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Public expenditure distribution, voting, and growth

by Lorenzo Burlon

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PUBLIC EXPENDITURE DISTRIBUTION, VOTING, AND GROWTH

by Lorenzo Burlon*

Abstract

In this paper we study why the misallocation of resources across different productive sectors tends to persist over time. To this end we propose a general equilibrium model that delivers two structural relations. On the one hand, the public expenditure distribution influences the future sectoral composition of the economy; on the other, the distribution of vested interests across sectors determines public policy decisions. The model predicts that different initial sectoral compositions entail different future streams of public expenditure and therefore different development paths.

JEL Classification: O41, O43.

Keywords: public expenditure, sectoral composition, vested interests, economic growth.

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1 Introduction

We present a general equilibrium growth model that helps us understand how the public expenditure distribution, the sectoral composition, and the productive efficiency of an economy are intertwined along a development path. The mechanism that connects these three elements is a voting process that drives public policy.¹

Given an economy's stock of physical and human capital, labor, and technology, the way in which these are allocated across sectors -and across firms or even across plants and individuals- determines the productive capacity of an economy. See Jones [2013] for a recent analysis of the role of misallocations in explaining income differences across countries. Once we acknowledge the importance of the misallocation of resources, we might ask ourselves why countries with less-than-efficient allocations of resources do not shift to more efficient ones, or why different allocations exist in the first place. The literature on political economy and economic growth answers these questions interpreting the misallocation as the equilibrium outcome of a political process, where institutions determine the way in which resources are distributed and the distribution of resources itself influences the type of institutions an economy adopts. See Acemoglu et al. [2005] for an extensive overview. For example, it might not be in the interests of the ruling elite to improve the allocation of resources, even though the aggregate efficiency of the economy as a whole might increase.

The differences in institutions may explain well the differences in efficiency between developing and developed countries.² Nevertheless, it is not clear why differences in allocative efficiency should exist between countries with the same institutional quality. For example, why do misallocations persist even among countries endowed with democratic systems? In this paper we claim that the link between public policy, sectoral composition, and aggregate efficiency helps to explain this question.

We employ a dynamic model with voting applied to economic growth.³

¹The views expressed do not reflect those of the Bank of Italy. This research was initiated during my PhD at Universitat Autònoma de Barcelona. I would like to thank my PhD supervisor, Prof. Jordi Caballé, for his comments and suggestions. This paper was the recipient of the Best Paper awards at the III Doctoral Meeting of Montpellier (2010) and at the Annual Meeting of ASSET in Alicante (2010). I benefited from the comments of participants to several seminars and conferences, among which the XIV Workshop on Dynamic Macroeconomics in Vigo (2009) and the VIII Workshop on Macroeconomic Dynamics in Pavia (2009). All remaining errors are mine.

²For example, Cuberes and Jerzmanowski [2009] show how growth reversals are more likely in less democratic countries.

³See Krusell et al. [1997] for an overview of the related literature.

Public decisions may influence the sectoral evolution of an economy through taxation and public investment.⁴ At the same time, policies are usually tailored to or influenced by the productive structure of an economy.⁵ Moreover, the sectoral composition of an economy explains a significant part of aggregate efficiency.⁶ We combine in a growth model the endogenous determination of both the policy and the sectoral composition of an economy. Policies influence the future sectoral composition, the current sectoral composition drives the policies, and both contribute to the evolution of aggregate efficiency over time.

On the one hand, the sectoral composition of the economy affects its aggregate efficiency. If the different sectoral inputs are substitutable enough in the production of the final consumption good, then specialization increases aggregate efficiency. If instead the sectoral inputs are complementary, then diversification increases aggregate efficiency.⁷ In our framework, the misallocation of resources consists of the distance of an economy from its efficient level of diversification or specialization. On the other hand, redistributions of public expenditure can be blocked in the voting process because they affect the current interests of the individuals working in different sectors. Hence, there exists the possibility of political blockages of reforms, whose likelihood depend on the initial sectoral composition of an economy. A change towards sectoral specialization is more likely in economies that are already specialized and a change towards sectoral diversification is more likely in economies with an already diversified distribution.

The model builds on Galor et al. [2009], where different stages of development emerge through private investment in physical capital and public investment in human capital, and differences in timing of transitions originate from differences in the initial inequality of land ownership. Our model instead relates differences in development paths to different initial sectoral compositions. Moreover, in our framework public policies change by majority voting over alternatives. Hence, our model can shed light also on the differences across developed, democratic countries.

⁴Galor and Moav [2006] for example model the transition to a different sectoral composition as driven by publicly provided education programs.

⁵For example, Galor et al. [2009] show how the inequality in land ownership caused delays in the emergence of public schooling and therefore in the transition from agricultural to industrial economies.

⁶For an analysis of the role of structural transformation on aggregate efficiency, see for example Caselli [2005], Chanda and Dalgaard [2008], Córdoba and Ripoll [2009], and Duarte and Restuccia [2010].

⁷By diversification we mean a more even distribution of resources across the same set of sectors, not an expansion of the set. Similarly specialization refers to a more uneven distribution on the same set of sectors.

The reduced form prediction of the model is that the output depends on the history of government proposals' successes and failures, whose probabilities depend on the sectoral composition of the economy in the initial period.⁸ This generates delays in the development paths of economies with too diversified or too concentrated sectoral compositions.⁹ Hence, any exogenous alterations of the initial sectoral composition can trigger different streams of reforms and therefore different development paths. If the economy is stuck to an inferior development path characterized by a persistent political blockage of possibly growth-enhancing proposals, any exogenous shock that modifies the sectoral composition may remove the political blockage and shift the economy to higher long run income levels. This may refer, first, to economic crises, where mass unemployment rises unevenly across sectors and reallocates the political opposition to reforms. Second, to trade liberalizations and technological innovations, where for example the introduction of new tradable goods changes the combination of vested interests into organized political blockages. Third, to institutional changes such as the decentralization of political, administrative, and fiscal authority, where the subnational public decision units may face less sectoral complexity in the allocation of public resources, and the possibility of different political majorities across regions may remove the political blockages that occur at the national level.

In the models with sequential voting and growth the voters' policy preferences should be in general formed on the prediction of the equilibrium effects of a change in the current policy on the future path of both the economic state variable and the policies. In order to solve this problem of sequential voting without commitment on the government side, we make the following key assumptions. First, voters vote only once. Second, agents have a joy-of-giving bequest motive. Third, they vote only when they are old. Fourth, leisure does not enter the utility function. In this way, we obtain that voters do not care about the next vote, neither through the equilibrium effects on the stocks nor on the prices. Our approach is close to Persson and Tabellini [1994], Saint-Paul and Verdier [1993] and Saint Paul and Verdier [1997], Glomm and Ravikumar [1992], Perotti [1993], and Fernandez and Rogerson [1996]. In this stream of literature, the overlapping generations framework helps in cutting the ties to the future, since the ability of agents to predict the economic outcome is restricted, or at least it is not necessary for the

⁸Krusell and Ríos-Rull [1996] cast a similar connection between the initial skill composition on an economy and the likelihood to adopt technological innovations.

⁹Alesina and Drazen [1991] and Fernandez and Rodrik [1991] obtain similar status quo biases due to the nonneutrality in which the gains and losses from a reform are distributed within the society.

median voter to be forward looking.¹⁰

The paper is organized as follows. Section 2 reports two examples that illustrate the main mechanisms of the model. Section 3 presents the set-up and the equilibrium solution. Section 4 analyzes the dynamics of the development process and their relation to the public expenditure distribution. Section 5 characterizes the political dynamics and the determinants of political blockages and approvals. Section 6 discusses the results and Section 7 draws the final conclusions. Proofs and numerical exercises are provided in the Appendix.

2 Illustrative examples

We provide two examples to shed light on the key aspects of the model, that is, the efficiency of production and the voting mechanism.

