau, \theta)$ strictly decreases in $\tau < 1$. Therefore,

$$\frac{\partial^2\Psi^L(x_i, \theta)}{\partial x_i^2} \quad = \quad -\frac{\partial\Lambda_B(\tau^*(x_i, \theta), \theta)}{\partial\tau^*(x_i, \theta)}\frac{\partial\tau^*(x_i, \theta)}{\partial x_i} \leq 0,$$

and $\Psi^L(x_i, \theta)$ is concave (strictly concave if $\psi < 1$ or $x_i < \theta_g\Omega$).

For an incumbent with executive skill vector $\theta \in \Theta^*$ and social type $x_i \geq w^R(\theta)$, define $\Psi^R(x_i, \theta)$ to be the net value of compromising to $\underline{\tau}(\theta)$,

$$\Psi^R(x_i, \theta) = U(x_i, \underline{\tau}(\theta), \theta) - u(x_i, \tau^*(x_i, \theta), \theta) - \delta\overline{U}(x_i).$$

Similar result holds: $\Psi^R(w^R(\theta), \theta) > 0$ and $\Psi^R(x_i, \theta)$ is a concave function of x_i.

Consequently, the compromise cutoff functions are defined as follows:

$$\begin{aligned} c^L(\theta) &= \{\min x_i \in [\underline{x}, w^L(\theta)] | \Psi^L(x,\theta) \geq 0\} \\ c^R(\theta) &= \{\max x_i \in [w^R(\theta), \overline{x}] | \Psi^R(x,\theta) \geq 0\}. \end{aligned}$$

A politician with ability θ and social type $x_i \in (c^L(\theta), w^L(\theta))$ compromises by adopting the highest tax $\overline{\tau}(\theta)$ that allows her to win re-election. A politician with ability θ and social type $x_i \in (w^R(\theta), c^R(\theta))$ compromises by adopting the lowest tax $\underline{\tau}(\theta)$ that allows her to win re-election. Politicians with ability θ and extreme type $x_i \notin (c^L(\theta), c^R(\theta))$ have a negative net value of compromising: they choose to adopt their preferred policy $\tau^*(x_i, \theta)$ and lose re-election, concluding the proof. ■

Lemma A. 3 *An equilibrium exists.*

Proof: Existence follows from a fixed point argument on $E[\Lambda_A]$ and $E[\Lambda_B]$. Recall that

$$\begin{aligned} \Lambda_A(\tau,\theta) &= \theta_v + \theta_g \left[\tau\theta_c \left[\frac{\gamma(1-\tau)\theta_c}{\mu} \right]^{\frac{\gamma}{\sigma-\gamma}} \Omega \right]^{\psi}, \\ \Lambda_B(\tau,\theta) &= \mu \left[\frac{\sigma-\gamma}{\sigma\gamma} \right] \left[\frac{\gamma}{\mu}(1-\tau)\theta_c \right]^{\frac{\sigma}{\sigma-\gamma}}. \end{aligned}$$

At each period, the lowest feasible values of $\Lambda_A(\tau,\theta)$ and $\Lambda_B(\tau,\theta)$ are $\underline{\theta}_v$ and zero, respectively. This occurs when the politician with lowest executive skill vector implements a tax rate $\tau = 1$. The highest feasible value of $\Lambda_A(\tau,\theta)$ is $\overline{\theta}_v + \overline{\theta}_g \left[\frac{\sigma-\gamma}{\sigma}\overline{\theta}_c \left[\frac{\gamma(1-\frac{\sigma-\gamma}{\sigma})\overline{\theta}_c}{\mu} \right]^{\frac{\gamma}{\sigma-\gamma}} \Omega \right]^{\psi}$, which occurs when the politician with highest executive skill vector implements the revenue maximizing tax rate $\tau = \frac{\sigma-\gamma}{\sigma}$. The highest feasible value of $\Lambda_B(\tau,\theta)$ is $\mu \left[\frac{\sigma-\gamma}{\sigma\gamma} \right] \left[\frac{\gamma}{\mu}\overline{\theta}_c \right]^{\frac{\sigma}{\sigma-\gamma}}$, which occurs when the politician with highest executive skill vector implements a zero tax rate. Computing present values, define the (compact and convex) set of feasible values of $E[\Lambda_A]$ and $E[\Lambda_B]$,

$$D \equiv \left[\frac{\underline{\theta}_v}{1-\delta}, \frac{\overline{\theta}_v}{1-\delta} + \frac{\overline{\theta}_g}{1-\delta} \left[\frac{\sigma-\gamma}{\sigma}\overline{\theta}_c \left[\frac{\gamma(1-\frac{\sigma-\gamma}{\sigma})\overline{\theta}_c}{\mu} \right]^{\frac{\gamma}{\sigma-\gamma}} \Omega \right]^{\psi} \right] \times \left[0, \frac{\mu}{1-\delta} \left[\frac{\sigma-\gamma}{\sigma\gamma} \right] \left[\frac{\gamma}{\mu}\overline{\theta}_c \right]^{\frac{\sigma}{\sigma-\gamma}} \right].$$

