Regional Economic Growth Disparities:
A Political Economy Perspective

Tomohito Okabe* Timothy Kam†

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Abstract

Regional differences in economic growth have been observed within many countries. Our story emphasises three region-specific factors driving growth—capital, labour and political factors. Conditional on differences in production factor (i.e., labor and capital) variations across democratic states, what role do differences in underlying "political factors" across regions play in accounting for regional growth disparities? We build a political economy model of endogenous growth where regions have the same political institutions, but experience different (and estimable) distributions over voter political biases (i.e., our "political factors"). In our model, political factors affect regional productivity as a consequence of politico-economic *equilibrium*. We discipline our regional growth accounting exercises by calibrating/estimating each model to American state-level economic and political-survey data. We show that the capital factor is the predominant driving force behind growth in American states. Nevertheless, regional variations in distributions of voter's political biases also account a great deal for regional growth disparities. We also evaluate how much politics would have distorted agents' welfare and regional growth, were regional economies given the opportunity to live under an efficient social planner's allocation system; and, if agents were to live under the same democratic system but where all voters have equal voting influence.

Keywords: Endogenous growth; Growth accounting; Regions; Political economy; Voter biases

JEL Classification: E02; D72; O43; O47; R11

*Research Division of Economic Institutions and Policy, Institute of Economic Research, Hitotsubashi University. E-mail address: t-okabe@ier.hit-u.ac.jp.

†Research School of Economics, The Australian National University. E-mail address: tcy.kam@gmail.com.

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1 Introduction

In this paper, our measurable political factor of interest is *region-specific political bias of voters towards major political parties.* We ask the question: How important is such a political factor—within otherwise similar democratic political institutions—in accounting for growth disparities across U.S. regions (i.e., states)?[1]

A standard empirical approach to growth accounting is production function based: The researcher assumes the key inputs to a production function and then estimates their relative importance in accounting for growth in total output.[2] Thus, one way to address our question is to incorporate the political factor directly into a (regional) economy's aggregate production function, and then assume that the political factor is some function of socio-economic fundamentals. This is the approach taken by some important related papers that empirically study the connection between political instability, fiscal policies and growth of countries (see, e.g., Alcántar-Toledo and Venieris, 2014, and the references cited therein). Also see Venieris and Gupta (1986, 1983).

However, given the nature of our question, we would require that the mapping between political factors and economic outcomes such a labor, capital and (productive) public goods be *endogenously determined* as part of a politico-economic equilibrium story. Thus, we consider a general-equilibrium endogenous growth model embedding a probabilistic voting framework (originally due to Lindbeck and Weibull, 1987).[3] Because the politico-economic connections are equilibrium objects in our story, we need to separately identify regional variations in the capital, labor and political factors in a deeper structural way.

As far as we are aware, ours is the first regional growth accounting exercise where the relationship between political variables, production and growth is an equilibrium object. Our approach provides a growth accountant and policy maker more structured understanding of what drives regional growth while ensuring that the endogeneity of public-private interactions is compellingly modelled from a microeconomic perspective (where agents' best responses may alter the reduced-form mapping between them). Despite allowing for the relation between political and economic outcomes to be endogenous, we find that our identified political factor still matters for explaining regional growth variations. Our exercise also provides a foundation for further empirical work in growth that seeks a deeper instrumental variable for "politics".

Using this framework, we tackle two sorts of accounting exercises. First, we ask how important is the political factor in accounting for a state's economic growth performance. We show that marginal impact of the political factor on growth is very important.[4] Second, given each estimated and calibrated model of a state economy, we show that relative to its planner's benchmark, the public infrastructure input is under-provided. In the paper we explain how differences in the political factor result in distortions to the provision of productive public goods, and how this contributes to lower growth.

The remainder of this paper is organised as follows: The model is presented in Section 2. The model is calibrated to data for each state in the U.S. in Section 3. Given the calibrations, we perform our regional growth accounting exercise. In Section 4, we show why, and how much, the political channel distorts growth and welfare. We conclude in Section 5.[5]

[1] Similar to existing cross-country inquiries into the subject (Acemoglu, 2008; Olson, 1984), political factors may also have an important bearing on the variations of within-country regional economic growth, in addition to physical and tangible inputs to production.

[2] See, e.g., Solow (1957); Jorgensen and Griliches (1967); Barro (1998); Sala-I-Martin et al. (2004); Mirestean and Tsangarides (2016). Also, Hulten and Schwab (1984) apply the same idea to accounting for regional growth differences. They find that disparities in capital and labor inputs account the regional growth differences. Also, see Gerking (1993) for other applications in American regional contexts.

[3] See also Austen-Smith and Banks (2005) and Persson and Tabellini (2002). It should be noted that the notion of political institution (i.e. the rules of the voting game and its corresponding description of democracy) is the same across regional economies. However, the politic-economic equilibrium mapping, and its outcome, is endogenous in our model in the sense that political outcomes will depend on the aggregate state of the economy, conditional on our estimates of the distributions underlying voters' political biases (i.e., our political factor of interest). The long-run equilibrium of the overall endogenous growth model resembles that of the famous AK model (Rebelo, 1991; Lucas, 1988; Romer, 1986).

[4] Using the calibrated model, we can calculate the marginal effect of each channel (capital, labor or political factor) on indicators such as the growth rate of a region, or, the model-consistent measure of welfare for different types of agents.

[5] Proofs of lemmata or propositions, and extended analyses, are relegated to a publicly accessible Online appendix. The permanent link to the Online appendix is `https://github.com/phantomachine/_regional-growth-politics`.

2 Model

General description. Consider a country consisting of regional economies. For simplicity, there is no population growth in the model. Every regional economy is closed to capital and labour flow as well as commodity trade.[6] That is, apart from region-specific differences in productivity due to differences in labor-market, capital-market, or political factors, all regions face a common technology level. For simplicity, we assume that this common technology is constant. Each local economy is populated by a continuum of two-period lived individuals (households), firms and a government. In this paper, the terms "households", "individuals" and "agents" are synonymous.

Within a local economy, a single good is produced, and its price is normalized to one. The produced good can be either consumed or invested to produce a new good at the beginning of the following period. An individual is endowed with one unit of labour time in their youth and with zero units in old age.

Individuals are divided into two types: capitalists and workers. At the beginning of their youth, individuals choose their type. The most important difference between two types is accessibility to an asset market. Capitalists can save in the form of capital stock to ensure income in old age, whereas workers cannot. Workers rely on transfers from the government to finance their consumption in old age. Income redistribution therefore plays a role of social security to support individuals with no access to the asset market.

Firms produce the output good using capital, labour and a productive public good. The public good is a non-excludable and non-rivalrous service flow that can be thought of as an infrastructure good. We use the terms "productive public good" and "infrastructure good" interchangeably. The government taxes labour and capital income, and provides transfers and the public good. Given the fixed tax rates, government expenditures are determined via a majority vote in every period.

Timing. Let time be indexed by $t \in \mathbb{N} := \{0, 1, \cdots\}$. Let superscript y denote the young, o the old, k the capitalists and ℓ the workers. Let $\mu_t^i \in (0,1)$ for $i \in \{y, o\}$ denote the fraction of capitalists in i-aged cohort of individuals at time t. At the beginning of each date $t \geq 0$, there is a pre-determined distribution of old agents over capitalist and worker types, and aggregate capital stock, respectively listed as $\left(\left(\mu_{t-1}^o, 1-\mu_{t-1}^o\right), K_t\right)$. Young individuals are born identical. Then they realise a shock e_t. Given e_t they choose their types: capitalist or worker. The existing old vote over current government policy, sufficiently indexed by the productive public good g_t (given fixed tax rates). Given government policy, the ex-post young agents make their optimal consumption decisions. The current distribution of the young over capitalist and worker types, $(\mu_t^y, 1-\mu_t^y)$ will be determined as a consequence. Then, next-period aggregate states are induced $\left((\mu_t^o, 1-\mu_t^o), K_{t+1}\right)$.

2.1 Households

Agents are *ex-ante* identical but *ex-post* heterogeneous. At the beginning of every period, identical individuals are born with one unit of labour time endowment. Then, each agent experiences a uniformly distributed idiosyncratic shock, $e \sim \mathbf{U}[0,1]$. The realised e will represent a time cost for being a capitalist, and remains fixed for the rest of each agent's life—i.e., a lower e represents an individual with a higher ability to become a capitalist.

Conditional on the realization of e, each newborn individual then chooses to be either a capitalist or a worker.

[6]This paper simplifies many inter-regional features such a cross-border trade, in order to focus on the variable political factor itself, while relegating the regional spillover effects to more reduced-form representations. That is, any inter-regional interaction will be reflected parametrically in the model—*viz.*, what we will terms as the capital (ρ) and labour (θ) channels later. We acknowledge that this is a very stark assumption, when dealing with regional economies.

We do so for the following reasons. First, if we assume that capital and labour are mobile across regions in a neoclassical environment, inter-regional flows of capital and labour eliminates the factor price differences. This results in no differences in the long-run growth rate of the productive factors, which would be counter-factual; see e.g., Harris (2011) for more details. Second, a similar approach is taken in most cross-country growth accounting exercises: Explicit international trade and factor flows between countries are often not modelled. Third, Capello and Nijkamp (2010, Ch.4) point out that we lack empirical evidence on whether trade is an important driving force for regional growth in the U.S.

To be a capitalist, an agent would have to have exerted e units of labour time and paid fixed cost, γ_t. The fixed cost is non-taxable, and given as $\gamma_t := \rho K_t$ where K_t is capital stock and $\rho > 0$ is a constant.[7] Both young capitalist and worker types supply labour to production. Following Razin et al. (2002), there is labour productivity heterogeneity between these capitalist and worker types. For each unit of labour time, young capitalist types generate a unit of labour income, whereas young worker types can only generate $\theta \in (0, 1)$ units of labour income per unit of labour time.

Consider the *ex-post* decision problems of the agents: After the agent types are determined, a young capitalist supplies $(1 - e)$ units of effective labour, whereas a young worker supplies one unit. Let $c_t^{i,m}$ denote consumption of an i-aged and m-type agent at time t, where $i \in \{y, o\}$ and $m \in \{k, \ell\}$. The individual's utility function is given by $u\left(c_t^{y,m}, c_{t+1}^{o,m}\right) := \ln c_t^{y,m} + \beta \ln c_{t+1}^{o,m}$, where $\beta \in (0, 1)$ is a common subjective discount factor.

2.1.1 *Ex-post* Capitalists

The budget constraints of a capitalist are given by:

$$s_t + c_t^{y,k} = \left(1 - \tau^\ell\right)(1 - e)\, w_t - \gamma_t, \tag{1a}$$

$$c_{t+1}^{o,k} = (1 - \tau^k)(1 + r_{t+1}) s_t, \tag{1b}$$

where s_t is savings, w_t wages and r_{t+1} the rental rate of capital. $\tau^\ell \in (0, 1)$ and $\tau^k \in (0, 1)$ are time-invariant tax rates on labour income and on capital income, respectively. Given market prices (w_t, r_{t+1}), the *ex-post* capitalist's optimal saving behavior is derived as:

$$s_t = \frac{\beta}{1+\beta}\left[\left(1 - \tau^\ell\right)(1 - e)\, w_t - \gamma_t\right]. \tag{2}$$

From the optimal saving (2) and the budget constraints (1a), (1b), the capitalist's optimal consumption behavior over his lifetime obeys:

$$c_t^{y,k} = \frac{1}{1+\beta}\left[\left(1 - \tau^\ell\right)(1 - e)\, w_t - \gamma_t\right], \tag{3}$$

$$c_{t+1}^{o,k} = \frac{\beta\left(1 - \tau^k\right)(1 + r_{t+1})}{1+\beta}\left[\left(1 - \tau^\ell\right)(1 - e)\, w_t - \gamma_t\right]. \tag{4}$$

2.1.2 *Ex-post* Workers

The budget constraints of workers are given by:

$$c_t^{y,\ell} = (1 - \tau^\ell)\theta w_t, \tag{5a}$$

$$c_{t+1}^{o,\ell} = c_{g,t+1}, \tag{5b}$$

where $c_{g,t+1} > 0$ is the lump sum transfer from the government. Recall the parameter $\theta \in (0, 1)$ represents the efficiency units of labour. Whereas capitalist types can work and save, worker types only work and cannot save. Since agents do not value leisure, the decision problem of the worker types is simple: it implies that young worker types consume their labor income in each period, and, old worker types consume from government transfers. That is, workers' optimal consumption sequence is pinned down directly by Equations (5a) and (5b), given wage w_t and the lump sum transfer $c_{g,t+1}$.

[7] As shown later, the latter assumption helps to ensure a balanced growth path of the local economy.

2.1.3 *Ex-ante* decision

This section details how each individual chooses whether to be a capitalist or a worker, and how the aggregate choices determine the distribution of agents, $\{\mu_t^y, 1-\mu_t^y\}$, where μ_t^y is the current aggregate proportion of young capitalists. We consider how individuals assess *ex post* payoffs. Given pre-determined initial capital K_t (and hence the fixed cost $\gamma_t = \rho K_t$), the set of government policies $\{\tau^k, \tau^\ell, g_t, c_{g,t}\}$, and the set of prices $\{w_t,\, r_t\}$, the *ex post* payoff of capitalists will depend on K_t and e.[8] The value function of an *ex-post* capitalist is given by:

$$U^k(K_t, e) := u\left(c_t^{y,k}(K_t, e), c_{t+1}^{o,k}(K_t, e)\right) = \ln c_t^{y,k}(K_t, e) + \beta \ln c_{t+1}^{o,k}(K_t, e), \tag{6}$$

where $c_t^{y,k}$ is given by Equation (3), and $c_{t+1}^{o,k}$ is given by Equation (4). The value function of an *ex-post* worker is given by:

$$U^\ell(K_t) := u\left(c_t^{y,\ell}(K_t), c_{t+1}^{o,\ell}(K_t)\right) = \ln c_t^{y,\ell}(K_t) + \beta \ln c_{t+1}^{o,\ell}(K_t), \tag{7}$$

where $c_t^{y,\ell}$ is given by Equation (5a), and $c_{t+1}^{o,\ell}$ given by Equation (5b). Notice that $U^\ell(\cdot)$ does not depend on e because the payoff across worker types is identical.The *ex-ante* decision problem of a newborn agent with realised idiosyncratic shock $e \in (0,1)$ is given by:

$$\max_{capitalist, worker} \left\{U^k(K_t; e), U^\ell(K_t)\right\}$$

subject to budget constraints (1a), (1b), (5a) and (5b). We can show that there is a unique agent type who is indifferent between being either capitalist or worker:

Lemma 1 *Given K_t, there is a unique cut-off level $e^* \in (0,1)$ in the ex-ante decision problem, such that $U^k(K_t, e^*) = U^\ell(K_t)$.*

Lemma 1 implies that those with $e \leq e^*$ choose to be capitalists, whereas those with $e > e^*$ choose to be workers. Since e is uniformly distributed on $[0,1]$, the cut-off level turns out to equal the fraction of (young) capitalists:[9]

$$e^* = \mu_t^y. \tag{8}$$

Moreover, this consequence determines the amount of labour supply. The aggregate labour supply by capitalists is given by:

$$\ell_t := \int_0^{e^*} N(1-z)dz = N\mu_t^y \left(1 - \frac{\mu_t^y}{2}\right),$$

where z is a dummy variable for e, and N is the size of population. The labour of workers is given by $N(1-\mu_t^y)\theta$. The total labour supply is then given by:

$$L_t := \ell_t + N(1-\mu_t^y)\theta. \tag{9}$$

[8] The contingency on e is obvious from Equations (3) and (4) where the optimal consumption is expressed as a function of e. The dependency on K_t is verified with the results of a profit maximisation problem to be shown in Section 2.2. Given the optimal demands of capital and labour by firms, the equilibrium levels of prices, i.e., w_t and r_{t+1}, turn out to be dependent on K_t. Therefore, the optimal consumptions are also dependent on K_t.

[9] A more general case where e is distributed according to a continuous density function is shown in our Online Appendix B.

2.2 Firms

In the local economy, there is a measure-one continuum of identical firms. The aggregate production function is $F(K, L, g) := AK^{\alpha} [Lg]^{1-\alpha}$, where $A > 0$ is a total factor productivity (TFP) level common to all regions, K is capital stock, L is labour, g is the productive public good, and $\alpha \in (0, 1)$ is the income share of capital. As in Barro (1990) and Angelopoulos et al. (2007), public good g is treated as a flow variable (i.e., it does not accumulate over time).

Total labour supply L_t is exactly equal to the labour input for the production. The markets for capital and labour are perfectly competitive, such that firms seek to maximise the profit $\Pi_t := Y_t - w_t L_t - (r_t + \delta) K_t$, where $\delta \in (0, 1)$ is the depreciation rate of capital stock. The first-order conditions for the profit maximisation problem are given by:

$$w_t = \frac{(1-\alpha)Y_t}{L_t}, \tag{10}$$

$$r_t = \frac{\alpha Y_t}{K_t} - \delta. \tag{11}$$

Given capital stock at the initial period K_0, capital accumulation is driven by:

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{12}$$

where I_t denotes private investment flow.

2.3 Government

The gross revenue of the government is given by:

$$T_t := \tau^{\ell} w_t L_t + \tau^k (1 + r_t) S_{t-1}, \tag{13}$$

where $S_{t-1} := N \int_0^{e^*} s_{t-1}(z)\, dz$ is the aggregate savings in the last period. The government allocates the available resources towards the productive public good g_t and income redistribution $N(1-\mu_t^o)c_{g,t}$. A balanced budget requires that:[10]

$$T_t = g_t + N(1-\mu_t^o)c_{g,t}. \tag{14}$$

The feasible set restricting expenditure on either public infrastructure, g_t, or transfers, $N(1-\mu_t^o)c_{g,t}$, is denoted by $G_t := [0, T_t]$.

2.4 Market clearing conditions

We focus on the good and asset markets here.[11] The sum of individual consumption levels is:

$$C_t := N \left[\int_0^{e^*} c_t^{y,k}(z)dz + (1-\mu_t^y)c_t^{y,\ell} + \int_0^{e^*} c_t^{o,k}(z')dz' + (1-\mu_t^o)c_t^{o,\ell} \right]$$

[10] In this paper, we do not consider the possibility that a regional government can also issue government debt to finance its outlays. Introducing government debt will allow a current majority of voters to further expand government expenditures in their favour, while crowding out future voters' enjoyment of government spending. In such a setting, current young voters may have the incentive to limit government debt (see, e.g., Song et al., 2012; Alesina and Passalacqua, 2015). We leave this additional margin of political conflict for future extensions.

[11] Since labor supplies are inelastic, the labour market is always in equilibrium.

$$=(1-\tau^{\ell})L_t w_t - (S_t + N\mu_t^y \gamma_t) + (1-\tau^k)(1+r_t)S_{t-1} + N(1-\mu_t^o)c_{g,t}. \tag{15}$$

The market clearing condition for the final good is given by $Y_t = C_t + I_t + g_t$, and the asset market clearing condition is given by:

$$I_t = S_t = \frac{\beta\left[(1-\tau^{\ell})\ell_t w_t - N\gamma_t \mu_t^y\right]}{1+\beta}. \tag{16}$$

Definition 1 *A competitive equilibrium in the regional economy is a sequence of relative prices* $\{w_t, r_t\}_{t=0}^{\infty}$*, fixed cost* $\{\gamma_t\}_{t=0}^{\infty}$*, consumption and savings* $\left\{c_t^{y,k}, c_t^{y,\ell}, c_t^{o,k}, c_t^{o,\ell}, s_t\right\}_{t=0}^{\infty}$*, capital stock* $\{K_{t+1}\}_{t=0}^{\infty}$*, distribution of agents* $\{\mu_t^y\}_{t=0}^{\infty}$*, given the initial capital stocks* K_0*, the initial distribution of old agents* μ_0^o*, a sequence of public policies* $\{g_t, c_{g,t}\}_{t=0}^{\infty}$*, and proportional tax rates* τ^k, τ^{ℓ}*, such that:*

(i) individuals optimize,

(ii) firms maximise profits,

(iii) all markets clear, and

(iv) the government budget is balanced.