Example 1 (Production). Suppose an economy that produces a unique final good using human capital coming from two sectors, 1 and 2. The aggregation in this economy is given by

$$Y = H_1^{1/3} + H_2^{1/3},$$

where H_1 is the human capital of sector 1 and H_2 is the human capital of sector 2. Suppose furthermore that the human capital in sector 1 is equal to the individual efficiency endowment h_1 of the individuals in sector 1 multiplied by the population p_1 that works in sector 1. The same holds in sector 2. In other words,

$$H_1 = p_1 h_1 \text{ and } H_2 = p_2 h_2,$$

where the total population, $p_1 + p_2$, is equal to 1 for simplicity. Moreover, suppose that at equilibrium the population distribution mirrors the distribution of individual efficiency, that is,

$$\frac{p_1}{p_2} = \frac{h_1}{h_2}.$$

¹⁰There exist other solutions to the problem of sequential voting in the presence of growth in the literature. First, we could restrict the voting at time zero only, as in Bertola [1993] and Alesina and Rodrik [1994]. Second, we could assume an equilibrium law of motion for policies consistent with individual maximization and market clearing which is used by the agents to form preferences over alternative policies, as in Krusell and Ríos-Rull [1996] and Krusell et al. [1997]. Third, we could focus on Markov-perfect equilibria á la Meltzer and Richard [1981] under aggregation, for which the policies result as a function of the pay-off relevant state and nothing else, as in Krusell and Ríos-Rull [1999] and Azzimonti et al. [2006] and Azzimonti et al. [2008]. Fourth, we could restrict the ability of the agents to predict the policy outcome, as in Boldrin [2005], Cukierman and Meltzer [1989], and Huffman [1993].

Let us call x the fraction of efficiency endowment in sector 1, that is, $x \equiv h_1/(h_1 + h_2)$. If x is equal to $1/2$ then there is perfect diversification and if x tends to 0 or 1 there is perfect specialization in sector 1 or 2. Solving for the aggregation Y we obtain

$$Y = A(x)(h_1 + h_2)^{1/3},$$

where $A(x)$ represents the aggregate efficiency of the economy and is given by

$$A(x) = [x^{2/3} + (1 - x)^{2/3}].$$

In this case, aggregate efficiency is maximal when the economy is perfectly diversified, that is, when $x = 1/2$. This is due to the fact that the human capital types are relatively complementary in the production of the final good. If instead the types of sector-specific human capital are more substitutable, for example if the aggregation is given by

$$Y = H_1^{2/3} + H_2^{2/3},$$

then $A(x) = [x^{4/3} + (1 - x)^{4/3}]$ and aggregate efficiency increases with specialization.

Example 2 (Voting). Suppose two economies, A and B , that have two sectors each, 1 and 2. Suppose furthermore that the population distribution across sectors mirrors the value added distribution. Economy A 's value added is composed 60% by Sector 1 and 40% by Sector 2. The policy of its government mirrors these relative magnitudes and distributes public expenditure 60% to Sector 1 and 40% to Sector 2. In Economy B instead the shares are 70% for Sector 1 and 30% for Sector 2, and the public expenditure is distributed accordingly. Both governments propose the same new public expenditure distribution, that is, 80% to Sector 1 and 20% to Sector 2. In both economies, the population in Sector 2 opposes the proposal because it would lose shares within government's budget if the proposal was approved. The population in Sector 1 instead supports the proposal. While in Economy A up to 40% of the population opposes the proposal, in Economy B only 30% of the population does so. Hence, Economy B is more likely to approve the proposal. If instead the proposal is to distribute expenditure 50% – 50% between Sector 1 and 2, Economy A is more likely to approve the proposal.

3 The Model

Our economy is in a process of development through overlapping generations. Time is discrete. The economy produces every period a homogeneous

good that can be used either for consumption or for investment. This good is produced using a continuous variety of productive sectors. The factors of production are physical and human capital. Physical capital is common across sectors, while human capital is sector-specific. The economy consists of a continuum of individuals distributed across sectors that accumulate physical and human capital. On the production side a firm maximizes profits under perfect competition, on the preference side a continuum of individuals maximize their utility, on the government side the budget is balanced and a voting process drives the distribution of public resources, and all markets clear.

3.1 Production

Consider an economy where a firm produces a unique final good according to a Cobb-Douglas production function,

$$Y_t = K_t^\alpha H_t^{1-\alpha}, \quad (1)$$

where $K_t \in \mathbb{R}_+$ is the stock of physical capital at time t and $H_t \in \mathbb{R}_+$ parameterizes the aggregate level of human capital. The shares of these two components are described by the constant $\alpha \in (0, 1)$. The human capital at the aggregate level is a combination of a continuous variety of sectoral specializations, each of them representing a different type of sectoral expertise. Thus, aggregate human capital is an additively separable sum of a continuum of mass J of sector-specific levels of human capital, that is,

$$H_t \equiv \left[\int_0^J [H_t(j)]^{1-\alpha} dj \right]^{\frac{1}{1-\alpha}}, \quad (2)$$

where j indexes the generic sector in the interval $[0, J] \subset \mathbb{R}_+$, and $H_t(j) \in \mathbb{R}_+$ indicates the sector-specific human capital. The firm operates under perfect competition. Since there is a unique final good, we can normalize its price to 1. The maximization problem for the final good firm at time t is

$$\max_{K_t, \{H_t(j)\}_{j \in [0, J]}} K_t^\alpha \int_0^J [H_t(j)]^{1-\alpha} dj - \int_0^J w_t(j) H_t(j) dj - r_t K_t, \quad (3)$$

where $w_t(j) \in \mathbb{R}_+$ is the wage per efficiency unit in sector j and $r_t \in \mathbb{R}_+$ is the rate of return on capital. The first order condition (FOC) with respect to the physical capital is

$$r_t = \alpha K_t^{\alpha-1} H_t^{1-\alpha}, \quad (4)$$

while the FOC with respect to the j -th sector-specific human capital $H_t(j)$ is

$$w_t(j) = (1 - \alpha) K_t^\alpha [H_t(j)]^{-\alpha}. \quad (5)$$

From the FOC we can recover the optimal shares of physical and human capital within the final output, that is,

$$r_t K_t = \alpha Y_t \quad \text{and} \quad \int_0^J w_t(j) H_t(j) dj = (1 - \alpha) Y_t. \quad (6)$$

3.2 Individuals

There is a continuum of individuals of mass 1, each of them indexed by i . Each individual lives for two periods, t and $t + 1$, and has a single child at the beginning of the second, so that every period a constant cohort of individuals of mass 1 is born. In the first period, every individual selects the sector where to work. In the second period, she works, votes, consumes, and leaves a bequest to her offspring.

Total public expenditure $\int_0^J G_t(j) dj$ is allocated across sectors according to the cumulative distribution function F_t , where $G_t(j)$ is the public expenditure devoted to sector j . We define $f_t(j) \equiv G_t(j) / \int_0^J G_t(j) dj$ as the share of total public expenditure devoted to sector j , and the function F_t such that $F_t(j) \equiv \int_0^j f_t(s) ds$. By construction, $\int_0^J f_t(j) dj = \int_0^J [G_t(j) / \int_0^J G_t(j) dj] dj = 1$.

In what follows we detail how the timing in period t unfolds.

1. The individual receives a bequest $b_t^i \in \mathbb{R}_+$ from her parent, saves inelastically all her financial endowment, and lends it to the firm.
2. She observes how public expenditure is allocated across sectors, that is, she observes the cumulative distribution function F_t of public expenditure.
3. She selects the sector j that guarantees her the highest wage income in period $t + 1$. Once she chooses the sector, she receives from the government the right to access the sector-specific public investment $\zeta G_t(j)$, where $\zeta \in (0, 1)$ is the exogenous share of expenditure devoted to investment.¹¹

In period $t + 1$, the individual realizes income.

¹¹We can think of $\zeta G_t(j)$ as the share of public expenditure in sector j devoted to research and development activities, or as the level of congestion-free public education guaranteed for the formation in sector j . For example, imagine that each individual that wants to work in sector j has to attend a sector-specific university. Then, $\zeta G_t(j)$ may represent public financing of that university.