The following function maps values from D to D. Given any $(E[\Lambda_A], E[\Lambda_B]) \in D$, define the continuation value $\overline{U}(x_i) = E[\Lambda_A] + E[\Lambda_B]x_i$. Use the median voter indifference condition from Lemma A.1 to compute the unique corresponding viable set θ^*, the unique tax-cutoff functions $\overline{\tau}$ and $\underline{\tau}$, and the unique type-cutoff functions w^L and w^R. Use the compromise rule from Lemma A.2 to compute the unique type-cutoff functions c^L and c^R. Finally, use these results to compute the unique new expected values of $(E[\Lambda_A]', E[\Lambda_B]')$, which must belong to the feasible set D. This function is continuous, so a fixed point exists. ■

■

A.4 Welfare

Proof: [**Proposition 1**] First notice that $\tau^{Eq}(x_i, \theta_i) = \tau^*(x_i, \theta_i)$ for centrist and extremist politicians. The first set of results follow directly from the fact that F.O.C. (8) and consequently $\tau^*(x_i, \theta_i)$ are not functions of θ_v, and $g(\tau_i, \theta_i)$ strictly increases in θ_v.

In the second set of results, $\tau^{Eq}(x_j, \theta_j) \leq \tau^{Eq}(x_i, \theta_i)$ follows from (8). From the definition of $g^*(\tau^*(x_i, \theta_i), \theta_i)$, for any $g^* > 0$

$$\frac{\partial g^*(\tau^*(x_i, \theta_i), \theta_i)}{\partial \theta_c} \frac{\theta_c}{[g^*(\tau^*(x_i, \theta_i), \theta_i) - \theta_v]}$$
$$= \psi \left[\frac{\sigma}{\sigma - \gamma} + \frac{\partial \tau^*(x_i, \theta_i)}{\partial \theta_c} \frac{\theta_c}{\tau^*(x_i, \theta_i)} \left[1 - \frac{\gamma}{(\sigma - \gamma)} \frac{\tau}{(1 - \tau)} \right] \right].$$

Hence, $\frac{\partial g^*(\tau^*(x_i, \theta_i), \theta_i)}{\partial \theta_c} \geq 0$ if and only if

$$\frac{\partial \tau^*(x_i, \theta_i)}{\partial \theta_c} \frac{\theta_c}{\tau^*(x_i, \theta_i)} \geq \frac{-\frac{\sigma}{\sigma - \gamma}}{\left[1 - \frac{\gamma}{(\sigma - \gamma)} \frac{\tau^*(x_i, \theta_i)}{(1 - \tau^*(x_i, \theta_i))}\right]}, \tag{20}$$

where we know that $[1 - \frac{\gamma}{(\sigma - \gamma)} \frac{\tau^*(x_i, \theta_i)}{(1 - \tau^*(x_i, \theta_i))}] \in (0, 1]$ since $\tau^*(x_i, \theta_i) \in [0, \frac{\sigma - \gamma}{\sigma})$. Take the derivative of the F.O.C. (8) with respect to θ_c. After some algebra we have

$$\frac{\partial \tau^*(x_i, \theta_i)}{\partial \theta_c} \frac{\theta_c}{\tau^*(x_i, \theta_i)} = \frac{-\frac{\sigma}{\sigma - \gamma}}{\left[1 + \frac{\gamma}{(\sigma - \gamma)(1 - \psi)(1 - \tau^*(x_i, \theta_i))} \frac{(\psi + \frac{(\sigma - \gamma\psi)\tau^*(x_i, \theta_i)}{(\sigma - \gamma)(1 - \tau^*(x_i, \theta_i))})}{(1 - \frac{\gamma \tau^*(x_i, \theta_i)}{(\sigma - \gamma)(1 - \tau^*(x_i, \theta_i))})}\right]} \tag{21}$$

The RHS of (21) is greater than the RHS of (20), since the former has a denominator greater than one, the later has a denominator between zero and one, both are negative and have the same numerator. Consequently, inequality (20) and the second set of results hold.