2.5 Political conflict of interest

Now we will describe what is a government policy and how agents' preferences may conflict over such policy outcomes. We will assume fixed proportional tax policies, so public policy in the model boils down to deciding the composition of total government spending.[12] The policy instruments are the public good expenditure, g_t, and the lump sum transfer per capita, $c_{g,t}$. However, the balanced budget requirement (14) implies that either of the two instruments will be determined once the other is chosen. Therefore, we analyse voters' preferences in terms of g_t.

We restrict our attention to old agents who will be the voters in the model.[13] The indirect utility functions of old agents over the public good policy are given by:

$$\begin{aligned} V^k(K_t, g_t; e) &:= \beta \ln c_t^{o,k}(K_t, g_t; e), \\ V^{\ell}(K_t, g_t) &:= \beta \ln c_t^{o,\ell}(K_t, g_t). \end{aligned}$$

Notice that the valuation of the capitalists, $V^k(K_t, g_t; \cdot)$ varies on the parameter domain $[0, e^*]$ because the amount of savings is contingent on the agent's time cost of being a capitalist, e.

Lemma 2 *Given* K_t *and* e*, every old individual exhibits a single-peaked preference over* $g_t \in G_t$ *in the competitive equilibrium such that:* $\partial^2 V^m(K_t, g_t; e)/\partial g_t^2 < 0$*, for each* $m \in \{k, \ell\}$*. There is a unique bliss point (or preferred policy) of the capitalists, given by:*

$$g_t^{\star k} = T_t(K_t, g_t^{\star k}; e), \tag{17}$$

[12] We will calibrate these regional tax rates later.

[13] We could also analyze the problem more generally by allowing all voters to vote. However, we chose to not do it here for two reasons. First, we have a theoretical justification for this simplification: If we also assumed that the current young vote, the young capitalists have no conflict of interest with the young workers, i.e., both groups prefer a higher g_t as it implies a higher wage w_t in equilibrium. (This can be deduced directly by observing their young-age budget constraints and the fact that in the current period, the young take future events as given.) Thus all the young agents—capitalist and worker types—agree with the current old capitalists, and they together would disagree with the current old worker types. Therefore, the nature of the static voting equilibrium each period in our model is unchanged even if we allowed young agents to vote. Our assumption is a special case of a probabilistic voting model where everyone votes, but in which the old voters (in the limit) have all the political influence. Mulligan and Sala-i-Martin (1999) have also argued that since older voters have a lower opportunity cost of time, they tend to have a larger influence on the determination of redistributive policies. Second, there is empirical support that suggest that our assumption here is a reasonable approximation of reality. In the U.S. data, older voters tend to be more active in electoral participation (see Leighley and Nagler, 2013; Wolfinger and Rosenstone, 1980).

whereas the unique bliss point of the workers is given by:

$$g_t^{\star\ell} \in G_t \quad \textit{satisfying} \quad \left.\frac{\partial V^\ell}{\partial g_t}\right|_{g_t = g_t^{\star\ell}} = 0. \tag{18}$$

Lemma 2 shows the conflicting preference between capitalists and workers. On one hand, Equation (17) indicates that the capitalists are consistently in favour of more public good because an increment in the public good raises the rental rate of capital, thus enhancing the saving returns. The most desired policy for the capitalists is where the government spends the entire tax revenue on the public good. Notice that the gross tax revenue T_t is simultaneously determined with the policy variable g_t because the amount of the public good affects the current prices of labour and capital, and hence the tax base. On the other hand, Equation (18) implies that the workers are in favour of more public good as long as it is under their bliss point $g_t^{\star\ell}$. A marginal increase in the public good raises tax revenue enough to enhance the lump sum transfer to them, i.e., $c_{g,t}$. However, once it is beyond the bliss point level, they would prefer less public good because additional increments in the public good decrease the lump sum transfer they would be getting.

Now we can identify the policy domain where the conflicting preferences emerge. Let $\eta(K_t, g_t) := K_t/g_t$ denote the capital-public good ratio. The following proposition is immediately established:

Proposition 1 *Given K_t, the conflicting preference over the policy g_t arises if and only if*

$$\eta(K_t, g_t) \in \left(\underline{\eta}_t, \overline{\eta}_t\right) \tag{19}$$

where $\underline{\eta}_t := \left[\frac{1}{(1-\alpha)A\Xi L_t^{1-\alpha}}\right]^{\frac{1}{\alpha}}$, $\Xi := \tau^\ell(1-\alpha) + \tau^k\alpha$, *and* $\overline{\eta}_t$ *satisfies* $\Xi A L_t^{1-\alpha}\overline{\eta}_t^\alpha + \tau^k \mu_t^y \rho \overline{\eta}_t - 1 = 0$.

Observe that $\underline{\eta}_t$ corresponds to the feasible upper bound of g_t, i.e., when $g_t = g_t^{\star k}$, whereas $\overline{\eta}_t$ corresponds to the lower limit of feasible $g_t = g_t^{\star\ell}$. Also, note that when we consider the balanced-growth or steady-state equilibrium path later, the open set $\left(\underline{\eta}_t, \overline{\eta}_t\right)$ will be constant.

2.6 Electoral competition

This section introduces a probabilistic voting game where policy variables are endogenously determined. Consider the case where (19) holds, so that there is a conflict of interest among voters.[14] In every period, all the old individuals vote to elect a politician who implements the policy after the election. There are two candidates, A and B, who seek to maximise their expected vote share. Let g_t^C denote the policy announced by candidate $C \in \{A, B\}$. The candidates differ in "ideology", a factor defined on a separate dimension orthogonal to the policy space. Ideology is a voter-intrinsic object that varies independently from the state of the economy and announced polices. From a politician's perspective, a person's ideological bias is a random variable, but it is known to the voter himself. (This captures the idea that political candidates do not perfectly know everything about voters' preferences.)

Specifically, suppose that candidate A is liberal (or left-wing) and candidate B is conservative (or right-wing). Individuals cast votes based on the announced policies and their individual ideological characteristics. Given the elected candidate $C \in \{A, B\}$, let the payoff of an m-type voter be given by:

$$W^m\left(K_t, g_t^C\right) = V^m\left(K_t, g_t^C\right) + \varepsilon_t^{C,m} \quad \text{for } m \in \{k, \ell\},$$

where $\varepsilon_t^{C,m}$ is agent-specific random utility that an m-type voter derives from the ideology of candidate C. The relative utility of an m-type voter in favour of candidate B is given by $\varepsilon_t^{B,m} - \varepsilon_t^{A,m}$. The expression $\varepsilon_t^{B,m} - \varepsilon_t^{A,m}$ is

[14] In our calibrated growth accounting exercise later, we ensure that this condition is respected in every balanced-growth path equilibrium we consider.

the random variable referred to as the voter's "political bias". Political bias is also known as ideological bias (see Persson and Tabellini, 2002).

We focus on the distribution of political bias. Suppose that m-type voters inherit their bias status from the same type ancestors from the prior period, and face an idiosyncratic shock to their bias at the beginning of the current period. The bias distribution then changes over time according to a Markov chain. Let the support for the bias distribution be given by a three-state space $\Omega := \{\omega_1 := -a, \omega_2 := 0, \omega_3 := a\}$, $(a > 0)$ where ω_1 represents liberal (left-wing) bias; ω_2 neutral (i.e., no bias); and negative element ω_3 conservative (right-wing) bias. Let $\phi_t(\cdot)$ denote the probability mass function over Ω, and let $\Psi_t(\cdot)$ denote its cumulative distribution function that is strictly increasing and strictly concave.[15]

The timing of the voting game is as follows: (1) Two candidates simultaneously announce their policies g_t^A and g_t^B. At this stage, they acknowledge the voter policy preferences $V^m(K_t, \cdot)$. They also know the distributions of political bias, $\boldsymbol{\phi}_t^m$ for each $m \in \{k, \ell\}$, but not yet its realised values; (2) The actual values of the political bias are realised, and hence all the uncertainties from candidates' perspective are resolved; (3) Voters cast votes; (4) The elected candidate implements her announced policy.

At Stage (2), the probability that an m-type individual votes for candidate A is given by:

$$Pr\left[\left\{W^m(K_t, g_t^A) - W^m(K_t, g_t^B)\right\} > 0\right] = \Psi_t^m\left[V^m\left(K_t, g_t^A\right) - V^m\left(K_t, g_t^B\right)\right].$$

The candidate A's expected vote share is then given by:

$$\begin{aligned}\pi_A\left(K_t, g_t^A, g_t^B\right) = N\mu_t^o\Psi_t^k\left[V^k\left(K_t, g_t^A\right) - V^k\left(K_t, g_t^B\right)\right] \\ + N(1-\mu_t^o)\Psi_t^\ell\left[V^\ell\left(K_t, g_t^A\right) - V^\ell\left(K_t, g_t^B\right)\right],\end{aligned}$$

and candidate B's vote share is given by $\pi_B\left(K_t, g_t^A, g_t^B\right) = 1 - \pi_A\left(K_t, g_t^A, g_t^B\right)$. Both candidates seek to maximise their own vote share. The optimal announced policies are therefore given by $g_t^{A*} \in \arg\max_{g_t^A} \pi_A(K_t, \cdot, g_t^B)$ and $g_t^{B*} \in \arg\max_{g_t^B} \pi_B(K_t, g_t^A, \cdot)$.

Given the strict concavity of $V^m(K_t, \cdot)$ on G_t and the strict concavity of $\Psi_t^m(\cdot)$ on Ω, $\pi_A\left(\cdot, g_t^B\right)$ is strictly concave, and so is $\pi_B\left(g_t^A, \cdot\right)$. We have a unique Nash equilibrium where both candidates announce an identical policy, $g_t^{A*} = g_t^{B*} := g_t^* = K_t/\eta$.

The first-order condition for the maximisation problem is given by:

$$\phi_t^k(0)\int_0^{\mu_t^o}\frac{\partial V^k(z)}{\partial g_t}dz + (1-\mu_t^o)\phi_t^\ell(0)\frac{\partial V^\ell}{\partial g_t} = 0, \tag{20}$$

where z is a dummy variable for the index e. Equation (20) has an integral with respect to e because the derivative of $V^k(\cdot)$ varies on $[0, e^*(=\mu_t^o)]$ from Lemma 1 and Equation (8). The measure $\phi_t^m(0)$ is the fraction of m-type voters with no political bias, i.e., the pivotal or swing voters.

Equation (20) is equivalent to the first-order condition for a Benthamite welfare maximisation problem, where the welfare function is given by:

$$\zeta(g_t) := \phi_t^k(0)\int_0^{\mu_t^o} V^k(z)dz + \phi_t^\ell(0)(1-\mu_t^o)V^\ell. \tag{21}$$

In fact, the Nash equilibrium outcome η^* is the maximiser of this welfare function.

[15] Denote a current unconditional distribution on Ω as $\boldsymbol{\phi}_t := (\phi_t(\omega_1), \phi_t(\omega_2), \phi_t(\omega_3))$. The Markov chain is given by the recursion $\boldsymbol{\phi}_{t+1} = \boldsymbol{\phi}_t\boldsymbol{\Lambda}$, with $\boldsymbol{\phi}_0$ known, and $\boldsymbol{\Lambda}$ is a stochastic (or Markov) matrix. We assume that this is an aperiodic and irreducible Markov chain. Given the irreducibility and aperiodicity of the Markov chain, the distribution converges to a unique stationary distribution as time approaches infinity, $\boldsymbol{\phi}^* := \lim_{t\to\infty}\boldsymbol{\phi}_0$.

Notice that $\phi_t^k(0)$ and μ_t^o define the political influence for capitalist-type voters, whereas $\phi_t^\ell(0)$ and $(1-\mu_t^o)$ determine the political weight for worker-type voters. These measures $\phi_t^k(0)$ and $\phi_t^\ell(0)$ index or identify the underlying "political factors" that we emphasize in this paper, and, we estimate them below from observed data from each American state.

We summarize the preceding results as follows:

Lemma 3 *Given K_t, the probabilistic voting game yields a unique Nash equilibrium, $\eta(K_t, g_t) \in (\underline{\eta}_t, \overline{\eta}_t)$ which is characterised by the first-order condition (20).*

Definition 2 *A politico-economic equilibrium is a sequence of prices $\{w_t, r_t\}_{t=0}^\infty$, per-period fixed costs $\{\gamma_t\}_{t=0}^\infty$, consumption and savings $\left\{c_t^{y,k}, c_t^{y,\ell}, c_t^{o,k}, c_t^{o,\ell}, s_t\right\}_{t=0}^\infty$, capital stocks $\{K_{t+1}\}_{t=0}^\infty$, distribution of agents $\{\mu_t^y\}_{t=0}^\infty$, sequence of public policies $\{g_t, c_{g,t}\}_{t=0}^\infty$, given the initial capital stocks K_0, constant tax rates τ^k, τ^ℓ, and the initial distribution of old agents μ_0^o such that:*

(i) individuals rationally choose agent types and optimise,
(ii) firms maximise profits,
(iii) all markets clear,
(iv) the government budget is balanced, and
(v) electoral competition is in Nash equilibrium where both candidates announce an identical policy.

In the politico-economic equilibrium, we can show that output follows the law of motion

$$Y_{t+1} = AL_{t+1}^{1-\alpha}\left(\frac{K_{t+1}}{g_{t+1}}\right)^{\alpha-1}\left\{1-\delta+\frac{\mu_t^y \beta L_t^{-\alpha}\left(K_t/g_t\right)^{\alpha-1} - N\rho}{1+\beta}\right\}K_t,$$

where the ratios $\eta_{t+1} := (K_{t+1}/g_{t+1})$ and $\eta_t := (K_t/g_t)$ are solutions to the voting equilibrium (20) in each date. Hence, as long as the distributions of voter biases (and thus, η_t) are evolving over time, the equilibrium path of the economy is also evolving around a constant balanced-growth path. The off-balanced-growth-path rate of growth for output, ν_{t+1} is:

$$\begin{aligned}1+\nu_{t+1} &:= \frac{Y_{t+1}}{Y_t}\\ &= \left(\frac{K_{t+1}}{g_{t+1}}\cdot\frac{g_t}{K_t}\cdot\frac{L_{t+1}}{L_t}\right)^{\alpha-1}\\ &\quad\times\left\{1-\delta+\frac{N\mu_t^y\beta\left[(1-\tau^\ell)(1-\mu_t^y/2)(1-\alpha)L_t^{-\alpha}\left(K_t/g_t\right)^{\alpha-1}-\rho\right]}{1+\beta}\right\}.\end{aligned}$$

2.7 Steady state

Later, when we conduct our growth accounting exercises, we will be doing so from the perspective of a steady-state or balanced-growth-path equilibrium for each regional economy.

Definition 3 *A steady state equilibrium is a politico-economic equilibrium path along which consumption and savings $c_t^{y,k}, c_t^{y,\ell}, c_t^{o,k}, c_t^{o,\ell}, s_t$, capital K_t, the productive public good g_t and fixed cost γ_t grow at a constant rate.*

As the ideological bias distributions approach the steady state, the growth rate converges to a constant given by:

$$\nu := -\delta + \frac{N\mu^*\beta\left[(1-\tau^\ell)(1-\mu^*/2)(1-\alpha)L^{*-\alpha}A\eta^{*\alpha-1}-\rho\right]}{1+\beta}, \tag{22}$$

where the superscript * denotes a constant value. The political constraint (20) characterising η^* is then recast as:

$$\phi^{*k}(0)\int_0^{\mu^*}\frac{\partial V^k(z)}{\partial g_t}dz + (1-\mu^*)\phi^{*\ell}(0)\frac{\partial V^\ell}{\partial g_t} = 0. \tag{23}$$

From Lemma 1 with Equation (8), the distribution of agents μ^* is characterised by

$$U^k(K_t,\mu^*) = U^\ell(K_t). \tag{24}$$

Finally, equilibrium labour allocation is given by:

$$L^* = \ell^* + N(1-\mu^*) = N\left[\mu^*\left(1-\frac{\mu^*}{2}\right) + (1-\mu^*)\,\theta\right]. \tag{25}$$

Observe that Equation (22) includes three endogenous variables, η^*, μ^* and L^* that are simultaneously determined by Equations, (23), (24) and (25). The equilibrium solution cannot be computed analytically. These results are summarised by the following proposition.

Proposition 2 (Balanced-growth equilibrium) *Along a steady-state growth path, the distributions of political bias are constant: $\boldsymbol{\phi}^k = \lim_{t\to\infty}\boldsymbol{\phi}_t^k$ and $\boldsymbol{\phi}^\ell = \lim_{t\to\infty}\boldsymbol{\phi}_t^\ell$. The balanced-growth equilibrium is thus a constant growth rate of output ν, private-capital-to-public-good ratio η^*, the distribution of agents μ^*, and, total labor allocation L^*, that satisfy the system of non-linear equations,*

$$\begin{aligned}
\nu &= \tilde{\nu}(\mu^*,\eta^*,L^*),\\
\eta^* &= \tilde{\eta}(\mu^*,L^*),\\
\mu^* &= \tilde{\mu}(\eta^*,L^*),\\
L^* &= \tilde{L}(\mu^*),
\end{aligned}$$

where, respectively, the equilibrium functions $(\tilde{\nu},\tilde{\eta},\tilde{\mu},\tilde{L})$ are implicitly characterised by (22), (23), (24) and (25).

Notice that the economic growth rate becomes constant along the steady state path, although individuals continue to face idiosyncratic shocks in terms of their political biases. This model is thus an AK-type growth model nesting Barro (1990) as a homogeneous-agents special case.

3 Accounting for Regional Disparities

We now consider the growth accounting question posed at the beginning of this paper. Specifically: How important is the political factor in accounting for regional differences in growth? The key region-specific channels are summarized by: (1) the fixed cost for being a capitalist, ρ; (2) labour productivity, θ, and (3) the equilibrium fraction of pivotal voters, $\phi^{*m}(0)$, $m \in \{k,\ell\}$. Recall that we interpreted channels (1) and (2) as embedding geographical and trade-related factors explaining the variation of one region from another, and channel (3) as the key identifier of the political factor in each region.

First, we will explain how our will put some data discipline on our numerical exercises for growth accounting, in Section 3.1. Second, we can get a sense of how variable growth rates are across the states on which we have data observations, and we show how this is mainly reflected in our calibration results as high cross-region variability in the ratio of private capital to public infrastructure. This is done in Section 3.2. Section 3.3 contains the actual regional growth accounting exercise.

Since we have no analytical solution for the balanced-growth-path politico-economic equilibrium conditions, we will need to obtain them numerically. To do so, we need to discipline parameter values of the model by calibrating each regional model to target specific region's observable charateristics. Below, we explain the main ideas behind how we discipline the parameters identifying the: (1) political factor, (2) labor market factor, and (3) the capital market factor, with respect to observed long-run data for each American state (or "region").