1. She accumulates human capital $h_{t+1}(j)$ that depends on the public investment directed to the sector she chose in the previous period, i.e., $h_{t+1}(j) \equiv h(\zeta G_t(j))$.¹² We assume that the function h is homogeneous of degree $\epsilon \in (0, 1)$, which implies that there are decreasing individual returns to scale on public investment.
2. She supplies inelastically one unit of labor in the sector she has chosen and receives an interest on her savings. Hence, her realized income is the sum of wage and capital income, $w_{t+1}(j)h_{t+1}(j) + r_{t+1}b_t^i$.
3. The realized income is taxed by the government at rate τ_t . After being taxed, an individual working in sector j is supposed to receive a lump-sum transfer $T_{t+1}(j)$ from the government.
4. She observes a proposal presented by the government. This proposal consists of an alternative cumulative distribution function \bar{F}_{t+1} for public expenditure.
5. She votes in favor of the proposal if and only if $T_{t+1}(j)|_{\bar{F}_{t+1}} \geq T_{t+1}(j)|_{F_t}$, i.e., if the transfer she would get is higher with the proposed distribution than with the old one. Otherwise, she votes against it.

Figure 1 wraps up the timing of individual decisions.

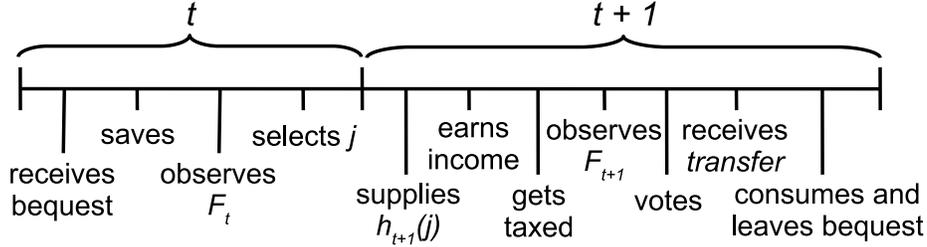


Figure 1: The timing of the individual.

The individual final income is

$$I_{t+1}^i(j) \equiv (1 - \tau_{t+1}) [w_{t+1}(j)h_{t+1}(j) + r_{t+1}b_t^i] + T_{t+1}(j). \quad (7)$$

¹²We rule out any congestion effect by considering public investment in a sector-specific pure public good. This simplification defines the distinction from the opposite case of complete congestion. As a consequence of complete congestion, the equilibrium population distribution would be independent of the public expenditure distribution and there would be no role for the public expenditure distribution.

The preferences of individual i born at time t and working in sector j in $t + 1$ are represented by a log-linear utility function,

$$u_t^i = (1 - \beta) \ln c_{t+1}^i + \beta \ln b_{t+1}^i,$$

where $\beta \in (0, 1)$ indicates the preference share of bequests, $c_{t+1}^i \in \mathbb{R}_+$ is second period's consumption, and $b_{t+1}^i \in \mathbb{R}_+$ is the transfer to the offspring due to a joy-of-giving bequest motive.¹³ The optimal choice of how much to consume and how much to leave as a bequest for member i of generation t in period $t + 1$ is then the solution to the following problem,

$$\begin{aligned} \max_{c_{t+1}^i, b_{t+1}^i} u_t^i &= (1 - \beta) \ln c_{t+1}^i + \beta \ln b_{t+1}^i \\ \text{subject to} \quad &c_{t+1}^i + b_{t+1}^i \leq I_{t+1}^i(j), \end{aligned} \quad (8)$$

where $I_{t+1}^i(j)$ is defined in (7). The first order conditions yield

$$c_{t+1}^i(j) = (1 - \beta)I_{t+1}^i(j) \text{ and } b_{t+1}^i(j) = \beta I_{t+1}^i(j). \quad (9)$$

The optimal bequest is indexed by the sector j . Similarly, also the parental bequest b_t^i should be indexed by the parent's sector j' . By extension, all individual choice variables at optimum depend on the sequence of the dynasty's sectoral choices. We neglect this element because it does not affect the aggregate dynamics of the model, although it does indeed drive the evolution of a dynasty's income through time and affect the cross-sectional income inequality.

The indirect utility function,

$$v_t^i(j) = \ln I_{t+1}^i(j) + (1 - \beta) \ln(1 - \beta) + \beta \ln \beta, \quad (10)$$

is a monotonically increasing function of final income, which depends positively on the lump-sum transfer devoted to sector j . This is the interest that drives the individual's voting behavior, that is, voting yes to the proposal \bar{F}_{t+1} if and only if $T_{t+1}(j)|_{\bar{F}_{t+1}} \geq T_{t+1}(j)|_{F_t}$.¹⁴ The choice of the sector in

¹³We choose a warm-glow-of-giving type of utility function merely for analytical simplicity. Allowing for an alternative bequest motive such as in Alonso-Carrera et al. [2012], that is, an interest in the after-tax contribution to the future life-time income of the offspring, would not change qualitatively the optimal choice of bequest and consumption. See Michel et al. [2006] for an overview of alternative mechanisms of intergenerational altruism.

¹⁴We stress the timing of the individuals because the results below are sensitive to it. In particular, if we put the voting decision in the first period and the sector selection in the second, on the one hand, individuals would not have a vested interest in voting in favor of a sector, as ex-ante they would not belong to any. On the other hand, individuals' final income would depend on aggregate efficiency, so they would vote in favor of efficiency-increasing public expenditure distribution proposals. There would be no conflict of interests and efficiency dynamics would be entirely driven by government proposals.

the first period of life is driven by the maximization of the wage income in the second period of life and not by the maximization of the indirect utility function (10). An underlying assumption of this approach is that young individuals are myopic with respect to the transfer they get when old. The transfer $T_{t+1}(j)$ depends on the political outcome in period $t + 1$. It suffices to assume that individuals do not have information on how the distribution of public expenditure is determined in the following period to justify their myopic behavior. The wage income when old is instead a deterministic function of choices of young individuals in the previous period. Hence, individuals can base their sectoral choice on the maximization of their wage income, and yet ignore the transfers they receive when old.

3.3 Government

The government taxes realized income at a flat rate τ_t and follows a balanced-budget constraint, that is,

$$\int_0^J G_t(j) dj = \tau_t \int_0^1 [w_t(j)h_t(j) + r_t b_{t-1}^i] di, \quad (11)$$

for every t . We could consider different forms of taxation. The distortions introduced by an exogenous flat income tax rate are not qualitatively different from the distortions of a labor or capital income tax since both the labor supply and the saving decision are inelastic. We could even consider lump-sum taxation but we prefer to maintain the tension between distortive taxation and public investment.¹⁵ Hence, we can focus on the role of the public expenditure distribution.

Once the government collects the fiscal revenue, it has to distribute the public expenditure across sectors. In our model, the government is not a central planner. It does not maximize any welfare function. Instead, it simply follows a constitutional rule, which consists of the following procedure. The government formulates a proposal \bar{F}_t , that is, a possible new distribution of public expenditure. If the individuals approve the proposal, then the government updates the distribution according to $F_t = \bar{F}_t$. Otherwise, the government ignores the proposal and sets $F_t = F_{t-1}$. The formulation of the proposal consists of a random draw from a set of possible public expenditure distributions.

¹⁵See for example Galor and Moav [2006] and Galor et al. [2009] for the growth consequences of the trade-off between private investment in physical capital and public investment in human capital.

Definition 1 (The set of possible proposals). The set Ω_t of possible proposals is an ordered set of public expenditure distributions such that for every $\bar{F}_t \in \Omega_t$ either

$$\bar{F}_t(j) \leq F_{t-1}(j) \text{ for every } j \in [0, J]$$

or

$$\bar{F}_t(j) \geq F_{t-1}(j) \text{ for every } j \in [0, J],$$

where the order \preceq is such that, for every pair of proposals \bar{F}_t^1 and \bar{F}_t^2 in Ω_t , $\bar{F}_t^1 \preceq \bar{F}_t^2$ if and only if $\bar{F}_t^1(j) \leq \bar{F}_t^2(j)$ for every $j \in [0, J]$.