In the third set of results, $\tau^{Eq}(x_j, \theta_j) \geq \tau^{Eq}(x_i, \theta_i)$ follows from (8). When $\tau^*(x_j, \theta_j) > 0$ the increase in tax rate is strict: g^* goes up while c^* goes down for every voter. When solutions are interior and voter (α, β) faces an incumbent with social type x_i, the change in utility $\frac{\partial U(\alpha,\beta,\tau^*(x_i,\theta_i),\theta_i)}{\partial \theta_g}$ has the same sign as

$$1 + \frac{\partial \tau^*(x_i, \theta_i)}{\partial \theta_g} \frac{\theta_g}{\tau^*(x_i, \theta_i)} \psi \tau^*(x_i, \theta_i)^{1-\psi} (1 - \tau^*(x_i, \theta_i))^{\frac{\gamma(1-\psi)}{\sigma-\gamma}} \left[\tau^*(x_i, \theta_i)^{-(1-\psi)} (1 - \tau^*(x_i, \theta_i))^{\frac{-\gamma(1-\psi)}{\sigma-\gamma}} - \frac{\gamma}{(\sigma-\gamma)} \tau^*(x_i, \theta_i)^{\psi} (1 - \tau^*(x_i, \theta_i))^{\frac{-(\sigma-\gamma\psi)}{\sigma-\gamma}} - \frac{\theta_c^{\frac{\sigma(1-\psi)}{\sigma-\gamma}}}{\psi \theta_g \Omega^{\psi}} \left[\frac{\gamma}{\mu} \right]^{\frac{\gamma(1-\psi)}{\sigma-\gamma}} \left(\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} \right) \right].$$

From the F.O.C. (8), the term in brackets is zero when $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} = x_i$, hence voter $x = x_i$ is strictly better. Since $\frac{\partial \tau^*(x_i,\theta_i)}{\theta_g} > 0$, there is a type cutoff $\overline{y} > x_i$ such that the change in utility is strictly positive for voters $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} < \overline{y}$, and strictly negative for voters $\frac{\alpha^{\frac{\sigma}{\sigma-\gamma}}}{\beta} > \overline{y}$. ■

Proof: **[Lemma 2]** The result is derived directly from Lemma A.1. Take any viable politician $\theta_i \in \Theta^*$. The highest tax rate that the politician can implement and still guarantee re-election is the highest tax $\overline{\tau}(\theta_i) \in [\tau^*(x_{med}, \theta_i), 1]$ such that $U(x_{med}, \overline{\tau}(\theta_i), \theta_i) \geq \overline{U}(x_{med})$. Now take any $\theta_j \in \Theta$ such that $\theta_j > \theta_i$. We have $U(x_{med}, \overline{\tau}(\theta_i), \theta_j) \geq \overline{U}(x_{med})$, which implies that the highest $\overline{\tau}(\theta_j)$ such that $U(x_{med}, \overline{\tau}(\theta_j), \theta_j) \geq \overline{U}(x_{med})$ is at least as high as $\overline{\tau}(\theta_i)$. Similar result holds for taxes below the median voter's bliss point, $\underline{\tau}(\theta_i) \geq \underline{\tau}(\theta_j)$. Inequalities are strict when solutions are interior. ■

Proof: **[Proposition 2]** The left-moderate politician (x_i, θ_i) implements tax rate $\overline{\tau}(\theta_i) < \tau^*(x_i, \theta_i)$; the left-moderate politician (x_j, θ_j) implements tax rate $\overline{\tau}(\theta_j) < \tau^*(x_j, \theta_j)$. From Lemma 2, $\overline{\tau}(\theta_j) > \overline{\tau}(\theta_i)$ when solutions are interior, therefore $\tau^{Eq}(x_j, \theta_j) > \tau^{Eq}(x_i, \theta_i)$. Politician j has higher ability and implements a higher tax rate on the left-side of the Laffer Curve, therefore she must provide more public goods $g^*(\tau^{Eq}(x_j, \theta_j), \theta_j) > g^*(\tau^{Eq}(x_i, \theta_i), \theta_i)$.

Both politicians compromise in order to be re-elected. It implies that the median voter is indifferent between each politician and the untried challenger; consequently, he is indifferent between either politician. Politician j provides more public goods, therefore the median voter must consume less of the private good in order to be indifferent. Equilibrium consumption of c is linear in $\alpha^{\frac{\sigma}{\sigma-\gamma}}$, so every voter must consume less when politician j is the incumbent, $c^*(\alpha, \beta, \tau^{Eq}(x_j, \theta_j), \theta_j) < c^*(\alpha, \beta, \tau^{Eq}(x_i, \theta_i), \theta_i)$.