3.1 Parameters identifying key factors: estimation and calibration

Estimated Political Factor. We estimate the "parameters" $\phi^k(0)$ and $\phi^\ell(0)$ for each region in the U.S. However, we do not observe the long run versions of $\phi^k(0)$ and $\phi^\ell(0)$ in the data. We overcome this problem as follows: Given our assumed Markov chain underlying voters' political biases, we first have to estimate the Markov matrix Λ, one for each U.S. region from finite samples of political bias distributions $\{\boldsymbol{\phi}_t\}_{t=0}^T$. Then we can calculate the implied long run distribution of the political biases in each region.

In terms of relating the model state space of ideologies to the data, we focus on party identification (PID). PID is a popular concept in American political science, and is defined as "an attachment to a party that helps the citizen locate him/herself and others on the political landscape" (Campbell et al., 1960). It can be thought of as a proxy for ideology, and hence of political bias. Suppose that PID observations are given as a three-point measure: Democrats, Independents and Republicans. We thus reinterpret the state space Ω given in Section 2.6 as a PID space where ω_1 represents for Democrats, ω_2 for Independents and ω_3 for Republicans.

We use a cross-sectional data set of a nation-wide public opinion survey, *the American National Election Study* (ANES). More details on is discussed in our Online Appendix F.

Using an estimation method proposed by Okabe (2015), we estimate $\boldsymbol{\Lambda}$ for the ideological bias' Markov chain for individual American states and compute the stationary distributions. The computed fractions of Independents are used as estimates for $\phi^{*k}(0)$ and $\phi^{*\ell}(0)$.

Model calibration to data. See the Online Appendix E for details on how we calibrated the rest of each regional model's parameters to observed data for a corresponding American state. Given our estimates for political bias parameters (i.e., $\phi^{*k}(0)$ and $\phi^{*\ell}(0)$), the remaining parameters, ρ and θ, are pinned down together with endogenous distribution μ^* using the first-order conditions (22), (23) and (24). Finally, population size N is pinned down by Equation (25), given μ^*, θ and the normalised aggregate labour, $L^* = 1$.

3.2 Regional variations and calibrations

Figure 1 shows the heat map of four-year average GSP growth rates, across the regions or states on which we have data.

[**Figure 1 about here.**]

The growth rates vary approximately $6-10\%$ across the states. In our Online Appendix F we also plot the region-specific parameters we have calibrated. We also summarize the equilibrium outcomes across the states, given the calibrations as Table G.7 in the same appendix. In short order, our calibrated equilibria show that the agent-type distributions and government expenditure composition do not differ greatly across the states. However, there are sizable variations across the regions, in the (long-run) equilibrium relative share of pivotal voters ($\phi^k(0)/\phi^\ell(0)$) and capital-public good ratio (η^*).

3.3 Regional growth accounting: equilibrium and measurement

This section details how the channel with the greatest influence on growth can be determined for a given region's politico-economic balanced-growth equilibrium. Previously, we showed that the balanced-growth equilibrium path of each regional economy is characterised by a system of four non-linear equations: (22), (23), (24) and (25).

Using this system, we can numerically decompose each of the three channels accounting for growth in the regional models—capital (ρ), labor (θ) and politics ($\phi^{*k}(0)$). First, from (22), we have the total derivative of each region's growth rate with respect to these region-specific parameters:

$$\frac{d\nu}{db} = \frac{\partial \nu}{\partial \eta^*}\frac{\partial \eta^*}{\partial b} + \frac{\partial \nu}{\partial \mu^*}\frac{\partial \mu^*}{\partial b} + \frac{\partial \nu}{\partial L^*}\frac{\partial L^*}{\partial b} + \frac{\partial \nu}{\partial b}, \tag{26}$$

where $b \in B := \{\rho, \phi^{*k}(0), \theta\}$. However the partial derivatives on the right-hand side of (26) are dependent on the entire equilibrium description (22), (23), (24) and (25). Applying the implicit function theorem allows us to (numerically) compute each of these partial derivatives. In the Online Appendix F, we show how this is done and provide some intuition for the forces underlying the signs of these (numerical) partial derivatives. We find that the total derivative with respect to each of the channels——capital (ρ), labor (θ) and politics ($\phi^{*k}(0)$)—have the following signs:

$$\frac{d\nu}{d\rho} < 0, \quad \frac{d\nu}{d\phi^{*k}(0)} > 0, \quad \frac{d\nu}{d\theta} < 0.$$

We then calculate a sensitivity measure for the impact of each of these channels on a region's growth rate:

$$R_b = \frac{\left|\dfrac{b}{\nu}\cdot\dfrac{d\nu}{db}\right|}{\left|\dfrac{\rho}{\nu}\cdot\dfrac{d\nu}{d\rho}\right| + \left|\dfrac{\phi^{*k}(0)}{\nu}\cdot\dfrac{d\nu}{d\phi^{*k}(0)}\right| + \left|\dfrac{\theta}{\nu}\cdot\dfrac{d\nu}{d\theta}\right|} \times 100\,(\%), \qquad b \in B := \{\rho, \phi^{*k}(0), \theta\}. \tag{27}$$

Note that $R_\rho + R_{\phi^{*k}(0)} + R_\theta = 100\,(\%)$. The growth-accounting measure (27) indicates the (absolute) elasticity of each region's growth rate with respect to channel b, relative to the total of all elasticities. The way to read this measure is as follows: If a channel $b \in B$ yields the largest percentage R_b, then we say that this is the most influential channel in accounting for the particular region's economic growth. (Of course this is understood to be conditional on our regional model as the interpretive structure and measurement device.)

Figures 2 and 3 show the cross-state growth accounting measures, respectively, for the private capital channel (ρ) and the political factor ($\phi^k(0)$). Each figure contains two pieces of growth-accounting information: the total derivative $d\nu/db$ and the relative elasticity measure R_b.

[**Figure 2 about here.**]

We observe that the capital channel (representing the regional market effects via capital outcomes) accounts the most for regional growth across 15 states ($R_\rho \simeq 40-50\%$). This suggests that the cross-state disparity in growth is shaped largely by the differences in the market working through capital. The political factor has the largest impact across four states ($R_{\phi^{*k}(0)} \simeq 40\%$).

[**Figure 3 about here.**]

Although there are not many states where the political factor accounts the most for growth, there are many states with $R_{\phi^{*k}(0)}$ which is close to R_ρ. In other words, variations in the political factor matters a lot in accounting for growth disparities across states.[16]

Interestingly, the most important identifier for growth differs between some states that exhibit similar growth rates. For instance, we restrict our focus on two states in our Group A classification: Georgia and New Jersey. The

[16] We also conduct the same exercise, combining with another data set on public opinion survey. The results are not greatly changed. The most influential channels are the capital channel in 20 states and the political factor in 4 states. See our Online Appendix G for this robustness check.

average growth rate of the former is 9.17%, and that of the latter is 9.18%. The most important factor accounting for growth in Georgia is the capital channel ($R_\rho = 43\%$), whereas that for New Jersey is the political factor ($R_{\phi^{*k}(0)} = 50\%$). Thus, given our interpretive framework and calibration to the data, this says that two states can end up on the same economic development path, but they can have quite different major reasons for getting there.

Next, consider the colour codes we use to evaluate the cross-state variations in the impact of each channel on regional growth. In Figure 2, the effect of the capital channel is larger in California, Florida and some of the northeastern states (e.g., Michigan, Ohio, Wisconsin). In such states, the capital market factor, identified in the model by the market friction ρ, is quite important in accounting for growth. Specifically, the magnitudes on the heat map suggests that for a 1% increase in ρ, we would expect to see a considerable reduction in economic growth in the order of $43-50\%$.

Figure 3 shows that the impact of the political factor is also large in Michigan and Florida. Interestingly, according to the political science literature (e.g., Watts, 2010), Florida is known to be one of the swing states where no single party dominates in elections. According to our model (which says that $d\nu/d\phi^{*k}(0) > 0$) would say that Florida may be able to boost economic growth if its capitalist types have more influence in terms of being swing voters.[17]

4 Accounting for political distortion

We now come to our second growth-accounting question: How much would each state have gained or lost had it moved from an efficient social planner's paradigm into its current politico-economic equilibrium? To answer this, we need to calculate the planner's benchmark solution. We shut down the electoral competition in the original model, and instead, introduce a social planner who maximises the welfare of all individuals, using the same calibrated parameters from previously. We then compare the equilibrium outcomes of this benchmark with those of the original model. (See Online Appendix I for the details of the planner's problem.)

4.1 On the mechanics of political distortion

To develop some intution, we first conduct a thought experiment using the calibration for the State of California (CA) as the example. (This also holds across all the other calibrations we have for the other US regions.) In our original calibration/estimation, recall that the labor- and capital-income marginal tax rates for each State is determined by the data—i.e., we take them as estimated parameters. In the following figures representing our thought experiment(s), we will vary these tax rates, one at a time, and then solve for each instance's long-run politico-economic equilibrium (and its corresponding social planner's solution as well). The equilibrium outcomes can be measured in terms of the State's long-run growth rate ν, the public-good-to-private-capital ratio $\eta^{-1} = g/K$ and the long-run measure of capitalists in that economy, μ. That way we can locate the actual region-calibrated equilibrium (and its hypothetical planner's) outcome as a point along some "Laffer-curve"-like set(s) of growth rates associated with each equilibrium (or planning allocation) at each arbitrary setting of the marginal tax rates.

Varying parameter τ^ℓ. Consider the comparative outcomes in terms of the social planner's economy (SP) versus the politico-economic equilibrium (PE), as we perturb the previously estimated parameter τ^ℓ, the marginal tax rate on labor.[18] Figure 4 plots the outcomes in terms of the average growth rate ν of the example economy of California. The green dashed graph is the growth rate across different social planner's solutions as a function of the parameter

[17] We have also done the same exercise in terms of the labor market channel, indexed by θ in each state. We report this exercise in our Online Appendix H.

[18] A similar exercise is done for τ^k, the tax rate on capital. This can be found in the Online Appendix I.

τ^{ℓ}, holding all other calibrations identical to the baseline for California.[19] The solid blue graph is the corresponding politico-economic equilibria as a function of τ^{ℓ}. The two graphs in this figure are hump shaped reflecting a Laffer curve effect from us exogenously varying the marginal tax rate on labor about the originally estimated point, $\tau^{\ell}_{calibrated}$. That is, a higher τ^{ℓ} tends to raise public revenue, productive public good g and therefore growth via the spillover effect of higher g, but too high a tax rate will begin to discourage the supply of capitalists' saving into private capital and also labor supplied by both workers and capitalists. However, note that the graph for the political economies (PE) is everywhere lower than its corresponding social planners' economies (SP). The vertical gap thus measures the political distortion on growth outcomes as a function of the parameter τ^{ℓ}, all else held constant. There is generally this positive gap because the planners' solutions tend to induce more public capital per unit of private capital (see Figure 5) compared to the political economy solutions. As consequence, the SP outcomes are also associated with a relatively higher measure of the capitalist population (see Figure 6).

[**Figures 4, 5 and 6 about here.**]

The main insight here is that for every fixed pair of tax rates (τ^{ℓ}, τ^{k}), the politico-economic (PE) equilibrium will exhibit a positive distortion to a region's growth rate relative to its hypothetical social planner's (SP) allocation. This is because relative to an SP allocation the PE equilibrium will induce more redistribution of resources away from productive public capital (that enhances the returns to labor and private capital), toward consumption transfers that only benefit the non-capitalists. In other words, what matters for driving long-run growth in each region's political economy, holding all else constant, is the influence of capitalist-type voters. A larger share of such voters implies a political equilibrium where government expenditure will be biased toward more spending on productive public goods. More productive public good each period, implies higher return on savings. This means more private saving and hence higher capital growth rate in the long run.

4.2 Measuring political distortions on regional growth and welfare

As we saw and explained previously using the case of California, the gain or loss—measured in terms of growth—in moving from the planning benchmark to the politico-economic equilibrium provides some measure of the degree of political distortion. As a corrollary exercise, we can also account for the distortion on growth and welfare measures associated with the political channel. What this additional exercise shows is that if we shift a region from the equal-influence hypothetical setting to the estimated actual political economy, where capitalists will have relatively more (less) influence in the latter economy, then there will relative more (less) equilibrium government spending on productive public good. As a consequence, there will be relatively higher (lower) long-run growth in that region, holding all else equal. This corroborates the mechanism in the model: If capitalist voters are more influential in determining election outcomes, then government policy will be biased toward more spending on productive public good, which induces more saving by capitalist types, and this promotes long-run growth. The details are found in our Online Appendix J.

5 Conclusion

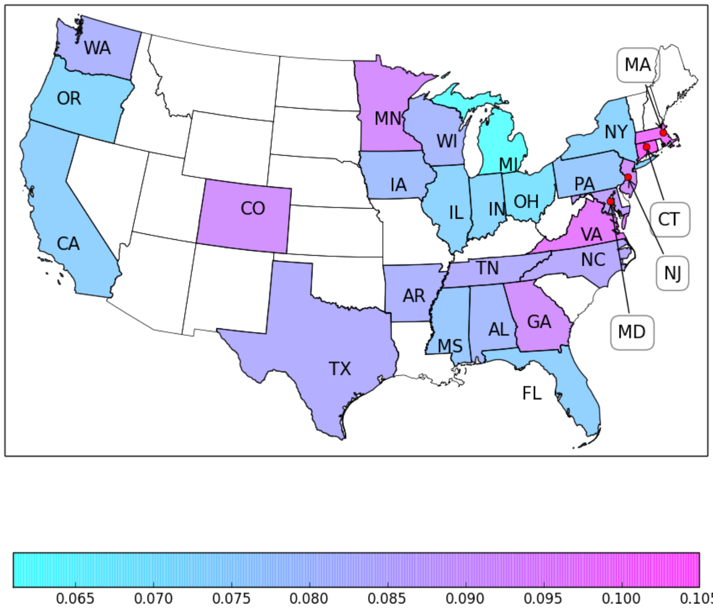
Our contribution in this paper to (regional) growth accounting was to construct a growth model where economic and political outcomes are endogenously dependent. From a growth accounting and policy point of view, our more structural exercise help provide an alternative and a more refined calculation of sources of regional growth (and

[19] As we can see, the peak growth rate ν^{*}_{SP} associated with $\tau^{\ell*}_{SP}$ on this graph is not the same as our baseline calibration for the State of California. This is not surprising since the original calibration was pinned down by the data, whereas what we have in the figure here is a normative statement—the economy could grow even faster if the planner were (exogenously) allowed to raise tax rates on labor up to $\tau^{\ell*}_{SP}$.

their attendant welfare consequences): In our approach, we identify these variations in otherwise seemingly identical political institutions through the use of a probabilistic voting model. What was key to the exercise was that the probabilistic voting model, through agents' political bias terms, provided an independent source of variation in the data in the political factor.

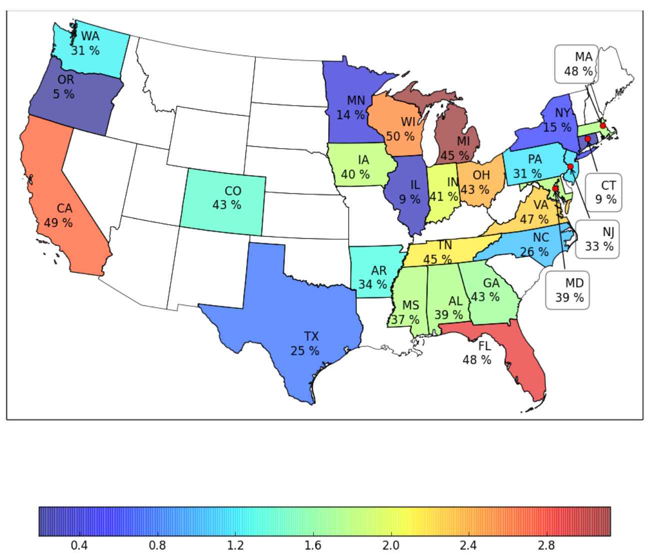
Using our estimated and calibrated regional economy models, we have shown that a market channel in the form of impediments to capital accumulation, is a crucial contributor to the economic growth performance of most states. Nevertheless, we also show that the political factor (voter bias) differences matter a lot in explaining economic growth disparities across regions, despite common political infrastructures. We also provided model-consistent accounts of the welfare costs of politics (relative to a first-best or to a political system with equal voter influence). We find that the costs are not small.

One can pursue more refinements to the model structure. For example, we have ignored the interactions of state-level politics with the Federal government, and, the role of regional government debt. Also, we have not explicitly modelled regional trade and geographical considerations. We leave these for future research.



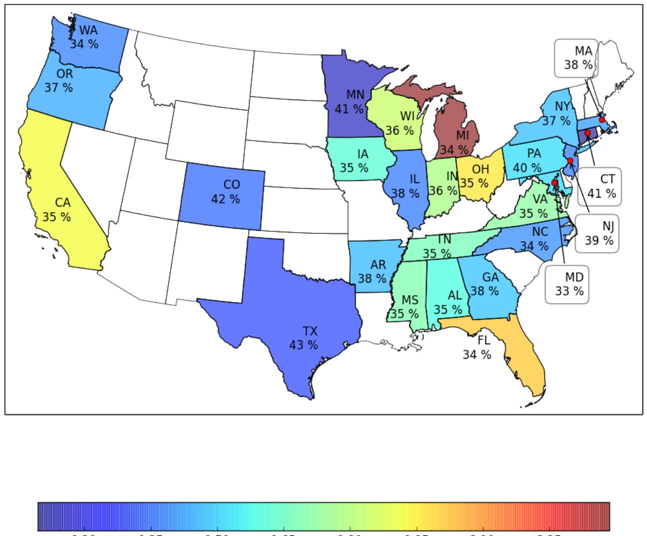
Note that colour codes indicate the average of four-year GSP growth rate for 1972-2003.

Figure 1: Growth disparity



Notes:
(1) Colour codes indicate the level of $\frac{\rho}{\nu} \cdot \frac{d\nu}{d\rho}$.
(2) Percentages below the state names are the ratio R_ρ.

Figure 2: Impact of the capital market factor (indexed by friction parameter ρ) on growth



Notes:
(1) Colour codes indicate the elasticity of growth with respect to "politics": $\frac{\phi^{k*}(0)}{\nu} \cdot \frac{d\nu}{d\phi^{*k}(0)}$.
(2) A percentage below the state name is the relative elasticity measure for that state: $R_{\phi^{*k}(0)}$.