This definition resembles the definition of a first-order stochastic ordering of random variables. Hence, we refer henceforth to the situation $A \preceq B$ as “ A dominates B .” Nevertheless, $G_t(j)$ is not a realization of a random variable. There is no stochastic aspect in the distribution of the mass G_t over the set $[0, J]$. In this sense, Ω_t is simply an ordered function space, and the corresponding order \preceq is not a stochastic order.¹⁶ Suppose that we order the sectors increasingly according to their sector-specific public investment, $G_t(j)$. We make an assumption in order to obtain an analytically tractable framework.

Assumption 1. The function G_t is continuous on $[0, J]$, and differentiable and strictly increasing on $(0, J)$ for every t . Moreover, $G_t(0) = 0$ for every t .

The rationale behind this assumption is that sectors in our model are different between each other only in terms of the public expenditure directed to them. There is no other intrinsic technological endowment that characterizes each sector. Hence, the sector-specific public investment differs between any pair of sectors j and k , that is, $G_t(j) \neq G_t(k)$. Assumption 1 implies that the function G_t is continuous and by construction that $G_t' > 0$. Consequently, also f_t is differentiable and strictly increasing.

The lower bound of Ω_t according to the order \preceq is the distribution \bar{F}_t of public expenditure such that $\bar{F}_t(J) = \int_0^J G_t(j) dj$ and $\bar{F}_t(j) = 0$ for every $j \in [0, J)$. If Assumption 1 holds, then the upper bound of Ω_t according to the order \preceq is the even distribution such that $\bar{F}_t(j) = j/J$ for every $j \in [0, J]$. Moreover, if Assumption 1 holds, neither the upper bound nor the lower bound of Ω_t belong to Ω_t .¹⁷ We can define a σ -algebra \mathcal{F}_t as a subset of the

¹⁶The set Ω_t depends on F_t but is not unique given a certain F_t , that is, for each given F_t there can exist two pairs of distributions (F_1, F_2) and (F_3, F_4) such that $F_1 \preceq F_2$, (F_1, F_2) dominate or are dominated by F_t , $F_3 \preceq F_4$, (F_3, F_4) dominate or are dominated by F_t , and yet it is possible that neither $F_1 \preceq F_3$ nor $F_3 \preceq F_1$.

¹⁷In stochastic terms, the upper bound would be the uniform distribution and the lower bound would be the Dirac mass on J .

power set of Ω_t such that \mathcal{F}_t is non-empty, closed under complementation, and closed under countable unions. Hence, $(\Omega_t, \mathcal{F}_t)$ is a measurable space, and $(\Omega_t, \mathcal{F}_t, \mathcal{P}_t)$ is a measure space where \mathcal{P}_t is a measure defined on \mathcal{F}_t such that $\mathcal{P}_t(\Omega_t) = 1$, that is, \mathcal{P}_t is a probability measure. We can therefore have a random variable X_t over $(\Omega_t, \mathcal{F}_t)$ whose probability measure \mathcal{P}_t is defined on the function space Ω_t .¹⁸ Since an explicit characterization of the probability measure \mathcal{P}_t goes beyond the scope of this paper, we leave this to future research and simply assume that the proposal \bar{F}_t formulated by the government in period $t + 1$ is the realization of a random variable X_t . This is the sense in which the government formulates the proposal by making a random draw from a set of possible future public expenditure distributions. A consequence of Definition 1 is that the ranking across sectors in $[0, J]$ remains constant over time.

The fiscal revenue available at any period t is distributed across sectors according to the public expenditure distribution F_t . Within each sector j , the expenditure $G_t(j)$ is split between investments, $\zeta G_t(j)$, and lump-sum transfers to individuals, $(1 - \zeta)G_t(j)$. The share ζ of public investment over total expenditure is exogenous and fixed. These two assumptions simplify the analysis and deserve further discussion. We can think of ζ as the result of a bargaining process between young and old individual at each t . Since each individual has only one offspring, the mass of young and old individuals at each point in time is the same. Hence, the bargaining process is likely to yield the same level of ζ for any generation t . In order to maintain the model parsimonious, we prefer to leave this aspect out of the model.¹⁹

The reason for the adoption of this set-up for the formulation of policies is that otherwise the policy space would be multidimensional. If individuals had preferences over the possible distributions of public expenditure, they would have to choose a share $f_t(j)$ in $[0, 1]$ for each sector j in the continuum $[0, J]$, under the constraint that $\int_0^J f_t(j) dj = 1$. Hence, the median voter theorem would yield no prediction, despite single-peaked individual preferences over any distribution. As an alternative to the median voter theorem we could allow for probabilistic voting, where social groups with greater homogeneity of preferences would be more politically powerful than those whose preferences are dispersed because the equilibrium policy would depend on the magnitude and density of social groups rather than on the median position of

¹⁸For example, a probability defined on a function space is used in the study of the Brownian motion.

¹⁹If the parameter ζ were sector-specific, that is, ζ_j , then the bargaining process between young and old individuals would take place within each sector, and ζ_j would be the outcome of the proportion of young and old individuals within sector j .

voters.²⁰ Nevertheless, we do not adopt probabilistic voting because we want to obtain the possibility of political blockages of possibly growth-enhancing reforms and not simply the absence of politically unfeasible policy proposals. In this sense, our framework is reminiscent of the agenda-setting model of Romer and Rosenthal [1978, 1979], since voters respond as price takers to the government’s supply offer, where in our case the supply consists of a given distribution of public expenditure. Voters can only choose between accepting the proposal of the “setter” or rejecting it in favor of an institutionalized “reversion” distribution, which in our case is the previous period’s distribution. The difference between our model and the agenda-setting model is that the government in our case is not an agent of the economy and does not control the agenda to maximize a welfare function. Given the ordered nature of the set Ω_t of possible government proposals, we could devise a government that selects an element in Ω_t such that it maximizes its objective function. Depending on the objective function, this selection may result as trivial or complex. If the objective function is simply future output or the steady state level of output, then the choice of the distribution is trivial, as we explain in Section 4. Since we want to cover a wider variety of political developments, we prefer to leave the proposal of new public expenditure distributions as the result of a random draw.

3.4 Market clearing conditions

The connections between the different sides of this economy consist of, first, the savings-investment equilibrium condition,

$$K_{t+1} = i_t = \int_0^1 b_t^i di, \quad (12)$$

where the right hand side is the sum of all bequests saved by individuals in the first period of life and the left hand side is the private investment in physical capital under full depreciation.²¹ Second, we consider the aggregation rule for sector-specific human capital,

$$H_t(j) = p_t(j)h_t(j), \quad (13)$$

²⁰See, e.g., the applications to special-interest politics in Persson and Tabellini [2002, Chapter 7] and Bellettini and Ottaviano [2005], or to social security in Profeta [2002] and Galasso and Profeta [2002].

²¹We can think of the full depreciation of physical capital as a consequence of the time span that separates two periods in our overlapping generations model. Individuals live for only two periods, so each period corresponds to around 25 – 35 years. If we consider a standard value of 2.5% for the depreciation rate of physical capital on a quarterly basis, this leads us to a depreciation rate of around 92% – 97%.

where $p_t(j) \in [0, 1]$ is the portion of total population working in sector j at time t . Since the mass of the population is 1, $\int_0^J p_t(j) dj = 1$. The variable $p_t(j)$ represents therefore the population density in sector j at time t . Note that $H_t(j)$ parameterizes the aggregate demand for sector j -specific efficiency units expressed by the firm. In equilibrium this must be equal to the total supply, which is the individual supply $h_t(j)$ of efficiency units of those who choose sector j multiplied by the total number $p_t(j)$ of individuals in sector j . Third, the transfer received by sector j is equally distributed among the population working in sector j , i.e.,

$$(1 - \zeta)G_t(j) = T_t(j)p_t(j), \quad (14)$$

for every j in $[0, J]$. Fourth, the workers select the sector according to the wage income that working in that sector guarantees. In equilibrium this implies that the wage income must be the same across sectors, that is,

$$w_t(j)h_t(j) = W_t, \quad (15)$$

for all $j \in [0, J]$. If this were not true, at the moment of choosing the sector any individual would have the incentive to choose the higher wage income sector, increasing the supply in that sector and lowering thereafter its wage per efficiency unit. Finally, we impose a political threshold for successful proposals, namely that proposals are approved if and only if the majority of the population expresses a vote in their favor.