Both politicians are re-elected. The change in the discounted payoff of voter x is

$$\begin{aligned}\Delta U(x) &= U(x,\tau^{Eq}(x_j,\theta_j),\theta_j) - U(x,\tau^{Eq}(x_i,\theta_i),\theta_i)\\ &= \frac{1}{1-\delta}\Bigg[\Lambda_A(\tau^{Eq}(x_j,\theta_j),\theta_j) + \Lambda_B(\tau^{Eq}(x_j,\theta_j),\theta_j)x\\ &\qquad -\Lambda_A(\tau^{Eq}(x_i,\theta_i),\theta_i) - \Lambda_B(\tau^{Eq}(x_i,\theta_i),\theta_i)x\Bigg]\end{aligned}$$

Politician j provides more public goods: from (17), $\Lambda_A(\tau^{Eq}(x_j,\theta_j),\theta_j) > \Lambda_A(\tau^{Eq}(x_i,\theta_i),\theta_i)$. The median voter is indifferent, $\Delta U(x_{med}) = 0$. This implies that $\Lambda_B(\tau^{Eq}(x_j,\theta_j),\theta_j) < \Lambda_B(\tau^{Eq}(x_i,\theta_i),\theta_i)$. The derivative of $\Delta U(x)$ with respect to x is $\frac{1}{1-\delta}\Big[\Lambda_B(\tau^{Eq}(x_j,\theta_j),\theta_j) - \Lambda_B(\tau^{Eq}(x_i,\theta_i),\theta_i)\Big] < 0$. Therefore, $\Delta U(x) > 0$ for every $x \in [\underline{x}, x_{med}]$, and $\Delta U(x) < 0$ for every $x \in [x_{med}, \overline{x}]$. ■

Proof: [**Proposition 3**] Similar to the proof of Proposition 2: $\underline{\tau}(\theta_j) < \underline{\tau}(\theta_i)$ implies that every voter consumes more of the private good when politician j is the incumbent. The median voter is indifferent, so j offers less public goods. The derivative of $\Delta U(x)$ with respect to x is now strictly positive. $\Delta U(x_{med}) = 0$ then yields the conclusion that $\Delta U(x) < 0$ for every $x \in [\underline{x}, x_{med}]$, and $\Delta U(x) > 0$ for every $x \in [x_{med}, \overline{x}]$ ■

A.5 Productivity Growth

Proof: [**Proposition 4**] Assume (A1), (A2), and $\delta(1+\phi)^{\frac{\sigma}{(\sigma-\gamma)}} < 1$, and follow the steps of Theorem 1. (A2) implies that the term $\beta\theta_v$ is irrelevant for the political equilibrium (all politicians have the same fixed cost at every period), so we can disregard this fixed cost from our analysis.

Under economic equilibrium, when voters optimally choose labor supply, (A1) implies that we can factor out the term $\Phi_t^{\frac{\sigma}{(\sigma-\gamma)}}$ from the period utility of each agent. The period utility function —Equation (6) — becomes

$$u(\alpha,\beta,\tau,\theta,\Phi_t) = \Phi_t^{\frac{\sigma}{(\sigma-\gamma)}}\left\{\beta\theta_g\tau\theta_c\left[\frac{\gamma(1-\tau)\theta_c}{\mu}\right]^{\frac{\gamma}{\sigma-\gamma}}\Omega + \mu\left[\frac{\sigma-\gamma}{\sigma\gamma}\right]\left[\frac{\gamma}{\mu}(1-\tau)\theta_c\alpha\right]^{\frac{\sigma}{\sigma-\gamma}}\right\}.$$

That is, holding everything else constant, a higher level of Φ_t generates a higher period payoff for every agent. However, the trade off between public and private consumption generated by the income tax rate τ is independent of the TFP level. Rewrite $\Phi_t^{\frac{\sigma}{(\sigma-\gamma)}}$ as $\left[(1+\phi)^t \Phi_0\right]^{\frac{\sigma}{(\sigma-\gamma)}}$. Without loss of generality, normalized $\Phi_0 = 1$. Hence, at any given period t, the period utility of each agent is multiplied by the term $\left[(1+\phi)^{\frac{\sigma}{(\sigma-\gamma)}}\right]^t$. All other equations and variables are the same as in an economy without growth. Therefore, we can define a new discount factor $\delta' = \delta(1+\phi)^{\frac{\sigma}{(\sigma-\gamma)}}$ and verify that all equilibrium equations are equivalent in both economies (with growth and without growth but with the higher discount factor δ'). ■

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