Figure 3: Growth accounting with respect to the political factor, $\phi^{*k}(0)$

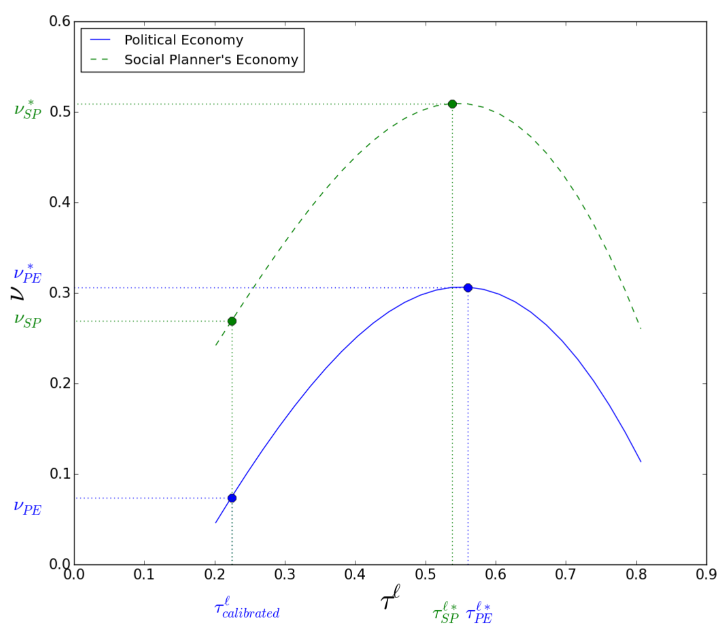


Figure 4: Sequence of planner's vs. Political Economy growth rate outcomes (ν) as functions of tax-rate parameter τ^ℓ—California (CA)

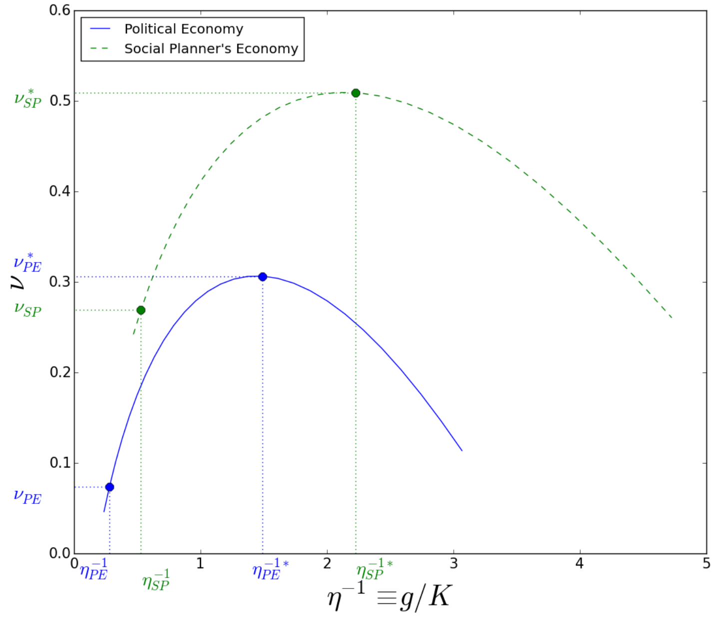


Figure 5: Sequence of planner's vs. Political Economy growth outcomes as functions of public-good-to-private-capital ratio ($\eta^{-1} = g/K$)–California (CA)

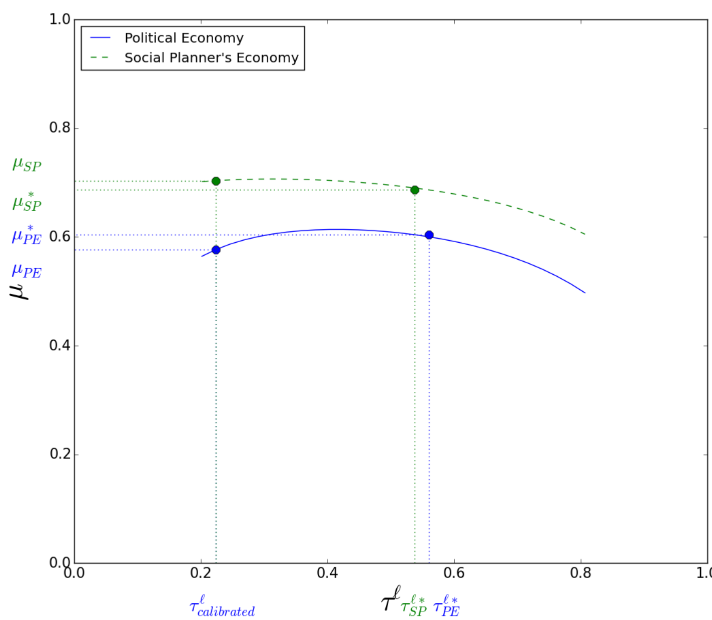


Figure 6: Sequence of planner's vs. Political Economy measures of capitalists (μ) as functions of tax-rate parameter τ^ℓ—California (CA)

— Supplementary (Online) Appendix —

Regional Economic Growth Disparities:
A Political Economy Perspective

Tomohito Okabe, t-okabe@ier.hit-u.ac.jp
Timothy Kam, tcy.kam@gmail.com
This document is public access: `https://github.com/phantomachine/_regional-growth-politics`

A Proof for Lemma 1

Using Equations (3) and (4), the first-order derivatives of $c_t^{y,k}$ and $c_{t+1}^{o,k}$ with respect to e are given by:

$$\frac{\partial c_t^{y,k}}{\partial e} = -\frac{(1-\tau^\ell)w_t}{1+\beta} < 0,$$
$$\frac{\partial c_{t+1}^{o,k}}{\partial e} = -\frac{\beta(1-\tau^k)(1+r_{t+1})(1-\tau^\ell)w_t}{1+\beta} < 0.$$

Therefore,

$$\frac{\partial U^k}{\partial e} = \frac{1}{c_t^{y,k}}\frac{\partial c_t^{y,k}}{\partial e} + \frac{\partial c_{t+1}^{o,k}}{\partial e} < 0.$$

Thus $U^k(K_t, \cdot)$ is strictly decreasing on $E := [0,1]$. In addition, given K_t is fixed at the beginning of each date t, $U^\ell(K_t)$ is a strictly positive and constant-valued function. Letting $\mathcal{U}^k$ denote a whole set of $U^k(K_t, \cdot)$, the graphs of $U^k(K_t, \cdot)$ and $U^\ell(K_t)$ obviously have a unique intersection in $(E \times \mathcal{U}^k)$ space. Figure 7 depicts the unique $e^* \in (0,1)$ in Lemma 1. ■

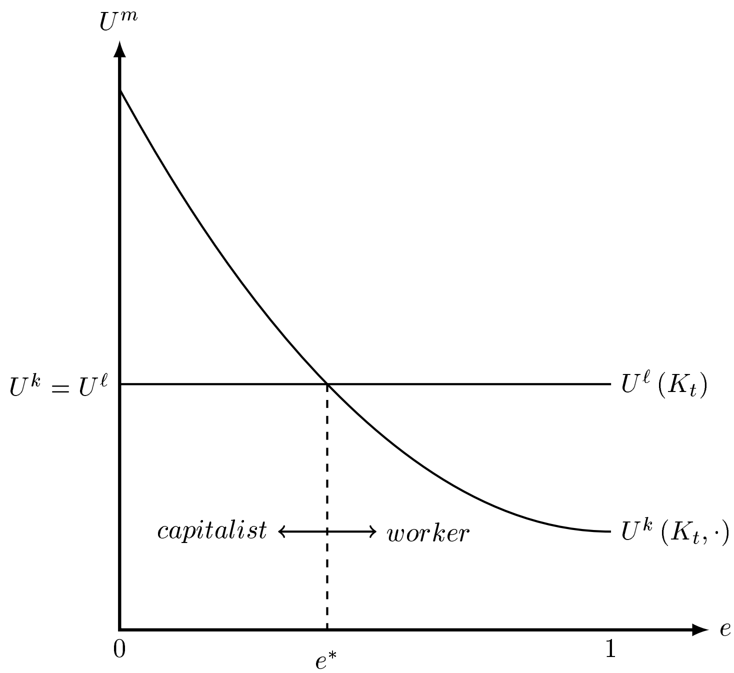


Figure 7: *Ex ante* decision

B Random e with continuous density

Suppose e is an i.i.d. random variable, and the distribution is given by a smooth density function $h(\cdot)$ on $[0,1]$. What follows focuses on some derivations that differ from the case of uniform distribution. First, Lemma 1 obviously holds also in this case. The fraction of agents who choose to be capitalists is given by:

$$\mu_t^y = \int_0^{e^*} h(z)dz.$$

The aggregate labour supply by capitalists in this case is given by:

$$\ell_t = N \int_0^{e^*} h(z) dz.$$

Aggregate consumption is:

$$\begin{aligned} C_t &= \int_0^{e^*} c_t^{y,k} h(z) dz + (1 - \mu_t^y) c_t^{y,\ell} + \int_0^{e^*} c_t^{o,k} h(z') dz' + (1 - \mu_t^o) c_t^{o,\ell} \\ &= (1 - \tau^\ell) L_t w_t - (S_t + N \mu_t^y \gamma_t) + (1 - \tau^k)(1 + r_t) S_{t-1} + N(1 - \mu_t^o) c_{g,t}; \end{aligned}$$

Aggregate savings is:

$$S_t = \int_0^{e^*} s_t h(z) dz,$$

where s_t is given by Equation (2). Note that the market clearing condition still holds. In the electoral competition, the expected vote share is now given by:

$$\begin{aligned} \pi_A(K_t, g_t^A, g_t^B) = N \int_0^{\mu_t^o} & h(z) \Psi_t^k \left[V^k \left(K_t, g_t^A, z \right) - V^k \left(K_t, g_t^B, z \right) \right] dz \\ &+ N(1 - \mu_t^o) \Psi_t^\ell \left[V^\ell \left(K_t, g_t^A \right) - V^\ell \left(K_t, g_t^B \right) \right]. \end{aligned}$$

The first-order condition is then given by:

$$\phi_t^k(0) \int_0^{\mu_t^o} \frac{\partial V^k(z)}{\partial g_t} h(z) dz + (1 - \mu_t^o) \phi_t^\ell(0) \frac{\partial V^\ell}{\partial g_t} = 0.$$

Under these characterisations, the political equilibrium still exists. It is straightforward to show that Lemma **??** still holds.

C Proof for Lemma 2

The first-order derivative of $V^m(\cdot)$ with respect to g_t is given by:

$$\frac{\partial V^m}{\partial g_t} = \beta \frac{1}{c_t^{o,m}} \frac{\partial c_t^{o,m}}{\partial g_t},$$

where

$$\begin{aligned} \frac{\partial c_t^{o,k}}{\partial g_t} &= \frac{\beta \left(1 - \tau^k\right) \left[\left(1 - \tau^\ell\right) \left(1 - e\right) w_t - \gamma_t \right]}{1 + \beta} \frac{\partial \left(1 + r_t\right)}{\partial g_t} > 0, \\ \frac{\partial c_t^{o,\ell}}{\partial g_t} &= \frac{1}{N(1 - \mu_t^o)} \left[\frac{\partial T_t}{\partial g_t} - 1 \right]. \end{aligned}$$

Therefore, V^k is monotonically increasing, whereas V^ℓ is not. The second order derivatives are given by:

$$\frac{\partial^2 V^m}{\partial g_t^2} = -\beta \frac{1}{(c_t^{o,m})^2} \frac{\partial c_t^{o,m}}{\partial g_t} + \beta \frac{1}{c_t^{o,m}} \frac{\partial^2 c_t^{o,m}}{\partial g_t^2},$$

where

$$
\begin{aligned}
\frac{\partial^2 c_t^{o,k}}{\partial g_t^2} &= \frac{\beta\left(1-\tau^k\right)\left[\left(1-\tau^\ell\right)(1-e)\,w_t-\gamma_t\right]}{1+\beta}\frac{\partial^2\left(1+r_t\right)}{\partial g_t^2}<0,\\
\frac{\partial c_t^{o,\ell}}{\partial g_t} &= \frac{1}{N(1-\mu_t^o)}\left[\frac{\partial^2 T_t}{\partial g_t^2}\right]\\
&= \frac{1}{N(1-\mu_t^o)}\left[\tau^\ell L_t\frac{\partial^2 w_t}{\partial g_t^2}+\tau^k S_t\frac{\partial^2\left(1+r_t\right)}{\partial g_t^2}\right]<0.
\end{aligned}
$$

Therefore,

$$
\frac{\partial^2 V^m}{\partial g_t^2}<0 \quad \forall m\in\{k,l\}.
$$

Given the concavity and the monotonic increasing property, V^k is maximised at a corner point given by:

$$
g_t^{\star k}=T_t.
$$

Likewise, given the concavity, V^ℓ is maximised at a unique point given by

$$
g_t^{\star\ell}\in G_t \quad \text{such that} \quad \left.\frac{\partial V^\ell}{\partial g_t}\right|_{g_t=g_t^{\star\ell}}=0 \qquad \blacksquare
$$

D Proof for Proposition 1

From Lemma 2, $V^m(\cdot)$, for all $m\in\{k,\ell\}$, is monotonically increasing on $[0,g_t^{\star\ell}]$. Therefore, given K_t, the conflicting preference arises on $(g_t^{\star\ell},T_t)$. The corner point $g_t^{\star\ell}$ is given as the solution of an equation given by:

$$
\begin{aligned}
&\frac{\partial V^\ell}{\partial g_t}=0\\
\Leftrightarrow\quad &\frac{\partial T_t}{\partial g_t}-1=0\\
\Leftrightarrow\quad &\Xi\frac{\partial Y_t}{\partial g_t}-1=0\\
\Leftrightarrow\quad &\eta=\left[\frac{1}{(1-\alpha)A\Xi L_t^{1-\alpha}}\right]^{\frac{1}{\alpha}}
\end{aligned}
$$

Likewise, $g_t^{\star k}=T_t$ is the solution of an equation given by:

$$
\begin{aligned}
&T_t=g_t\\
\Leftrightarrow\quad &\Xi Y_t+\tau^k N\mu_t^y\rho K_t-g_t=0\\
\Leftrightarrow\quad &\Xi A L_t^{1-\alpha}\eta^\alpha+\tau^k\mu_t^y\rho\eta-1=0
\end{aligned}
$$

Summarising these results yields the proposition. $\blacksquare$

E Data

We use a cross-sectional data set of a nation-wide public opinion survey, *the American National Election Study* (ANES). The data covers the observations of 26 American states during the period from 1972 to 2002. We disaggregate the original data into state-by-state samples at four-year frequency. Narrowing the frequency enhances the numbers of state-level observations in each period. The observations include occupations and PID responses. Occupation is categorised into six groups: 1, professional and managerial; 2, clerical and sales workers; 3, skilled, semi-skilled and service workers; 4, labourers, except farmers; 5, farmers, farm managers, farm labourers and foremen forestry and fishermen and 6, homemakers. The occupation observations are used to identify the types of individuals. Specifically, we assume that the occupation category, "professional and managerial" is the identifier for capitalists, whereas the occupation category "skilled, semi-skilled and service workers" is the identifier for workers. This is because those with the former identifier are more likely to possess higher capitalist ability (i.e., a lower e realisation) and accumulate savings, whereas those with the latter are more likely to have lower earnings with lower capitalist ability (i.e., a higher e realisation). Thus, we estimate the Markov matrix $\mathbf{\Lambda}$ for those with each occupational category.

F Estimation of political bias and model calibrations

In section F.1 we show the figures and results of our estimated and calibrated models. The remainder section F.2 outlines the estimation procedure of the transitional matrix $\mathbf{\Lambda}$ for the Markov chain representing the stochastic process of voters' political bias. Then we discuss how the rest of each model is calibrated to observed long-run data of American states.

F.1 Omitted figures from the paper

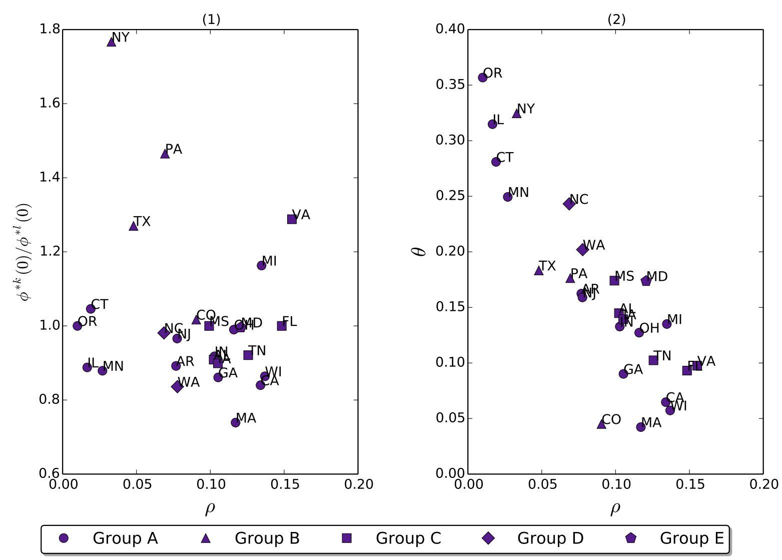


Figure F.1: Estimated and calibrated (to data): State-specific parameters identifying political, capital and labor market factor.

Panel (1) shows the state-specific calibrations of the capital and political channels, indexed respectively by ρ and $\phi^{*k}(0)/\phi^{*\ell}(0)$. Panel (2) depicts that of the labour versus capital channels, respectively, θ and ρ.

Notice that the various combinations of the parameters in Figure F.1, from the regional models' perspectives, are responsible for the growth disparity shown in Figure 1 in the paper. (Recall these parameters are calibrated to match the regional growth data.)

Table F.1: Variations in the political equilibrium

State		Growth rate ν ($\star$)	Distribution of agents μ^*	Capital-public good ratio η^*	Public good-tax revenue ratio g_t/T_t
Group A					
Arkansas	AR	8.16%	0.564	3.687	77.9%
California	CA	7.44%	0.577	3.557	76.9%
Connecticut	CT	10.48%	0.594	3.509	81.5%
Georgia	GA	9.17%	0.591	3.509	78.2%
Illinois	IL	7.29%	0.557	3.891	78.7%
Indiana	IN	7.20%	0.551	3.665	77.2%
Massachusetts	MA	10.05%	0.637	3.411	78.3%
Michigan	MI	6.09%	0.520	3.462	78.1%
Minnesota	MN	9.27%	0.583	3.741	79.3%
New Jersey	NJ	9.18%	0.575	3.529	79.2%
Ohio	OH	6.88%	0.542	3.585	77.5%
Oregon	OR	7.24%	0.555	3.777	79.8%
Wisconsin	WI	8.11%	0.589	3.446	77.6%
Group B					
Colorado	CO	9.23%	0.688	4.031	84.6%
New York	NY	7.32%	0.619	4.095	87.2%
Pennsylvania	PA	7.62%	0.619	4.118	85.3%
Texas	TX	8.37%	0.640	4.288	84.9%
Group C					
Alabama	AL	8.00%	0.543	3.360	77.0%
Florida	FL	7.41%	0.538	3.193	77.1%
Iowa	IA	7.89%	0.542	3.370	76.8%
Mississippi	MS	7.56%	0.530	3.321	77.5%
Tennessee	TN	8.37%	0.554	3.245	77.2%
Virginia	VA	9.80%	0.555	2.817	80.7%
Group D					
North Carolina	NC	8.52%	0.522	3.025	77.5%
Washington	WA	8.20%	0.524	3.164	76.0%
Group E					
Maryland	MD	8.74%	0.505	2.676	76.4%

($\star$) The calibrated growth rates are equal to the averages of four-year GSP growth rates for 1972-2003.

Table F.1 summarises the equilibrium outcomes across the states, given the calibrations. A region's distribution over agent types, as measured by μ^*, varies in the range $0.62-0.69$ for Group B states, and in the range $0.51-0.64$ for the other four Groups. The capital-public good ratio, η^*, varies in the range $3.4-3.9$ for Group A regions, $4.0-4.3$ for Group B, and $2.7-3.4$ for the other three groups. The public good-to-tax-revenue ratio, g_t/T_t, representing the government expenditure composition, varies within $85-87\%$ for Group B, and $76-82\%$ for the other four groups.