Assumption 2 (Approval Threshold). A proposal \bar{F}_{t+1} is approved if the mass of individuals in favor is greater or equal than $1/2$.

The existence of an approval threshold is a salient element of the results below, but the level of such a threshold is qualitatively irrelevant. We choose majority voting for simplicity and consistency with widespread concepts in the literature such as median voters and Condorcet winners.

3.5 Equilibrium

We define and solve for the intertemporal equilibrium as follows.

Definition 2 (Intertemporal Equilibrium). An intertemporal equilibrium is a set of firm decisions $\{K_t\}_{t=0}^\infty$ and $\{\{H_t(j)\}_{j \in [0, J]}\}_{t=0}^\infty$, individual decisions $\{\{c_t^i, b_t^i\}_{i \in [0, 1]}\}_{t=0}^\infty$, tax rates $\{\tau_t\}_{t=0}^\infty$, public expenditure distributions $\{F_t\}_{t=0}^\infty$, and prices $\{r_t\}_{t=0}^\infty$ and $\{\{w_t(j)\}_{j \in [0, J]}\}_{t=0}^\infty$, such that

- a) $\{K_t, \{H_t(j)\}_{j \in [0, J]}\}$ is a solution to problem (3) given r_t and $\{w_t(j)\}_{j \in [0, J]}$ for every $t \in \{0, 1, \dots\}$,

- b) $\{c_{t+1}^i, b_{t+1}^i\}_{i \in [0,1]}$ is a solution to problem (8) given (7), for all $i \in [0, 1]$ and all $t \in \{0, 1, \dots\}$,
- c) $\{\{G_t\}_{j \in [0,J]}, \tau_t\}$ satisfies the balanced-budget constraint of the government (11) for all $t \in \{0, 1, \dots\}$,
- d) and the market clearing conditions (12), (13), (14), (15), and Assumption 2 are satisfied for all $t \in \{0, 1, \dots\}$.

We can combine the first order conditions of the different agents and the market clearing conditions in order to summarize the equilibrium solution in the following proposition.

Proposition 1 (The Equilibrium Solution). *Given the tax rate τ_t , total output evolves over time depending on the public expenditure distribution F_t , that is,*

$$Y_{t+1} = \psi_t(Y_t|F_t) \equiv M(\tau_t)\phi(F_t)^\alpha Y_t^{\epsilon(1-\alpha)+\alpha}, \quad (16)$$

where

$$M(\tau_t) \equiv [1 - \tau_t\zeta]^\alpha [\tau_t\zeta]^{\epsilon(1-\alpha)} \beta^\alpha h(1)^{1-\alpha}$$

and

$$\phi(F_t) \equiv \int_0^J f_t(j) \frac{\epsilon(1-\alpha)}{\alpha} - 1 dF_t(j).$$

Moreover, the distribution of population across sectors at time $t + 1$ mirrors the public expenditure distribution decided at time t , that is,

$$p_{t+1}(j) = \left(\frac{h_{t+1}(j)}{H_{t+1}} \right)^{\frac{1-\alpha}{\alpha}} = \frac{f_t(j) \frac{\epsilon(1-\alpha)}{\alpha}}{\phi(F_t)}. \quad (17)$$

and the transfer that each individual working in sector j receives is a linear function of the share of that sector within the government budget, that is,

$$T_{t+1}(j) = f_{t+1}(j) \frac{(1 - \zeta)\tau_{t+1}Y_{t+1}}{p_{t+1}(j)}. \quad (18)$$

4 The Development Process

We show how the public expenditure distribution affects aggregate human capital and therefore the law of motion of total output. The equilibrium law of motion, (16), expresses future output Y_{t+1} as a function of the public expenditure distribution F_t and current output level Y_t . Suppose we fix the

distribution to a constant level, i.e., $F_t = F$ for every t . Furthermore, we also fix the exogenously given tax rate to a constant level, $\tau_t = \tau$. The law of motion ψ_t is in this case time invariant, that is, $Y_{t+1} = \psi(Y_t|F)$ for every t . In other words, we neglect for the moment that F_t is a product of the voting in every period. Thus, there is only one endogenous state variable, namely the current level of output Y_t . Then we have that

$$Y_{t+1} = \psi(Y_t|F) = M(\tau)\phi(F)^\alpha Y_t^{\epsilon(1-\alpha)+\alpha},$$

where

$$M(\tau) = [1 - \tau\zeta]^\alpha [\tau\zeta]^{\epsilon(1-\alpha)} \beta^\alpha h(1)^{1-\alpha}$$

and

$$\phi(F) \equiv \int_0^J f(j) \frac{\epsilon(1-\alpha)}{\alpha} - 1 dF(j).$$

In order to analyze how output evolves over time maintaining constant the other variables, we state the following proposition.

Proposition 2 (Development Path with Constant Distribution). *Suppose that $F_t = F$ and $\tau_t = \tau$ for every t . Then,*

- a) $\psi'(Y_t|F) > 0$ for every Y_t ,
- b) $\psi''(Y_t|F) < 0$ for every Y_t ,
- c) $\lim_{Y_t \rightarrow \infty} \psi'(Y_t|F) = 0$,
- d) $\lim_{Y_t \rightarrow 0} \psi'(Y_t|F) = +\infty$,
- e) $\psi(0|F) = 0$,

that is, the law of motion is strictly increasing, strictly concave, and respects the Inada conditions.

This proposition assures that the law of motion is well behaved and that the economy is able to follow a development process independently of the public expenditure distribution. In particular, let us define a steady state.

Definition 3 (Steady State with Constant Distribution). Consider a fixed public expenditure distribution, F . A steady state Y_s is a level of income such that $\psi(Y_s|F) = Y_s$.

Proposition 2 implies that, if there exists a non-trivial steady state $Y_s > 0$, it is unique and identified by the public expenditure distribution F . In order to obtain a closed form solution for it, we set

$$\psi(Y_s|F) = M(\tau)\phi(F)^\alpha Y_s^{\epsilon(1-\alpha)+\alpha} = Y_s,$$

which yields a unique solution greater than 0,

$$Y_s = Y_s(F) \equiv [M(\tau)\phi(F)^\alpha]^{-\frac{1}{1-\epsilon(1-\alpha)-\alpha}}. \quad (19)$$

The steady state level of total output depends on F . This unique non-trivial steady state is also stable, because the condition under which $Y_{t+1} > Y_t$ is

$$M(\tau)\phi(F)^\alpha Y_t^{\epsilon(1-\alpha)+\alpha} > Y_t,$$

which corresponds to $Y_t < Y_s$. Hence, given the law of motion with the properties defined in Proposition 2, there exists a unique non-trivial steady state which is stable and whose level depends on the public expenditure distribution. If the public expenditure distribution is constant, the economy follows a standard development path towards a unique stable steady state, as Figure 2 shows.

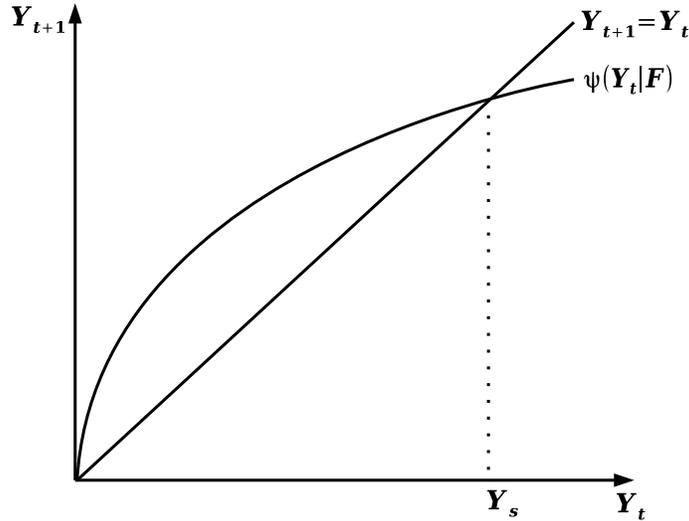


Figure 2: Development Path with a Constant Distribution

There exists a multiplicity of steady states, each one identified by a different public expenditure distribution. It is then crucial to understand the

effect of changes in the public expenditure distribution on the development path. In order to do so, we have to sort different distributions and see if there is a relation between this sorting and different development paths. In what follows, we choose to classify distributions according to their degree of first-order stochastic dominance, as this delivers the most clear-cut results.²²

Proposition 3 (Efficiency with Dominance). *Consider two distributions, F_t^1 and F_t^2 . Suppose that F_t^1 dominates F_t^2 . If*

$$\epsilon(1 - \alpha) \geq \alpha, \tag{20}$$

then $\phi(F_t^1) \geq \phi(F_t^2)$. If $\epsilon(1 - \alpha) \leq \alpha$, then $\phi(F_t^1) \leq \phi(F_t^2)$. Moreover, if F_t^1 strictly dominates F_t^2 and

$$\epsilon(1 - \alpha) > \alpha, \tag{21}$$

then $\phi(F_t^1) > \phi(F_t^2)$. If $\epsilon(1 - \alpha) < \alpha$, then $\phi(F_t^1) < \phi(F_t^2)$.

This proposition suggests that when sectors are relatively substitutable specialization is a channel of productive efficiency. Instead, when sectors are relatively complementary aggregate efficiency increases with diversification. The intuition for the substitutability case is that the increase in aggregate productivity is due to the concentration of the population in the most efficient sectors. The population equilibrium distribution, (17), mirrors the public investment distribution across sectors. Hence, an increase in dominance causes a corresponding increase in the population distribution dominance. Since $p_{t+1}(j)$ is strictly increasing in $f_t(j)$, if the latter increases, then the former increases as well. Hence, population migrates from low-productive and less-populated sectors to high-productive and more-populated sectors. The concentration occurs because the public investment in a sector is a pure public good for the individuals that choose that sector. This creates the possibility of aggregate positive returns on concentration, as long as sectors are substitutable enough. An increase in dominance causes, on the one hand, an increase in individual productivity and in the number of workers in a few sectors and, on the other hand, a decrease in productivity and in the number of workers in all the other sectors. If the parameter restrictions implied by condition (20) or condition (21) hold, the former effect overcome the latter for any degree of concentration, paving the way for persistent positive returns. The parameter α plays a specific role in the production function, namely in (1) and (2), since if α is equal to 0 the sectors are perfectly substitutable,

²²It is possible to obtain also results for second-order stochastic dominance, but the necessary restrictions on the parameter space are even stronger as we need the concavity or convexity of the integrated function. The main insights are the same so we focus on the simple case of first-order stochastic dominance.

while if α tends to 1 we approach perfect complementarity. Then, condition (20) and condition (21) imply that aggregate improvement through sectoral specialization is possible only if the sectors are sufficiently substitutable for the production of the final good. Indeed, if the sectors are enough complementary to reverse conditions (20) and (21), sectoral diversification leads to aggregate efficiency. Hence, conditions (20) and (21) help in defining a perspective of analysis. If they hold, specialization leads to aggregate efficiency. If they do not hold, diversification is the efficient policy.²³ The main message of Proposition 3 is that, although there are no aggregate increasing returns of the amount $\int_0^J G_t(j) dj$ of public investment, there may be a limited scope for efficiency gains from the direction of such an investment.

An increase (decrease) in dominance when sectors are substitutable (complementary) causes an increase in future output and therefore a generalized increase in future wage income, because $W_{t+1} = (1 - \alpha)Y_{t+1}$. This is not necessarily a Pareto-improvement. As (18) states, transfers decrease for individuals who work in sectors that lose shares in the overall public expenditure. This has also a repercussion on the bequest that these individuals leave to their offspring, and therefore on the disposable income of part of the future generation. Hence, a change in dominance in period t increases overall income in period $t + 1$, but it also prejudices the current income of some individuals and consequently of their offspring. In other words, it generates income redistributions through time.

Proposition 3 states that if sectors are, say, sufficiently substitutable, the function ϕ in the law of motion for output (16) depends negatively on F_t . The more dominant the public expenditure distribution the higher the aggregate efficiency. We can interpret ϕ as decreasing in F_t , that is, every increase in dominance leads to a higher value of ϕ . According to (16), if $\phi(F^1) \geq \phi(F^2)$ for some F^1 and F^2 , then $\psi_t(Y_t|F^1) \geq \psi_t(Y_t|F^2)$, i.e., an increase in dominance causes a higher future output. This has consequences on the development path that an economy follows depending on the initial distribution, as the next proposition clarifies.

Proposition 4 (Initial Distribution and Development). *Suppose that condition (20) holds. Consider two distributions, F^1 and F^2 , such that F^1 dominates F^2 . Then,*

$$a) \psi(Y_t|F^1) \geq \psi(Y_t|F^2),$$

²³The parameter α measures the share of physical capital in the production function. If we take the standard value of 0.3 for α , and therefore $(1 - \alpha) = 0.7$, then condition (20) holds for values of the homogeneity degree ϵ of the human capital accumulation function close to 1. This means that the returns of public investment on human capital must be not too decreasing for condition (20) or condition (21) to hold.

$$b) \psi'(Y_t|F^1) \geq \psi'(Y_t|F^2),$$

$$c) \psi''(Y_t|F^1) \leq \psi''(Y_t|F^2),$$

for every Y_t , that is, a distribution that shows a higher dominance degree generates a superior transition path. Moreover, a higher dominance leads to a higher steady state, i.e., $Y_s(F^1) \geq Y_s(F^2)$. Strict inequalities apply if condition (21) holds and F^1 strictly dominates F^2 .

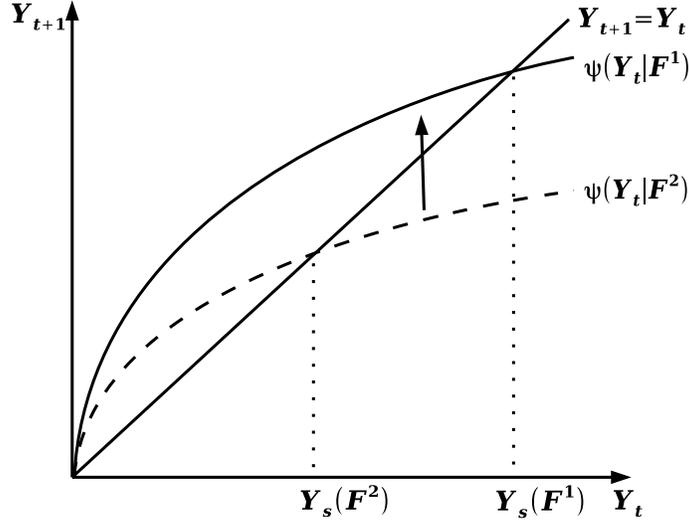


Figure 3: Dominance and Superior Development Paths

A direct implication of this proposition is that, if at a certain stage of the development process the dominance degree changes, the economy shifts to a development path that would have been unreachable with the original distribution. This shift may be positive depending on whether to a substitutability of sectors corresponds an increase in the dominance and to a complementarity of sectors corresponds a decrease in dominance. This effect is common to any level of income Y_t and to pair of distributions F_t and \hat{F}_t , as we can see in Figure 3.

The effect of changes in the exogenous variables τ_t and β on the steady state and on the transition path are not the focus of this paper. Nevertheless, we can show that there exists a value $\tau^* \equiv \epsilon(1 - \alpha)/\zeta(\epsilon(1 - \alpha) + \alpha)$ for the tax rate τ_t that maximizes future output.²⁴ The share of bequests within

²⁴According to Proposition 1, $\partial M(\tau_t)/\partial \tau_t = 0$ if and only if $\tau_t = \tau^*$.

individuals' incomes, β , fastens the development path, though the returns of β on $M(\tau_t)$ are decreasing because $\alpha \in (0, 1)$. Since in our model bequests act as intergenerational savings, this is consistent with the standard effect of the saving rate on growth.