F.2 Estimating the distributions of voter political biases ("political factor")

The estimation method follows from Okabe (2015). The computation consists of two steps.

F.2.1 Multinomial logistic regression

The first step conducts multinomial logistic (MNL) regression for every sample group to compute the sequences of the PID distribution, i.e., $\{\phi\}_{t=0}^{T}$.

Consider the estimation for a sample group. Let a set of independent variables $\mathbf{c}_i$ denote individual i's attributes. $\mathbf{c}_i$ is a $(K+1)$-vector with first-element unity. The utility individual i obtained from choosing alternative ω_j is given by:

$$W_{ij} := \mathbf{c}_i'\boldsymbol{\beta}_j + \varepsilon_{ij},$$

where $\boldsymbol{\beta}_j$ is a $(K+1)$-vector. ε_{ij} is an error term, and follows an i.i.d. type I extreme value distribution. Individual i maximises her utility W_{ij} by choosing alternative d_i. The response probability that individual i chooses PID $\omega_j \in \Omega$ is then given by:

$$
\begin{aligned}
\pi_{ij} &:= \text{Prob}\ (d_i = \omega_j | \mathbf{c}_i) && \text{(F.1)}\\
&= \text{Prob}\,(W_{ij} \geq W_{ik}, \quad \text{for all } k \neq j)\\
&= \text{Prob}\,(W_{ij} - W_{ik} \leq 0, \quad \text{for all } k \neq j)\\
&= \text{Prob}\left(\varepsilon_{ik} - \varepsilon_{ij} \leq \mathbf{c}_i'\boldsymbol{\beta}_j - \mathbf{c}_i'\boldsymbol{\beta}_k, \quad \text{for all } k \neq j\right) && \text{(F.2)}\\
&= \begin{cases} \dfrac{1}{1+\sum_{r=2}^{3}\exp\left(\mathbf{c}_i'\boldsymbol{\beta}_r\right)}, & j = 1 \\[2ex] \dfrac{\exp\left(\mathbf{c}_i'\boldsymbol{\beta}_j\right)}{1+\sum_{r=2}^{3}\exp\left(\mathbf{c}_i'\boldsymbol{\beta}_r\right)}, & j = 2, 3 \end{cases} && \text{(F.3)}
\end{aligned}
$$

where $0 < \pi_{ij} < 1$, $\sum_j \pi_{ij} = 1$, and ω_1 is the baseline alternative. Equations (F.2) and (F.3) imply that $\varepsilon_{ik} - \varepsilon_{ij}$ follows a logistic distribution.

It is noteworthy that the error terms ε_{ij} represent cognitive fallacy in survey responses. Recall that PID observations are subjective responses based on personal beliefs. For example, it may happen that an Independent respondent (i.e., an individual who actually has no preferable parties) records her PID as Democrat due to lack of awareness.

Define a probability function as:

$$
\eta(d_i \mid \mathbf{c}_i; \boldsymbol{\beta}_2, \cdots, \boldsymbol{\beta}_J) = \prod_{j=1}^{3} \left(\pi_{ij}\right)^{\theta_{ij}}, \tag{F.4}
$$

where θ_{ij} is a binary indicator given by:

$$
\theta_{ij} = \begin{cases} 1 & \text{if individual } i \text{ chooses alternative } \omega_j = d_i \\ 0 & \text{otherwise} \end{cases}
$$

The probability function (F.4) maps individual i's probability of observing her actual response from her attributes. Given the sample size of the cross-section data $\mathcal{I}$, the log-likelihood function is then given by:

$$
\begin{aligned}
\ln L\left(\boldsymbol{\beta}_2, \cdots, \boldsymbol{\beta}_J; \mathbf{d}, \mathbf{c}\right) &= \ln\left(\eta\left(d_i\right)\right) && \text{(F.5)}\\
&= \sum_{i=1}^{\mathcal{I}} \sum_{j=1}^{3} \theta_{ij} log \pi_{ij}, && \text{(F.6)}
\end{aligned}
$$

where $\mathbf{d} = \{d_1, \cdots, d_{\mathcal{I}}\}'$ and $\mathbf{c} = \{\mathbf{c}_1, \cdots, \mathbf{c}_{\mathcal{I}}\}'$. We can obtain the estimator $\hat{\boldsymbol{\beta}}_j$ by maximising the log-likelihood function (F.6).

After obtaining the estimates for $\boldsymbol{\beta}_j$, we compute the PID distribution for each socio-economic category. Suppose that individual i belongs to category $m \in \mathcal{M}$ (e.g., female, Hispanic, in her 30s). The probability that a m-category individual possesses alternative ω_j is given by

$$\hat{\pi}_{ij} = \frac{\exp\left(\mathbf{c}_i'\hat{\boldsymbol{\beta}}_j\right)}{1+\sum_{r=2}^{3}\exp\left(\mathbf{c}_i'\hat{\boldsymbol{\beta}}_r\right)} \qquad \text{for } j=1,2,3, \tag{F.7}$$

Using $\hat{\pi}_j$ as estimated proxies for $\phi_t(\omega_j)$ in the Markov chain, we can obtain the sequence of PID distributions $\{\boldsymbol{\phi}_t\}_{t=0}^{T}$.

The values of $\hat{\boldsymbol{\beta}}_j$ would vary across different samples. Nevertheless, it is well known that maximum likelihood estimators asymptotically follow normal distributions; for example, see Wooldridge (2010) for the proof. This allows one to treat the estimates as random variables with asymptotic normal distributions, and hence conduct some significance tests for the estimates, e.g., Wald tests.

The asymptotic normality assumption also allows one to compute confidence intervals. The $100(1-\alpha)\%$ confidence interval for $\hat{\boldsymbol{\beta}}_j$ is given by:

$$\mathbf{c}_i{}'\hat{\boldsymbol{\beta}}_j \pm z_{\alpha/2}\sigma, \tag{F.8}$$

where $z_{\alpha/2}$ is $100(1-\alpha/2)$ percentile point of a standard normal distribution, and σ is the standard error. We can calculate σ from a Hessian matrix in the maximisation problem of the log likelihood (F.6); see, e.g., Wooldridge (2010) for more details. We will utilise this confidence interval in the second step.

F.2.2 Maximum entropy method

The second step estimates the transitional matrix $\boldsymbol{\Lambda}$ with the maximum entropy method. Entropy is a measure of the statistician's uncertainty regarding a probability distribution parametrised on a set of events. This notion was advocated by Shannon (1948). Applying this measure to estimation, Jaynes (1957a,b) developed the principle of maximum entropy. The key idea is to estimate unknown parameters such that they maximise the entropy subject to imposed constraints on observations and other available information. In practice, we can employ a more general variant of the method proposed by Golan et al. (1996), i.e., the generalised entropy method (GME).

Suppose we obtained the sequence of PID distributions, $\{\boldsymbol{\phi}_t\}_{t=0}^{T}$ in the first step. The observation constraints are given by:

$$\mathbf{b} = \mathbf{A}\mathbf{p} + \mathbf{e},$$

where

$$\mathbf{b} := [\boldsymbol{\phi}_1, \cdots, \boldsymbol{\phi}_T]'$$

$$\mathbf{A} := \begin{bmatrix} \mathbf{A}(0) \\ \vdots \\ \mathbf{A}(T-1) \end{bmatrix}, \qquad \mathbf{A}(t) := \begin{bmatrix} \boldsymbol{\phi}_t & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \boldsymbol{\phi}_t & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \boldsymbol{\phi}_t \end{bmatrix},$$

$$\mathbf{p} := [\boldsymbol{\lambda}(1)', \boldsymbol{\lambda}(2)', \boldsymbol{\lambda}(3)']' = [\lambda_{11}, \lambda_{21}, \lambda_{31}, \lambda_{12}, \lambda_{22}, \lambda_{32}, \lambda_{13}, \lambda_{23}, \lambda_{33}]'$$

$$\mathbf{e} := [e_{11}, e_{12}, e_{13}, \cdots, e_{T1}, e_{T2}, e_{T3}]'.$$

where $\mathbf{b}$ is a $3T$-vector of the observations, $\mathbf{A}$ is a $(3T \times 3^2)$ matrix of the observations, $\mathbf{p}$ is the vectorised transitional matrix, $\mathbf{e}$ is a $3T$-vector of unobserved noise. The noise term will be included in the constraint. Recall that the

PID distribution $\boldsymbol{\phi}_t$ is computed based on the maximum likelihood estimator $\hat{\boldsymbol{\beta}}_j$ that varies according to a normal distribution. Therefore, $\{\boldsymbol{\phi}_t\}_{t=0}^{T}$ is not a deterministic, but a stochastic path varying with $\hat{\boldsymbol{\beta}}_j$, which we refer to as a "noisy" Markov path.

Next, suppose a compact support for each λ_{xy} that allows for treating it as a random variable. The $\mathbf{p}$ vector is then re-parameterised as:

$$\mathbf{p} = \mathbf{Z}\mathbf{q} = \begin{bmatrix} \mathbf{Z}(1) & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{Z}(2) & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{Z}(3) \end{bmatrix} \begin{bmatrix} \mathbf{q}(1) \\ \mathbf{q}(2) \\ \mathbf{q}(3) \end{bmatrix}, \qquad \mathbf{Z}(j) := \begin{bmatrix} \underline{z}_{j1} & \overline{z}_{j1} & 0 & 0 & 0 & 0 \\ 0 & 0 & \underline{z}_{j2} & \overline{z}_{j2} & 0 & 0 \\ 0 & 0 & 0 & 0 & \underline{z}_{j3} & \overline{z}_{j3} \end{bmatrix}$$

$$\mathbf{q}(j) := \left[\underline{q}_{j1}, \overline{q}_{j1}, \underline{q}_{j2}, \overline{q}_{j2}, \underline{q}_{j3}, \overline{q}_{j3},\right]'$$

where $\mathbf{Z}$ is a $(3^2 \times 2 \cdot 3^2)$ sparse matrix representing the supports, $\mathbf{q} \gg \mathbf{0}$ is a $(2 \cdot 3^2)$-vector of probabilities. Likewise, suppose each element of noise vector $\mathbf{e}$ has a compact support. The re-parametrisation is then given by:

$$\mathbf{e} = \mathbf{V}\mathbf{w} = \begin{bmatrix} \mathbf{V}(0) & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{V}(1) & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{V}(T-1) \end{bmatrix} \begin{bmatrix} \mathbf{w}(0) \\ \mathbf{w}(1) \\ \vdots \\ \mathbf{w}(T-1) \end{bmatrix},$$

$$\mathbf{V}(t) := \begin{bmatrix} \underline{v}_{t1} & \overline{v}_{t1} & 0 & 0 & 0 & 0 \\ 0 & 0 & \underline{v}_{t2} & \overline{v}_{t2} & 0 & 0 \\ 0 & 0 & 0 & 0 & \underline{v}_{t3} & \overline{v}_{t3} \end{bmatrix}, \qquad \mathbf{w}(t) := [\underline{w}_{t1}, \overline{w}_{t1}, \underline{w}_{t2}, \overline{w}_{t2}, \underline{w}_{t3}, \overline{w}_{t3}]'$$

where $\mathbf{V}$ is a $(3T \times 2T \cdot 3)$ sparse matrix representing the supports and $\mathbf{w} \gg 0$ is a $(2T \cdot 3)$ vector of probabilities. The GME estimators are given by solving the following optimisation problem.

$$\begin{aligned} &\max_{\mathbf{q},\mathbf{w}} \Gamma(\mathbf{q}, \mathbf{w}) = -\mathbf{q}' \ln(\mathbf{q}) - \mathbf{w}' \ln(\mathbf{w}) \\ &\text{subject to} \\ &\mathbf{b} = \mathbf{A}\mathbf{Z}\mathbf{q} + \mathbf{V}\mathbf{w} \\ &\mathbf{1}_J = (\mathbf{I}_J \otimes \mathbf{1}_2)'\mathbf{q} \\ &\mathbf{1}_T = (\mathbf{I}_T \otimes \mathbf{1}_2)'\mathbf{w} \\ &\mathbf{q} \geq \mathbf{0} \\ &\mathbf{w} \geq \mathbf{0} \end{aligned}$$

where Γ is the entropy.

In addition, this paper reflect an extra constraint, $\lambda_{13} = \lambda_{31} = 0$. The transitional matrix to be estimated is then given by:

$$\boldsymbol{\lambda} = \begin{bmatrix} \lambda_{11} & \lambda_{12} & 0 \\ \lambda_{21} & \lambda_{22} & \lambda_{23} \\ 0 & \lambda_{32} & \lambda_{33} \end{bmatrix}.$$

This follows an hypothesis by Mebane and Wand (1997) that American individual PID gradually changes in the short-run. The hypothesis is verified by a Wald test.

F.3 Results

The data source, the ANES is a repeated cross-section survey. It covers 26 states and the period from 1972 to 2002. We disaggregate the original data into state-by-state samples, and further separate them into eight periods. The data is now divided into (26 states) $\times$ (8 periods) sample groups as shown in Table F.2.

In the first step, we conduct MNL regression, for each sample group, with independent variables for occupations: professional dummy (1 if occupation = professional and managerial, 0 otherwise) and skilled-worker dummy (1 if occupation = skilled, semi-skilled and service workers, 0 otherwise).[20] The baseline PID is Independent. Based on the MNL estimators, we compute the sequence of PID distributions for professional and skilled workers. Table F.3 shows the estimated distributions for Alabama. Some of the distributions are identical due to failures in rejecting the null hypothesis $H_0 := \hat{\boldsymbol{\beta}}_j = \mathbf{0}$ for $j = 2, 3$ at the Wald test. The significance level for the test is 10%.

Given the time sequence of the PID distributions, we estimate the transitional matrix. Table F.4 summarises the estimated transitional matrices, stationary distributions and other relevant results. The Wald test with the null hypothesis $H_0 := \lambda_{13} = \lambda_{31} = 0$ results in failing to reject the null at less than 1% significance level. The resulting stationary distribution give calibration values for the political bias parameters: the fraction of professionals with Independent status, i.e., 0.290 for $\phi^{*k}(0)$, the fraction of skilled workers with Independent status, i.e., 0.319 for $\phi^{*\ell}(0)$.

We conduct the estimation for the other states in a similar fashion, but the entire cross-state results are omitted for brevity.

F.4 Calibration of other model parameters and factors

Period configuration. The model period is set to four years, so that it equals the frequency of the PID data. The active duration of agents is set to eight model periods (i.e., 32 years) that covers the total time period of the PID data (i.e., 30 years). The duration of youth and old age is set to four model periods (i.e., 16 years) each. Thus, this period set-up ensures that the lifetime bias transitions of the model are approximated by the data spanning almost the same range.

In addition, we suppose that individuals are "born" (i.e., the enter the scene) at age 18. They become "old" in four periods (i.e., at age 34), and become inactive after further four periods (i.e., at age 46). The relevant lifetime of agents is therefore scaled to 46 years, which is not the same as actual life expectancy, but this suffices for the purposes of our accounting exercises. The frequency setting results in eight cohorts at every period. Figure F.2 depicts the generation structure.

Other parameters. Table F.5 shows the calibrated values of parameters we take to be identical across regions. These refer to parameters defining the production and capital-accumulation technologies, and also preferences.

The capital share of output, α, and the depreciation rate, δ, are taken from Cooley and Prescott (1995), but the latter is adjusted to the four-year basis. The TFP parameter, A, is set such that the capital-public good ratio η^* takes reasonable values satisfying constraint (19). The discount factor, β, is simply taken from an empirical study by Hurd (1989). This is justified by the life-cycle model literature, e.g., Heer and Maussner (2009, Ch7).[21]

Table F.6 shows the calibrated values for tax rates and the steady-state rental rate of capital. The cross-state tax rates have five variations, whereas the rental rates differ across the states. Since no studies estimate state-level

[20] We do not employ other independent variables to avoid the multicollinearity that is likely to occur with the following reasons: The sample size of each American state is not necessarily large. Those with the occupation category of professional and managerial have limited population share in each state.

[21] The literature says that we should empirically measure the discount factor for the OLG model because we have no theoretical restrictions to pin down its value from other observables, unlike in the case of infinite time horizon models.

Table F.2: ANES cross-section data

State	1972/ 1974	1976/ 1978	1980/ 1982	1984/ 1986	1988/ 1990	1992/ 1994	1996/ 1998	2000/ 2002	Total
AL	49	86	53	93	113	74	110	100	**678**
AR	170	115	78	92	97	67	23	56	**698**
CA	331	390	278	512	416	412	215	329	**2,883**
CO	48	69	51	76	81	76	62	72	**535**
CT	85	66	54	82	73	49	29	35	**473**
FL	120	184	147	176	117	194	146	150	**1,234**
GA	142	104	79	192	184	222	113	62	**1,098**
IL	208	206	136	119	136	131	75	108	**1,119**
IN	60	102	65	114	82	169	141	74	**807**
IA	103	88	50	87	83	53	51	55	**570**
MD	88	93	42	81	84	87	66	70	**611**
MA	148	135	79	87	76	108	53	101	**787**
MI	177	199	141	299	204	250	126	130	**1,526**
MN	92	85	46	114	101	143	97	115	**793**
MS	121	103	77	72	54	76	52	40	**595**
NJ	150	147	101	117	87	146	84	76	**908**
NY	252	266	197	334	312	268	175	206	**2,010**
NC	203	153	101	120	125	74	24	52	**852**
OH	284	254	182	163	183	118	80	134	**1,398**
OR	73	88	51	93	95	74	70	62	**606**
PA	246	271	157	99	122	116	98	105	**1,214**
TN	53	80	54	187	232	137	71	71	**885**
TX	119	201	166	300	283	329	279	240	**1,917**
VA	75	97	77	147	97	229	227	158	**1,107**
WA	85	101	63	65	88	72	68	85	**627**
WI	37	68	38	97	125	79	134	130	**708**
Total	**3,519**	**3,751**	**2,563**	**3,918**	**3,650**	**3,753**	**2,669**	**2,816**	**26,639**

Table F.3: Computed PID distributions for Alabama

Professionals				
		Democrat	Independent	Republican
Period 1	*	0.531	0.204	0.265
Period 2	*	0.651	0.233	0.116
Period 3		0.769	0.000	0.231
Period 4	*	0.613	0.075	0.312
Period 5		0.417	0.000	0.583
Period 6	*	0.595	0.081	0.324
Period 7		0.318	0.136	0.545
Period 8		0.389	0.000	0.611
Skilled workers				
		Democrat	Independent	Republican
Period 1	*	0.531	0.204	0.265
Period 2	*	0.651	0.233	0.116
Period 3		0.800	0.100	0.100
Period 4	*	0.613	0.075	0.312
Period 5		0.476	0.071	0.452
Period 6	*	0.595	0.081	0.324
Period 7		0.680	0.120	0.200
Period 8		0.731	0.115	0.154

Note that * indicates that the distribution is identical between two groups. This is the case where the Wald test for the whole regressors fails to reject the null at 10% singificance level

Table F.4: Estimated transitional matrices for Alabama

Professionals			
PID_{t-1}	PID_t		
	Democrat	Independent	Republican
Democrat	0.730	0.270	0.000
Independent	0.366	0.276	0.359
Republican	0.000	0.328	0.672
Stationary distribution	0.393	0.290	0.317
$\overline{\Gamma}(\mathbf{q})=$	0.694		
$v=$	[-0.769	0.769]	
Skilled workers			
PID_{t-1}	PID_t		
	Democrat	Independent	Republican
Democrat	0.722	0.278	0.000
Independent	0.376	0.288	0.366
Republican	0.000	0.328	0.672
Stationary distribution	0.432	0.319	0.250
$\overline{\Gamma}(\mathbf{q})=$	0.713		
$v=$	[-0.900	0.900]	

where $\overline{\Gamma}(\mathbf{q})$ is the normalised entropy, v the support of the noise.

Table F.5: Calibrated region-common parameters

Parameter	Definition	Value	Reference/ process
α	capital share	0.36	Cooley and Prescott (1995)
$1-(1-\delta)^{1/4}$	depreciation rate	0.048	Cooley and Prescott (1995)
A	TFP	3.11	set to match with reference values of capital-output ratio
$\beta^{1/16}$	discount factor	1.011	Hurd (1989)

effective taxes in the U.S., this paper utilises the national level estimates by Gomme and Rupert (2007) as reference values. The reference can be thought of as the average of the cross-state rates. Group A takes the reference values,

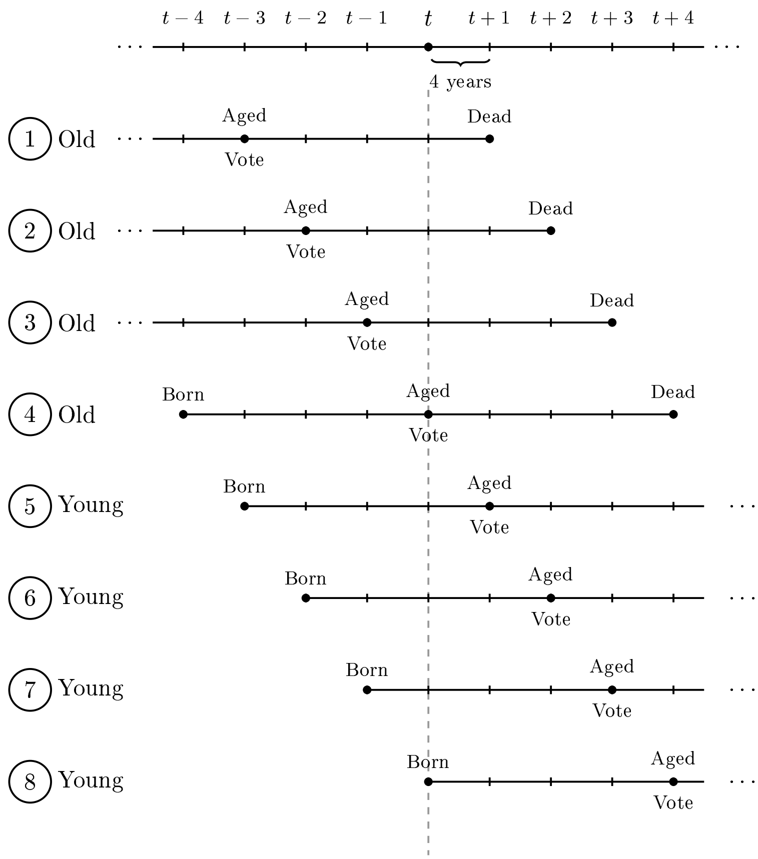


Figure F.2: Eight cohorts at time t

and the other four groups (Group B to Group E) take values that are slightly adjusted from the reference. The adjustment for the latter four groups will be conducted to maintain consistency with endogenous outcomes and other parameters. We calibrate the rental rate of capital using Equation (11). However, we will compute the capital-output ratio with reference values, because once again there are no studies that estimate state-level rental rates. The cross-state capital stocks are estimated by Yamarik (2013), but we do not directly employ his estimates because they result in very high rental rates. Instead, we compute the cross-state fractions of the state-level to the national-level estimate, and multiply them by national-level fixed capital assets measured by *the Bureau of Economic Analysis* (BEA). In turn, what are obtained are the reference values for cross-state capital. The outputs are simply taken from measures of Gross State Product (GSP) available from the BEA. Given the computed capital-output ratios for the period from 1972 to 2003, we obtain the rental rates of capital from 6.0 to 9.1% per annum which are close to the national-level (pre-tax) real return on capital in the business cycle literature; see Gomme and Rupert (2007). Table F.7 shows the calibrated region-specific parameters.

G Marginal effects of the three growth channels

Previously we showed that the balanced-growth equilibrium path of each regional economy is characterised by a system of four non-linear equations: (22), (23), (24) and (25). From this system of equations, we will be able to extract (implicitly) the growth accounting insights. Before we arrive at this growth accounting exercise proper, we will need to know the marginal contributions of the three channels in each regional model—capital (ρ), labor (θ) and politics ($\phi^{*k}(0)$)—to the four endogenous variables ν, η^*, μ^* and L^*, denoting growth rate, capital-to-public-infrastructure ratio, measure of capitalists, and total labor, respectively. As an illustration, we present the numerical

Table F.6: Calibrated tax rates and steady-state rental rate of capital

State		τ^k	τ^ℓ	r^* (annual basis)
Group A				
Arkansas	AR	0.2921	0.2241	0.069
California	CA	0.2921	0.2241	0.071
Connecticut	CT	0.2921	0.2241	0.072
Georgia	GA	0.2921	0.2241	0.072
Illinois	IL	0.2921	0.2241	0.066
Indiana	IN	0.2921	0.2241	0.070
Massachusetts	MA	0.2921	0.2241	0.074
Michigan	MI	0.2921	0.2241	0.073
Minnesota	MN	0.2921	0.2241	0.068
New Jersey	NJ	0.2921	0.2241	0.072
Ohio	OH	0.2921	0.2241	0.071
Oregon	OR	0.2921	0.2241	0.068
Wisconsin	WI	0.2921	0.2241	0.074
Group B				
Colorado	CO	0.2500	0.2000	0.064
New York	NY	0.2500	0.2000	0.063
Pennsylvania	PA	0.2500	0.2000	0.062
Texas	TX	0.2500	0.2000	0.060
Group C				
Alabama	AL	0.2921	0.2400	0.075
Florida	FL	0.2921	0.2400	0.079
Iowa	IA	0.2921	0.2400	0.075
Mississippi	MS	0.2921	0.2400	0.076
Tennessee	TN	0.2921	0.2400	0.078
Virginia	VA	0.2921	0.2400	0.087
Group D				
North Carolina	NC	0.2921	0.2600	0.082
Washington	WA	0.2921	0.2600	0.079
Group E				
Maryland	MD	0.2921	0.2800	0.091

results for the state of Alabama. The same conclusions hold true for all the other states.

Figure G.1 shows the results for Alabama. It consists of nine panels: (A1)-(A4) show the effects of ρ; (B1)-(B4) the effects of $\phi^{k*}(0)$, holding $\phi^{\ell*}(0)$ constant; and (C1)-(C4) the effects of θ. The observed effects are all monotonic with respect to the parameter, except for Panel (C3).

Private capital market channel. From Panels (A1)-(A4), the effects of marginal change in ρ are summarised as follows:

$$\frac{\partial \eta^*}{\partial \rho} > 0, \quad \frac{\partial \mu^*}{\partial \rho} < 0, \quad \frac{\partial L^*(\mu^*(\rho))}{\partial \rho} < 0, \quad \frac{\partial \nu\left(\eta^*(\rho), \mu^*(\rho), L^*(\rho), \rho\right)}{\partial \rho} < 0.$$

We derive the economic intuitions behind these effects.

First, recall that $\rho \times K_t$ is the total per-period fixed cost for an agent being a capitalist. Since K_t is fixed at the beginning of each date, an increment in ρ decreases saving, thus having the direct impact of decreasing growth. On the left side of Equation (22), this shows up as an explicit negative ρ term.

Second, observe that the growth rate also depends on three endogenous variables, $\eta^*(\rho)$, $\mu^*(\rho)$ and $L^*(\mu^*(\rho))$. For now, we restrict our attention on the marginal change in the capital-public-good ratio η^* and the agent distribution μ^*. These two variables are determined by Equations (23) and (24). The former is the first-order condition describing a probabilistic voting equilibrium, whereas the latter is the cut-off condition for an agent's *ex-ante* choice. Suppose ρ is marginally increased. In the *ex-ante* choice, on one hand, an increment in ρ reduces the net amount of savings, and hence the *ex-post* payoff of "capitalists", holding the electoral outcome constant. On the other hand, it decreases the capital tax base, and hence the lump sum transfer, thus decreasing the *ex-post*

Table F.7: Calibrated region-specific parameters

State		Pecuniary cost parameter ρ	Fraction of neutral capitalists $\phi^{*k}(0)$	Fraction of neutral workers $\phi^{*\ell}(0)$	Time efficiency parameter θ	Size of population N
Group A						
Arkansas	AR	0.077	0.307	0.344	0.162	2.101
California	CA	0.134	0.147	0.175	0.065	2.284
Connecticut	CT	0.019	0.365	0.349	0.281	1.881
Georgia	GA	0.105	0.242	0.281	0.090	2.206
Illinois	IL	0.017	0.262	0.295	0.315	1.847
Indiana	IN	0.103	0.268	0.292	0.133	2.180
Massachusetts	MA	0.117	0.218	0.295	0.042	2.225
Michigan	MI	0.135	0.306	0.263	0.135	2.223
Minnesota	MN	0.027	0.269	0.306	0.249	1.934
New Jersey	NJ	0.078	0.284	0.294	0.159	2.095
Ohio	OH	0.116	0.298	0.301	0.127	2.205
Oregon	OR	0.010	0.183	0.183	0.357	1.787
Wisconsin	WI	0.137	0.260	0.301	0.057	2.278
Group B						
Colorado	CO	0.090	0.301	0.296	0.045	2.148
New York	NY	0.033	0.265	0.150	0.325	1.814
Pennsylvania	PA	0.069	0.274	0.187	0.176	2.022
Texas	TX	0.048	0.254	0.200	0.183	1.995
Group C						
Alabama	AL	0.102	0.290	0.319	0.145	2.166
Florida	FL	0.148	0.182	0.182	0.093	2.293
Iowa	IA	0.105	0.284	0.316	0.139	2.178
Mississippi	MS	0.099	0.213	0.213	0.174	2.122
Tennessee	TN	0.126	0.293	0.318	0.102	2.241
Virginia	VA	0.155	0.277	0.215	0.098	2.251
Group D						
North Carolina	NC	0.069	0.312	0.318	0.243	1.992
Washington	WA	0.078	0.255	0.305	0.202	2.071
Group E						
Maryland	MD	0.121	0.283	0.284	0.174	2.158

payoff of "workers". Since the lifetime payoffs of both agents are lowered, it is uncertain whether the proportion of capitalists μ^* is eventually increased or decreased. However, this has consequences on the electoral competition that subsequently occurs. In the election, the marginal change in μ^* affects the electoral outcome, summarised in terms of capital-to-public-infrastructure ratio, η^*. Recalling that μ^* is the weight for the welfare of capitalists, an increase in μ^* lowers η^*, whereas a decrease in μ^* raises η^*. In fact, the effect of the electoral outcome feeds back to the *ex-ante* choice because individuals have perfect foresight on the aggregate-level equilibrium outcomes. The numerical comparative statics shows that these endogenous effects eventually result in an increase in η^* and a decrease in μ^*. An increase in η^* is equivalent to a decrease in public good expenditure. A decrease in μ^* lowers savings, and hence decrease capital stock. Both these effects reduce the growth rate.

Finally, we discuss how L^* responds at the margin to a small change in in ρ. From Equation (25), an increase in μ^* raises L^* for small enough θ. This indicates that the labour productivity of capitalists is much larger than that of workers. An increase in the population of capitalists increases the aggregate labour, *viz.* that $L^*(\cdot)$ is an increasing function of μ^*. Therefore, the direction of the marginal effect of ρ on L^* is identical to that on μ^*. A decrease in L^* raises the marginal product of labour, and hence savings. This raises the growth rate, but this positive effect is cancelled out by the negative effect mentioned earlier.

Given these direct and indirect effects, the growth rate monotonically decreases as ρ increases.

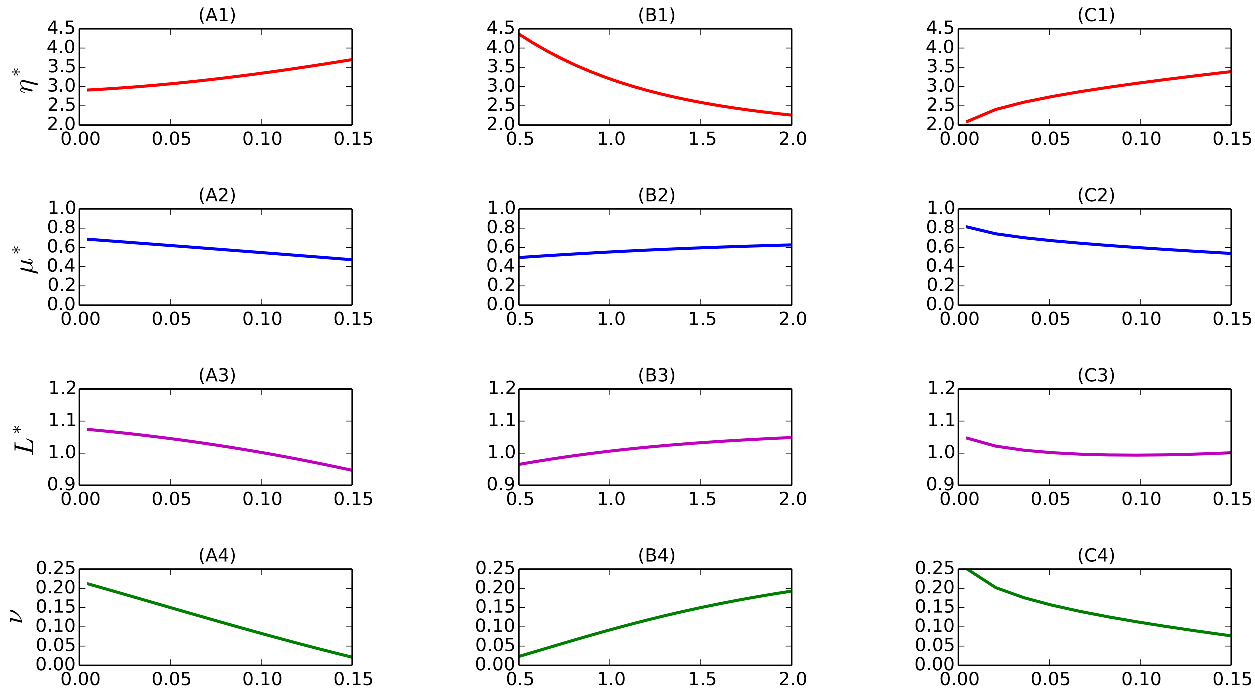


Figure G.1: Effects of parameters for Alabama

Political factor. From Panels (B1)-(B4) in Figure G.1, the effects of the political factor are summarised as:

$$\frac{\partial \eta^*}{\partial \phi^{*k}(0)} < 0, \quad \frac{\partial \mu^*}{\partial \phi^{*k}(0)} > 0, \quad \frac{\partial L^*(\mu^*(\phi^{*k}(0)))}{\partial \phi^{*k}(0)} > 0,$$
$$\frac{\partial \nu\left(\eta^*(\phi^{*k}(0)), \mu^*(\phi^{*k}(0)), L^*(\phi^{*k}(0))\right)}{\partial \phi^{*k}(0)} > 0.$$

We now explain the forces underlying these partial derivative results. Suppose that $\phi^{*k}(0)$ is marginally increased. Since the political bias parameter is not present in the function $\nu(\cdot)$, the change in $\phi^{*k}(0)$ does not directly affect growth, but $\phi^{*k}(0)$ directly affects electoral outcome. In the probabilistic voting equilibrium, $\phi^{*k}(0)$ serves as a weight for the welfare of capitalists. Therefore, an increase in $\phi^{*k}(0)$ lowers η^*, and hence raises the public good expenditure. This increases wages and rent of capital. Those effects are taken into account in agents' *ex-ante* choice. In the *ex ante* choice, the higher factor rental rates raises the *ex-post* payoff of capitalists and workers, thus altering μ^*. The change in μ^* again influences the outcome of the subsequent electoral competition. Similar to that in the capital channel discussed earlier, the numerical results indicate that this makes capitalists much better off than workers, thus increasing μ^*. An increase in μ^* raises the capital stock. An increase in $\phi^{*k}(0)$ enhances the public good expenditure. These two effects increase growth. L^* rises due to increases in μ^*, thus lowering the marginal product of labour. However, this negative effect on growth is dominated by the two positive forces above. In sum, the growth rate is increased by increasing $\phi^{*k}(0)$.

Labour channel. From Panels (C1)-(C4) in Figure G.1, the marginal effects of the labor productivity parameter θ are given by:

$$\frac{\partial \eta^*}{\partial \theta} > 0, \quad \frac{\partial \mu^*}{\partial \theta} < 0, \quad \frac{\partial L^*}{\partial \theta} \gtreqless 0, \quad \frac{\partial \nu\left(\eta^*(\theta), \mu^*(\theta), L^*(\theta)\right)}{\partial \theta} < 0.$$

We explain the forces behind these partial derivative results. Suppose that θ is marginally increased. Similar to the situation for the political factor above, θ does not directly affect growth. We therefore focus on the changes in the endogenous variables. In the *ex-ante* choice, on one hand, an increment in θ raises the labour earnings of workers, thus increasing the *ex-post* payoff of workers. On the other hand, an increase in θ raises the labour tax base. This enhances the productive public good allocation, thus increasing the *ex ante* payoff of capitalists, holding the electoral outcome constant. This changes μ^*, but the effect is ambiguous. The change in μ^* alters the electoral outcome η^*. However, agents will anticipate this electoral outcome change, in their *ex-ante* choice problem. The calibrated and computed results suggest that the overall, we have an increase in η^* and a decrease in μ^*. The change in L^* is not monotonic because the change in θ directly affects the aggregate labour allocation. Given these effects, the growth rate monotonically decreases as the labor productivity parameter increases. This implies that the non-monotonic effect via a change in L^* is not dominant overall.