5 Political Opposition and Blockages

5.1 Neutral sector and political blockage

In every period the government makes a random draw from the set of possible distributions and proposes such a distribution to the population. The population observes the proposal and decides whether to approve it. The proposal is approved if the majority of the population is in favor, as Assumption 2 states. In case the proposal \bar{F}_{t+1} passes the voting test in period $t + 1$, the government sets the public expenditure distribution to $F_{t+1} = \bar{F}_{t+1}$. The individual expresses her vote on the proposal in her second period of life, depending on whether $T_{t+1}(j)|_{\bar{F}_{t+1}} \geq T_{t+1}(j)|_{F_t}$. If this condition holds, the individual votes in favor of the proposal. Otherwise, she votes against it. This leads to the following proposition.

Proposition 5 (Opposition to Proposals). *An individual in sector j votes against a proposal if and only if $f_{t+1}(j)|_{\bar{F}_{t+1}} < f_{t+1}(j)|_{F_t} = f_t(j)$.*

If the share of the sector where the individual works would decrease with the proposal, she votes against it. The transfer that she would get in case the proposal was approved is lower than the transfer she would get if the public expenditure distribution remained the same. Given a sector j such that $f_{t+1}(j) \geq f_t(j)$ if \bar{F}_{t+1} was approved, all the individuals who work in that sector in $t + 1$ vote in favor of the proposal. Hence, the number of “yes” votes coming from sector j in period $t + 1$ for the proposal \bar{F}_{t+1} is $p_{t+1}(j)$, which is a function of $f_t(j)$ and F_t according to (17). Let us consider the equilibrium population distribution as described by its cumulative distribution function, that is,

$$P_{t+1}(j) \equiv \int_0^j p_{t+1}(s) ds = \frac{\int_0^j f_t(s) \frac{\epsilon(1-\alpha)}{\alpha} - 1 dF_t(s)}{\phi(F_t)}. \quad (22)$$

The sectors are ordered increasingly according to their share in government's budget. Suppose that \bar{F}_{t+1} consists of an increase in the dominance. Thus, if $f_{t+1}(j) < f_t(j)$, then for every sector k such that $f_t(k) \leq f_t(j)$, that is, for every sector k such that $k < j$, $f_{t+1}(k) < f_t(k)$ as well. An increase in dominance implies that, if a sector loses shares with a proposal, every sector that is currently entitled with a lower share loses shares as well. So, $P_{t+1}(j)$

expresses the amount of population who votes “no” to the proposal up to sector j . Similarly, if the proposal \bar{F}_{t+1} consists of a decrease in dominance, then $1 - P_{t+1}(j)$ represents the mass of population that opposes the proposal. The following key concept helps to compute the total amount of population that opposes the proposal.

Definition 4 (Neutral Sector). A neutral sector j^n is a sector such that $f_{t+1}(j^n) = f_t(j^n)$ if $F_{t+1} = \bar{F}_{t+1}$. In other words, a neutral sector is a sector whose share within government’s budget would not change with the proposal \bar{F}_{t+1} .

Since the share in government’s budget remains the same under the proposal, the individuals that work in the neutral sector are indifferent between the proposal and the current distribution. If Assumption 1 holds, then it is not possible to propose redistributions of public expenditure from the sector with the lowest share to the others. Redistributions in this way affect a strictly positive mass of sectors and this ensures the existence of at least one neutral sector.

Proposition 6 (Existence of the Neutral Sector). *Suppose Assumption 1 holds. If a proposal \bar{F}_{t+1} strictly dominates or is strictly dominated by the initial distribution F_t , there exists a neutral sector j^n .*

We can consider a particular case of dominant proposal such that, if $F_{t+1} = \bar{F}_{t+1}$, $F''_{t+1}(j) > F''_t(j)$ for every j in $(0, J)$. The intuition behind this case is that, given a sector j , the sectors that have slightly higher shares in government’s budget than j ’s increase the distance of their shares from j ’s. In other words, $f'_{t+1}(j) > f'_t(j)$. In this case, the neutral sector is unique, and the same applies if the proposal is strictly dominated by the initial distribution.

Proposition 7 (Uniqueness of the Neutral Sector). *Suppose Assumption 1 holds. If a proposal \bar{F}_{t+1} strictly dominates (is strictly dominated by) the initial distribution F_t and if $\bar{F}''_{t+1}(j) > F''_t(j)$ ($\bar{F}''_{t+1}(j) < F''_t(j)$) for every j in $(0, J)$, then there exists a unique neutral sector j^n . Moreover, $f(j)_{t+1} < f_t(j)|_{\bar{F}_{t+1}}$ ($f(j)_{t+1}|_{\bar{F}_{t+1}} > f_t(j)$) for every $j < j^n$ and $f_{t+1}(j)|_{\bar{F}_{t+1}} > f_t(j)$ ($f(j)_{t+1}|_{\bar{F}_{t+1}} < f_t(j)$) for every $j > j^n$.*

Consider a dominant proposal. An individual in a sector j such that $j < j^n$ expresses her vote against the proposal, because the share of her sector decreases with the proposed distribution and this has negative effects on her transfer. Instead, an individual that works in a sector j such that $j > j^n$ votes in favor of the proposal. Hence, the amount of negative votes

is $P_{t+1}(j^n)$, and the amount of positive votes is $1 - P_{t+1}(j^n)$. Conversely, if the proposal \bar{F}_{t+1} decreases the dominance, then $P_{t+1}(j^n)$ is the amount of positive votes and $1 - P_{t+1}(j^n)$ is the amount of negative votes. Since the threshold for approval of a proposal is given by Assumption 2, we can state in the following proposition.

Proposition 8 (Political Blockage and Approval). *Suppose Assumption 1 holds. Consider a proposal \bar{F}_{t+1} that strictly dominates (is strictly dominated by) the initial distribution F_t . Moreover, suppose that $\bar{F}_{t+1}''(j) > F_t''(j)$ ($\bar{F}_{t+1}''(j) < F_t''(j)$) for every j in $(0, J)$. If $1 - P_{t+1}(j^n) \geq 1/2$ ($P_{t+1}(j^n) \geq 1/2$), then the government sets $F_{t+1} = \bar{F}_{t+1}$. If instead $P_{t+1}(j^n) > 1/2$ ($1 - P_{t+1}(j^n) > 1/2$), then there is a blockage and the government sets $F_{t+1} = F_t$.*

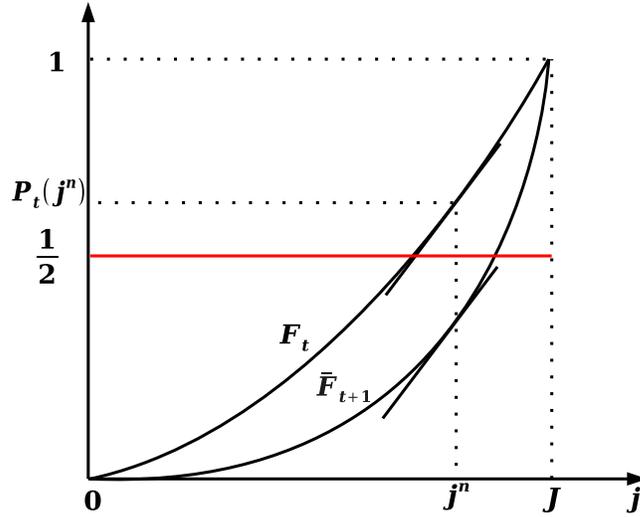


Figure 4: The Neutral Sector and Political Opposition to Proposals

Consider a proposal \bar{F}_{t+1} that exhibits a higher dominance than F_t . Moreover, suppose condition (20) or condition (21) holds. According to Proposition 8 and to Proposition 3, the consequence of a blockage in period $t + 1$ is a lower dominance in $t + 1$ and therefore a lower level of total output in $t + 2$. If the government made the proposal only in period $t + 1$ and not in every period, this would mean that the economy may be bound to an inferior development path from period $t + 1$ onward, as Proposition 4 states. Since

the government proposes a new distribution every period, this means that potentially the economy oscillates between development paths depending on the approval or blockage of proposals.