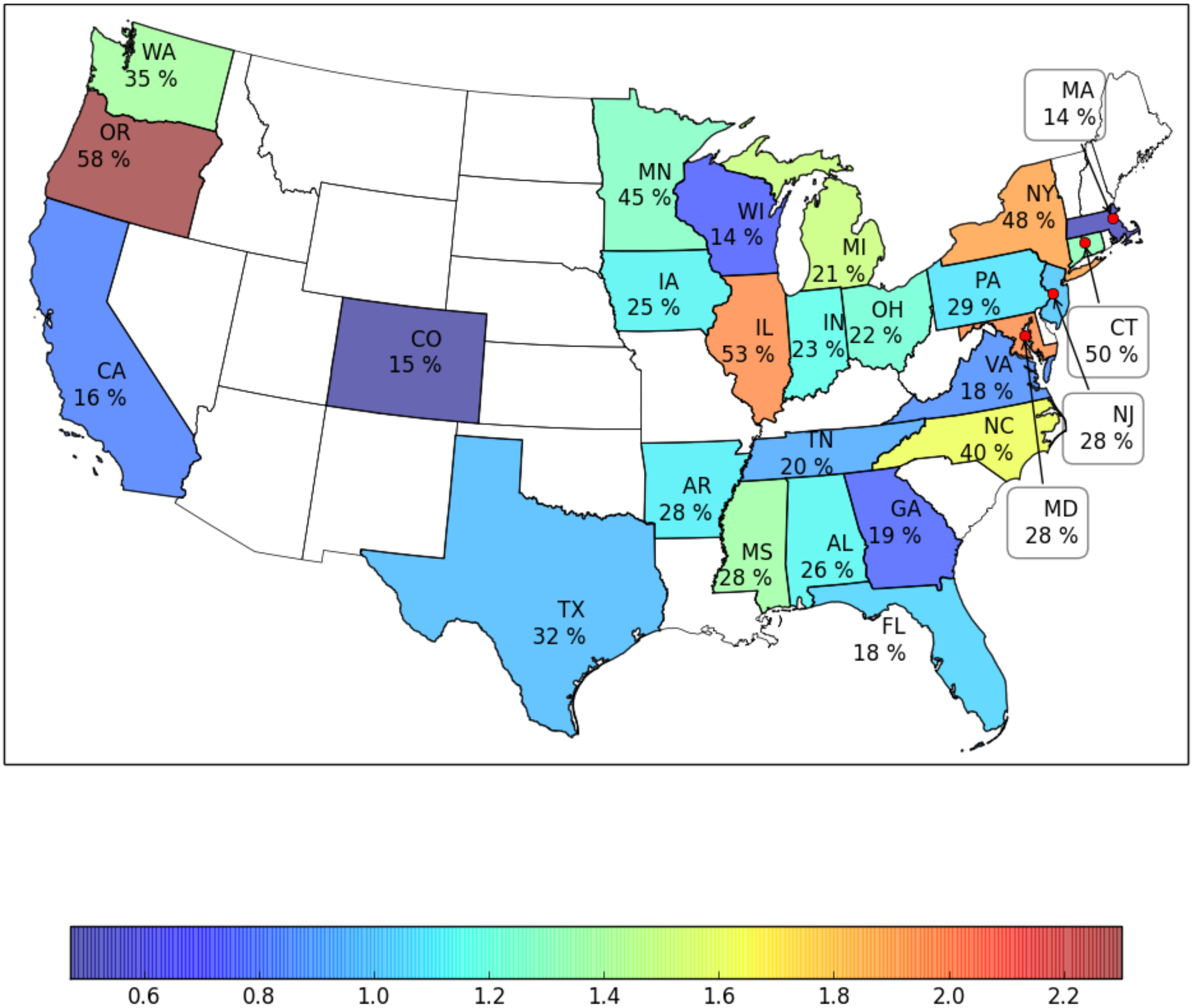
H Robustness of channels

Since the ANES data employed in this paper are from a national-level survey, the sample size of the cross-section is not necessarily large. We therefore combined the ANES data with another national-level public opinion survey, the *General Social Survey* (GSS). Combining the data increases the total number of observations from 26,639 to 64,378. We then re-estimated the bias parameters. Table H.1 shows the results in terms of the relative ratio of bias parameters, $\phi^{*k}(0)/\phi^{*\ell}(0)$ The differences in the relative ratios between two estimations vary $0 - 74\%$.

We re-calibrate the models based on these re-estimated parameters, and re-do the growth accounting exercise. Table H.2 shows the results. The region-common parameters are held the same as in Section 3.3. The first six columns summarise the cross-region averages and the standard deviations of the sensitivity measurements. In spite of an alternative data source and the resulting re-calibration, the results do not differ greatly from what we did in the main paper. The most influential channels are: the capital channel (in 20 states), the political (or voter bias distributions) factor (in four states) and the labour channel (in two states).

H.1 Effect of "labour channel" on growth

Figure H.1 shows the effect of θ on growth across states. The colour codes indicate that the effect on growth is large especially in Oregon.



Notes:
(1) Colour codes indicate the level of $\frac{\theta}{\nu}\frac{d\nu}{d\theta}$.
(2) Percentages below state names are ratio R_θ.

Figure H.1: Impact of the labour channel (indexed by θ) on growth

Table H.1: Estimated bias parameters

State		$\phi^{*k}(0)/\phi^{*\ell}(0)$ ANES	ANES + GSS	Difference (%)
Arkansas	AR	0.892	0.858	3.9
California	CA	0.840	0.719	14.4
Connecticut	CT	1.046	1.029	1.6
Georgia	GA	0.861	0.963	-11.8
Illinois	IL	0.888	1.232	-38.7
Indiana	IN	0.918	1.406	-53.2
Massachusetts	MA	0.739	1.000	-35.3
Michigan	MI	1.163	0.947	18.6
Minnesota	MN	0.879	1.414	-60.9
New Jersey	NJ	0.966	0.882	8.7
Ohio	OH	0.990	1.087	-9.8
Oregon	OR	1.000	1.000	0.0
Wisconsin	WI	0.864	1.375	-59.2
Colorado	CO	1.017	0.978	3.8
New York	NY	1.767	0.867	50.9
Pennsylvania	PA	1.465	1.358	7.3
Texas	TX	1.270	0.825	35.1
Alabama	AL	0.909	1.584	-74.2
Florida	FL	1.000	1.085	-8.5
Iowa	IA	0.899	0.760	15.4
Mississippi	MS	1.000	0.984	1.6
Tennessee	TN	0.921	1.000	-8.5
Virginia	VA	1.288	0.925	28.2
North Carolina	NC	0.981	1.655	-68.7
Washington	WA	0.836	1.000	-19.6
Maryland	MD	0.996	1.000	-0.4

Table H.2: The results of growth accounting

		ANES	ANES + GSS
R_ρ	Avg	34.2	42.7
	Std. Dev	13.7	12.7
$R_{\phi^{*k}(0)}$	Avg	36.8	37.0
	Std. Dev	2.8	2.8
R_θ	Avg	29.0	20.3
	Std. Dev	12.7	12.3
Most influential channel (Number of states)			
ρ		15	20
$\phi^{*k}(0)$		4	4
θ		7	2

I Explaining political distortion

In this section we provide the description of a benchmark planner's solution (section I.1). We also give further results on the mechanics of the political distortion (section I.2), which was discussed in section 4.1 of the paper.

I.1 Benchmark social planner's problem

The social planner problem is given by:

$$\max_{g_t} \int_o^{\mu_t^y} V^{y,k}(g_t; z)dz + (1 - \mu_t^y)V^{y,\ell}(g_t) + \int_0^{\mu_t^o} V^{o,k}(g_t; z')dz' + (1 - \mu_t^o)V^{o,\ell}(g_t),$$

where $V^{i,m}(\cdot)$ is the indirect utility function of i-aged, m-type individuals over the policy g_t. Since the objective function is concave, we can obtain a unique solution g_t^*. Notice that the bliss point of young agents is identical to that of old capitalists given by Lemma 2 because an extra increment in g_t raises the current wage, thus raising the earnings of the young. Replacing the political constraint (20) with the first-order condition of the social planner problem allows for obtaining the equilibrium of the benchmark economy. The first-order condition is given by:

$$\int_o^{\mu^*} \frac{\partial V^{y,k}(z)}{\partial g_t} dz + (1 - \mu^*)\frac{\partial V^{y,\ell}}{\partial g_t} + \int_0^{\mu^*} \frac{\partial V^{o,k}(z')}{\partial g_t} dz' + (1 - \mu^*)\frac{\partial V^{o,\ell}}{\partial g_t} = 0. \tag{I.1}$$

Thus, the steady state of the social planner economy is characterised by a system of Equations (22), (24), (25) and (I.1).

I.2 Mechanics of distortion

In the main paper, we have discussed the partial mechanics from a comparative exercise by varying the tax rate on labor income, for each state we considered. We used the calibration on the state of California as an illustration. This section now expands on the exercise by also looking at varying the tax rate on capital income.

Varying parameter τ^k. Consider the sequence of outcomes for both the social planner's economy (SP) versus the politico-economic equilibrium (PE), as we perturb the previously estimated parameter τ^k, which is the marginal tax rate on capital. Figure I.2 depicts the outcomes in terms of the average growth rate of the example economy of California. The graphs in this figure are humped shaped reflecting a Laffer curve effect from us exogenously varying the marginal tax rate on capital about the originally estimated point, $\tau^k_{calibrated}$. That is, a higher τ^k tends to raise public revenue, productive public good g and therefore growth via the spillover effect of higher g, but too high a tax rate will begin to discourage the supply of capitalists and their saving into private capital, another necessary ingredient for growth. Again, the respective maximum growth rate outcomes in the social planner's and the political economy are not the same as their counterparts in the actual calibrated economy—e.g., the points $(\tau^{k*}_{SP}, v^*_{SP})$ versus $(\tau^k_{calibrated}, \nu_{SP})$—since the original calibration took τ^k as an estimated parameter from the data. As before with our though experiment before with respect to τ^ℓ, the main point from this figure is that at any given τ^k, the vertical gap in growth-rate outcomes, between the planner's economy and the political economy, is always positive. This positive gap, again, reflects the inefficiency or distortion created by the political economy constraints: Relative to the planner's outcome, the political economy induces a smaller measure of the population of agents who work and own capital—i.e. the "capitalists"—as shown in Figure I.4, which in turn is associated with a corresponding long-run equilibrium allocation of productive public good relative to private capital (η^{-1}) that is lower (see Figure I.3).[22] As a result, the political economy ends up with lower growth rate than the corresponding

[22] The peculiar backward-bending portion of the graphs in Figure I.3 is not surprising in this model. With sufficiently high taxes on capital income, agents ex-ante would not find being capitalists a profitable alternative. As a result of perturbing τ^k to be high enough,

planner's economy.

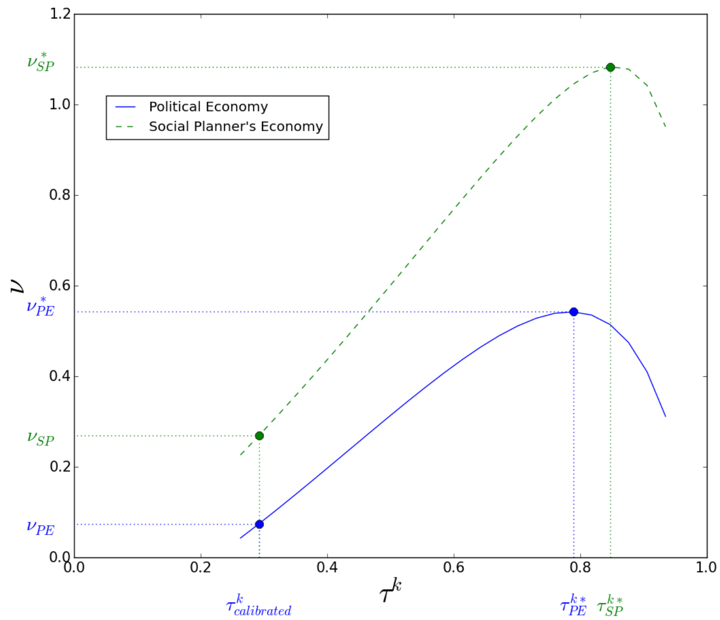


Figure I.2: Sequence of planner's vs. Political Economy growth rate outcomes (ν) as functions of tax-rate parameter τ^k—California (CA)

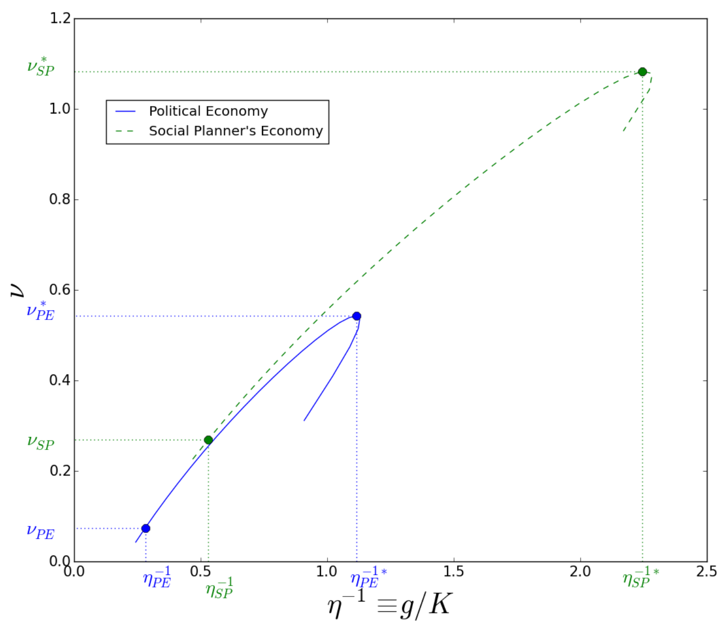


Figure I.3: Sequence of planner's vs. Political Economy growth outcomes as functions of public-good-to-private-capital ratio ($\eta^{-1} = g/K$)—California (CA)

a drastic decrease of the population of capitalists μ and a associated reduction in the ratio $\eta^{-1} = g/K$ can arise, thus pushing growth rates down.

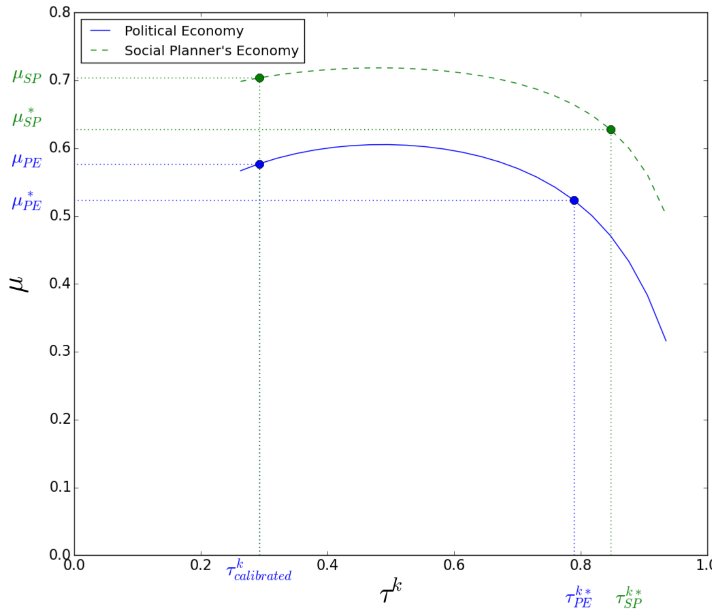


Figure I.4: Sequence of planner's vs. Political Economy measures of capitalists (μ) as functions of tax-rate parameter τ^k—California (CA)

J Distortion due to political influence

In this section we detail the exercises for measuring political distortions on regional growth and welfare (see section 4.2 in the paper).

J.1 Distortion relative to planners' solutions

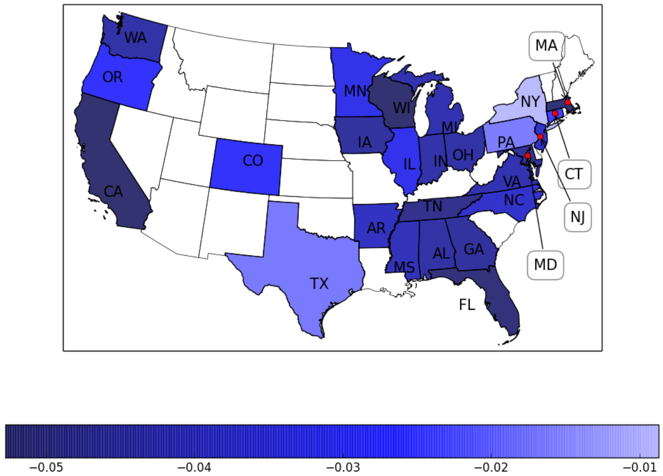
Letting ν_{SP} denote the steady-state growth rate of the social planner economy using our original calibrations for each US region, we define the measure of political distortion (in terms of growth) as $\Delta\nu_{SP} := \nu - \nu_{SP}$, where now ν will be taken to mean the politico-economic (PE) equilibrium outcome on growth. Figure J.1 shows the results. Observe that $\Delta\nu_{SP}$ is negative in all the states. This suggests that the political factor yields inferior growth performance across all state, relative to the social planner's outcome. The losses in growth performance are sizeable: They are in the order of $1 - 5\%$ on an annual basis.

Similarly, we evaluate the welfare costs borne by i-aged, m-type individuals due to political distortion. The costs are measured by $\Delta\tilde{c}^{i,m}_{SP} := \left(\tilde{c}^{i,m} - \tilde{c}^{i,m}_{SP}\right)/\tilde{c}^{i,m}_{SP}$, where $\tilde{c}^{i,m}$ and $\tilde{c}^{i,m}_{SP}$ are the consumption-to-capital ratios for i-aged, m-type individuals in the political economy and in the social planner economy, respectively, i.e., $\tilde{c}^{i,m} := c^{i,m}_t/K_t$, $\tilde{c}^{i,m}_{SP} := c^{i,m}_{t,SP}/K_t$.

The political distortion appears in terms of welfare losses to young capitalists, young workers and old capitalists across all the sample states, because the infrastructure expenditures are lower, relative to each region's social-planner economy. Since the cross-state welfare maps for young agents are identical to that for old capitalists, we focus on the welfare effect on old agents, which are summarised in Figures J.2 and J.3.

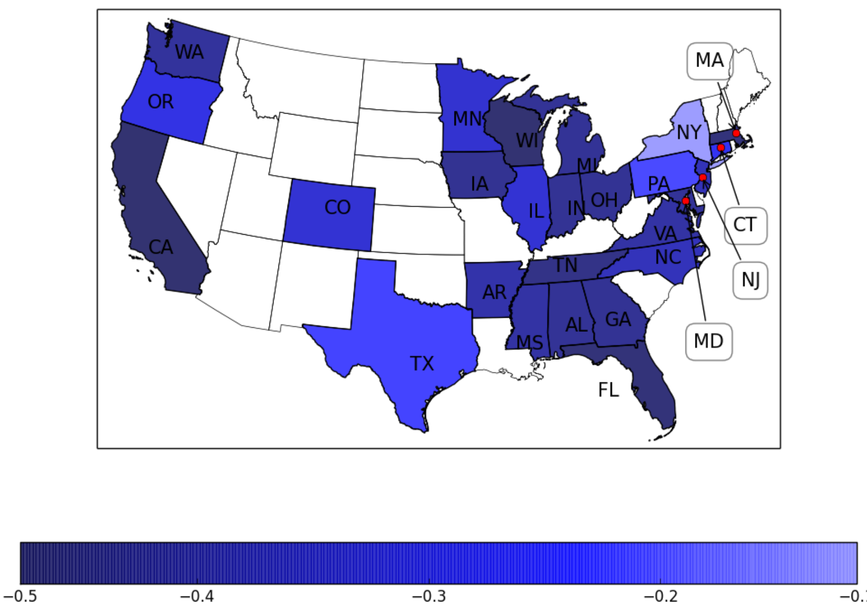
Now, we report the results for the young agents. Figure J.4 and J.5 show the political distortion on the welfare of young agents across states. The welfare loss of young capitalists varies by $9 - 36\%$. The welfare loss of young workers varies by $8 - 31\%$.

Figures J.6 and J.7 show the distortion in the welfare of young agents due to political bias across states. The



Note that colour codes indicate $\Delta\nu_{SP}$ on an annual basis.

Figure J.1: Political distortion in growth

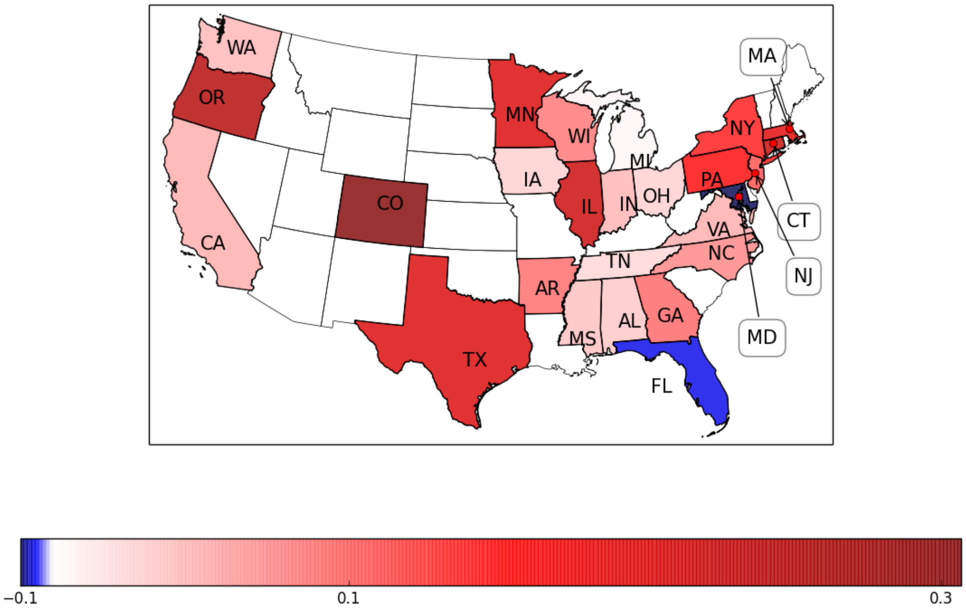


Note that the colour codes indicate $\Delta\tilde{c}^{o,k}_{SP}$.

Figure J.2: Political distortion in old capitalists' welfare

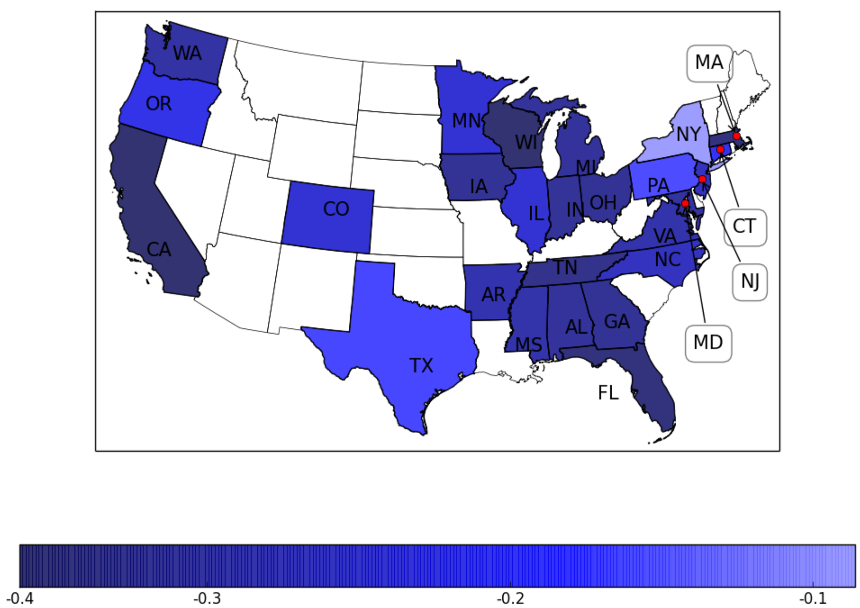
welfare benefit of young capitalists varies by -11 – 20%. The welfare benefit of young workers varies by -10 – 19%. Notice the negative values indicating the loss of welfare.

Not surprisingly, the political distortion which induces less infrastructure expenditure (relative to the planner's allocation) results in lower capitalists' welfare (by approximately 10 – 50%). In contrast, the welfare of the old workers is raised in most states by approximately 1 – 30% because the lump sum transfer to them is enhanced. The exceptions are Florida and Maryland where the welfare of old workers is slightly lowered. Even though the "aggregate-level" transfer, i.e., $T_t - g_t$ is raised also in these states, the "individual-level" transfer i.e., $c_{g,t} =$



Note that the colour codes indicate $\Delta\tilde{c}^{o,\ell}_{SP}$.

Figure J.3: Political distortion in old workers' welfare

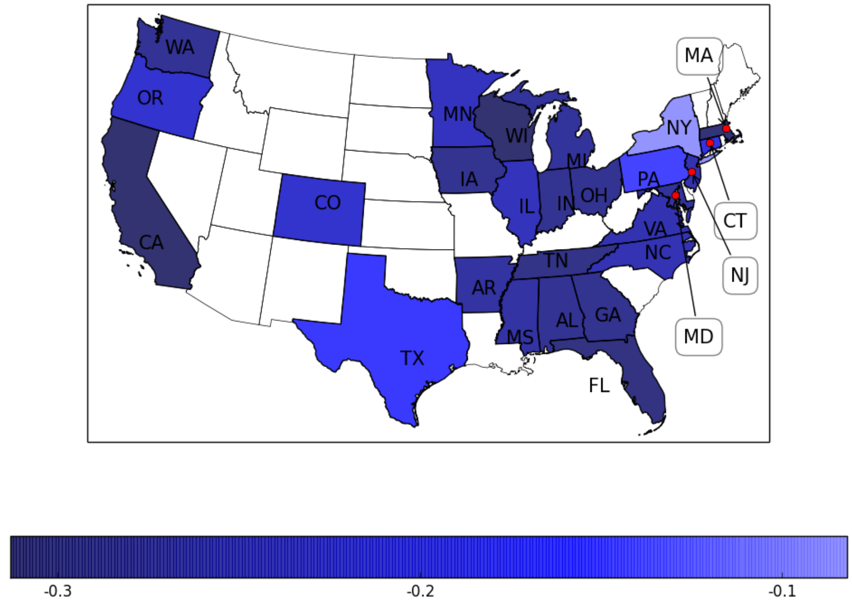


Note that colour codes indicate $\Delta\tilde{c}^{y,k}_{SP}$.

Figure J.4: Political distortion in young capitalists' welfare

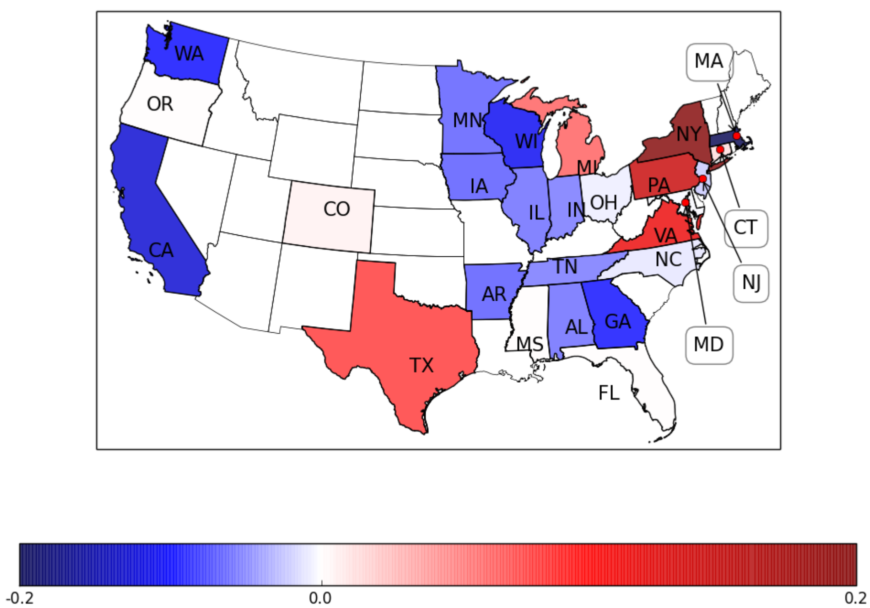
$(T_t - g_t)/N(1-\mu^*)$, is, in turn, decreased due to the increase in workers. In fact, the fraction of workers, $1-\mu^*$ is increased by approximately $10-20\%$ across all states.

For completeness, we consider another thought experiment asking how much is lost, if the regions moved from



Note that colour codes indicate $\Delta\tilde{c}_{SP}^{y,\ell}$.

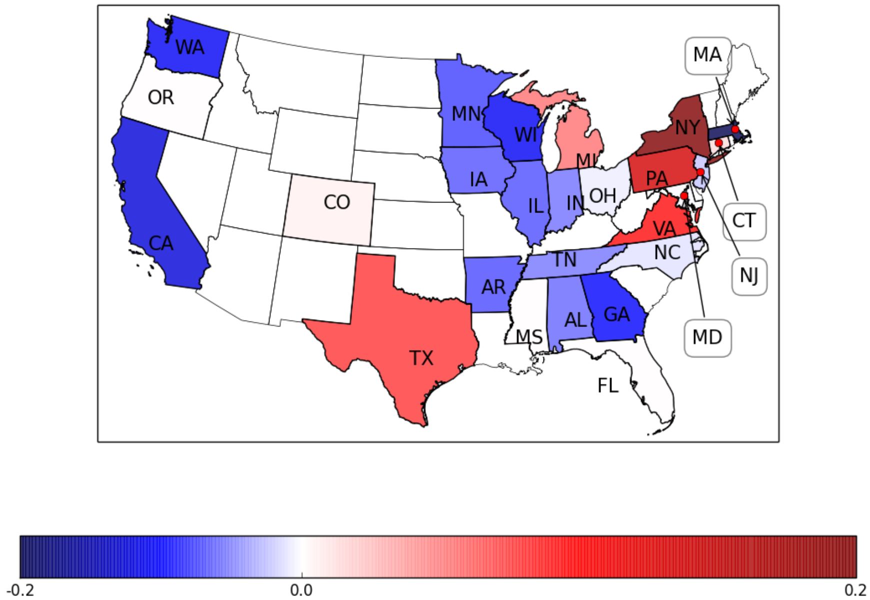
Figure J.5: Political distortion in young workers' welfare



Note that colour codes indicate $\Delta\tilde{c}_{NB}^{y,k}$.

Figure J.6: Distortion in young capitalists' welfare due to political bias

a fictitious political system where there is equal political influence between capitalists and workers, to the data-calibrated setting where there is unequal political influence between the classes. This is done in the next section.



Note that colour codes indicate $\Delta \tilde{c}_{NB}^{y,\ell}$.

Figure J.7: Distortion in young workers' welfare due to political bias

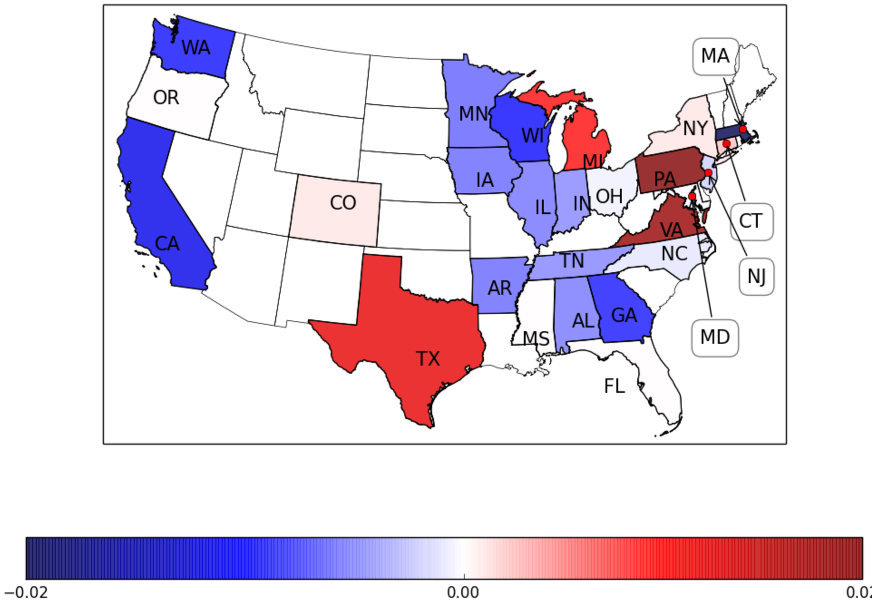
J.2 Gains from equal political influence

In section 4, we examined the thought experiment: What is to be lost if the regions moved from an efficient planning outcome to their current politico-economic outcome? Here, we follow up on this theme, and consider the question: What is to be lost if the regions moved from the same political regime (but with equal political influence between capitalists and workers) to its current incarnation where there is asymmetric political influence between capitalist- and worker-voters?

The benchmark is now the political economy with $\phi^{*k}(0)/\phi^{*\ell}(0) = 1$, holding all else identical to the calibrated setting in the paper.

We start with the loss measured in terms of economic growth, $\Delta\nu_{NB} := \nu - \nu_{NB}$, where ν_{NB} denotes the growth rate of the benchmark economy. The results are shown in Figure J.8. No distortion emerges in Florida, Mississippi and Oregon, where the original political economy also possesses no asymmetry in political influence; i.e., $\phi^{*k}(0)/\phi^{*\ell}(0) = 1$, and hence is identical to the benchmark economy. In six states, Connecticut, Michigan, Virginia, Colorado, New York, Pennsylvania and Texas, for which the original parameter $\phi^{*k}(0)/\phi^{*\ell}(0) > 1$, the bias towards capitalists raises the infrastructure expenditure, thus leading to a positive impact on growth. Recall that $\phi^{*k}(0)/\phi^{*\ell}(0)$ serves as the relative weight for the policy favoured by old capitalists in the probabilistic voting, i.e., the infrastructure good allocation. Therefore, a political economy with the increased relative weight enhances infrastructure expenditure. In the rest of the states with the original parameter $\phi^{*k}(0)/\phi^{*\ell}(0) < 1$, the bias occurs in the opposite direction and causes a negative impact. Since the political economy has a decreased weight, it lowers infrastructure expenditures, and instead enhances the lump sum transfer. The cross-state impacts are sizeable, and vary within $\pm 2\%$ on an annual basis.

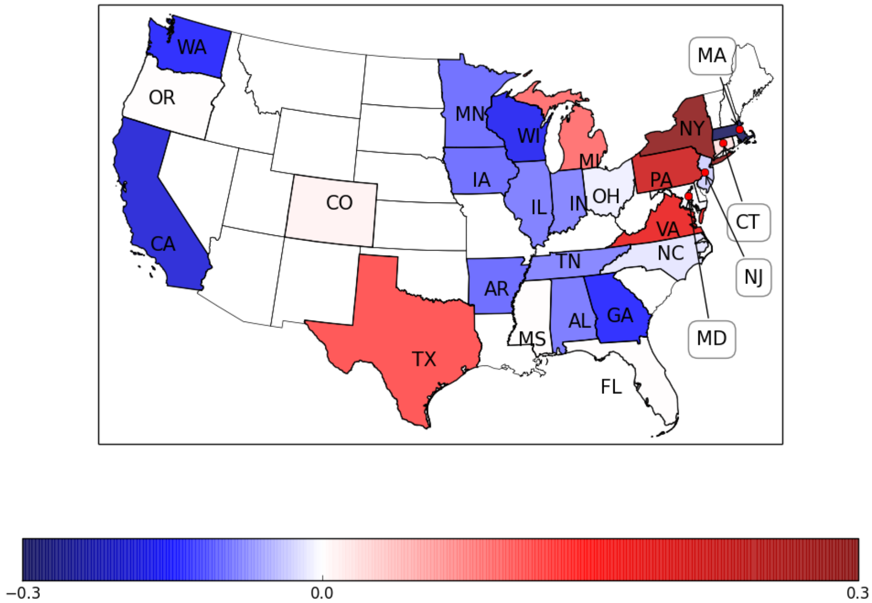
Next, we evaluate the welfare costs. Similarly to the evaluation of the political distortion, these costs are measured by $\Delta \tilde{c}_{NB}^{i,m} := \left(\tilde{c}^{i,m} - \tilde{c}_{NB}^{i,m}\right)/\tilde{c}_{NB}^{i,m}$ where $\tilde{c}_{NB}^{i,m} := c_{t,NB}^{i,m}/K_t$ is the consumption-capital ratio for i-aged, m-type individuals in the benchmark economy. For the same reason as in Section 4 in the paper, we only present the welfare impacts on old agents; see Appendix **??** for the results for young agents. Figure J.9 shows the welfare



Note that the colour codes indicate $\Delta\nu_{NB}$ on an annual basis.

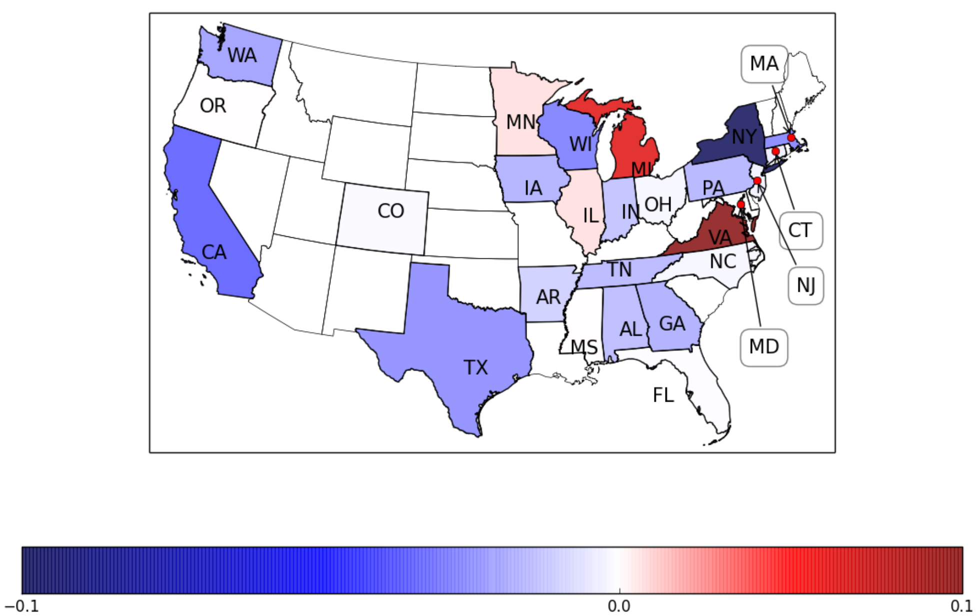
Figure J.8: Distortion in growth due to political bias

cost to the capitalists. As is the case for political distortion in the main paper, the cross-state pattern of the heat map is identical to Figure J.8. Figure J.10 shows the welfare costs to old workers. In some states including Texas and Illinois, we observe opposite impacts, whereas in other states, including Virginia and Alabama, we observe parallel impacts. In the former case, the individual-level transfer to workers changes inversely with infrastructure expenditure. In the latter case, the transfer is shifted in the same direction as the infrastructure expenditure. For the same reason as in Section 4 of the main paper, the consequence of the distortion depends on the movement of agent fractions through the *ex-ante* choice.



Note that the colour codes indicate $\Delta\tilde{c}^{o,k}_{NB}$.

Figure J.9: Distortion in old capitalists' welfare due to political bias



Note that the colour codes indicate $\Delta\tilde{c}^{o,\ell}_{NB}$.

Figure J.10: Distortion in old workers' welfare due to political bias

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