5.2 Likelihood of a political blockage

We now turn to the probability of political blockage, that is, the probability that $P_{t+1}(j^n) \geq 1/2$. This probability depends on two elements, the endogenous state F_t and the exogenous random component \bar{F}_{t+1} , which generate the neutral sector j^n interacting with F_t . We illustrate this point by means of Proposition 9, Proposition 10, Proposition 11, and the simulation exercise.

First, we consider the likelihood of a political blockage under two alternative initial distributions and the same proposal. If the two initial distributions produce the same neutral sector in combination with the same proposal, then the measure of population that opposes the proposal is different depending on how distant in terms of dominance the two initial distributions are. Hence, an otherwise blocked proposal which would increase (decrease) the dominance is approved if the initial distribution has the same neutral sector and shows a sufficiently higher (lower) dominance level. Figure 5 illustrates this point for the case of a dominance-increasing proposal.

Proposition 9 (Political Blockage with Different Initial Distributions). *Suppose Assumption 1 holds. Consider a proposal \bar{F}_{t+1} and two initial distributions, F_t^1 and F_t^2 , such that F_t^1 strictly dominates F_t^2 and there exists the same unique neutral sector j^n for both the pair (F_t^1, \bar{F}_{t+1}) and the pair (F_t^2, \bar{F}_{t+1}) . Then, $P_{t+1}(j^n)|_{F_t^1} < P_{t+1}(j^n)|_{F_t^2}$.*

The intuition of Proposition 9 is that an economy with a more concentrated distribution of public expenditure is more likely to approve a proposal that concentrates public expenditure even further. Conversely, an economy with a more diversified distribution is more likely to approve a proposal that distributes public expenditure even more evenly. This is independent of how distant the proposed distribution is from the initial distributions.

Second, we study the likelihood of a political blockage under two alternative initial distributions and two alternative proposals. By construction, in Proposition 9 the initial distribution with a higher dominance is closer to a dominance-increasing proposal, and the initial distribution with a lower dominance is closer to a dominance-decreasing proposal. In what follows we show that the higher likelihood of approval does not depend on the distance between initial and proposed distribution. Instead, it depends solely on the dominance of the initial distribution.

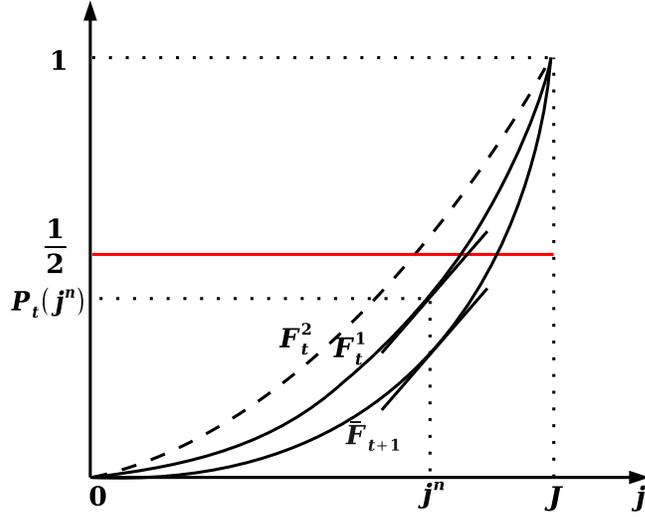


Figure 5: The likelihood of a political blockage under alternative initial distributions.

Proposition 10 (Political Blockage with Different Initial Distributions and Different Proposals). *Suppose Assumption 1 holds. Consider two initial distributions, F_t^1 and F_t^2 , and two proposals \bar{F}_{t+1}^1 and \bar{F}_{t+1}^2 such that F_t^1 strictly dominates F_t^2 , \bar{F}_{t+1}^1 strictly dominates (is strictly dominated by) F_t^1 , \bar{F}_{t+1}^2 strictly dominates (is strictly dominated by) F_t^2 , and there exists the same unique neutral sector j^n for both the pair (F_t^1, \bar{F}_{t+1}^1) and the pair (F_t^2, \bar{F}_{t+1}^2) . Then, $P_{t+1}(j^n)|_{F_t^1, \bar{F}_{t+1}^1} < P_{t+1}(j^n)|_{F_t^2, \bar{F}_{t+1}^2}$.*

A higher (lower) initial dominance increases the possibility of approval of all dominance-increasing (dominance-decreasing) proposals that generate the same j^n , independently of how large the change in dominance is from the initial distribution and the proposal. As long as the neutral sector is the same, the political support for any proposal depends exclusively on the initial distribution.

Third, we look at the subset of proposals that are approved for sure. In order to do so, we need to define another important sector in the political equilibrium.

Definition 5 (Approval Sector). An approval sector j^a is a sector such that $P_{t+1}(j^a) = 1/2$.

The approval sector measures the span of sectors whose population is sufficient to approve a proposal.

Proposition 11 (Approval Sector and Political Blockage). *Suppose Assumption 1 holds. Consider an initial distribution F_t and a proposal \bar{F}_{t+1} such that \bar{F}_{t+1} strictly dominates (is strictly dominated by) F_t and there exists a unique neutral sector j^n . Then, there exists a unique approval sector j^a and the proposal is blocked if $j^n > j^a$ ($j^n < j^a$).*

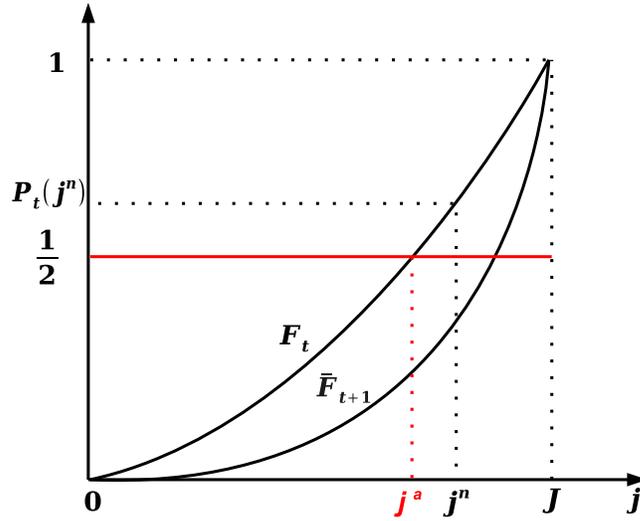


Figure 6: Approval sector and political blockage.

If the neutral sector j^n is lower in ranking than the approval sector j^a , that is, if $j^n \leq j^a$, then the dominance-increasing proposal generating such a neutral sector is approved, since in this case $P_t(j^n) \leq P_t(j^a) = 1/2$. Hence, the condition $j^n \leq j^a$ is sufficient for the approval. Figure 6 illustrates Proposition 11. The opposite signs apply if the proposal is dominance-decreasing. The approval sector is generated by the previous period's distribution F_t , and it is thus independent of any proposal \bar{F}_{t+1} . Hence, an increase in the initial dominance of the distribution shifts the position of j^a over $(0, J)$.

Proposition 12. *Suppose Assumption 1 holds. Consider two initial distributions, F_t^1 and F_t^2 , such that F_t^1 strictly dominates (is strictly dominated by) F_t^2 . Then, $j^a|_{F_t^1} > j^a|_{F_t^2}$ ($j^a|_{F_t^1} < j^a|_{F_t^2}$).*

If we increase the dominance degree of the initial distribution the ranking of j^a increases, so the span of sectors that might result as a successful neutral sector of a dominance-increasing proposal increases with the dominance degree of the initial distribution. Conversely, the span of sectors that might result as a successful neutral sector of a dominance-decreasing proposal decreases. If each sector had the same probability of resulting as the neutral sector generated by the randomly drawn proposal, then the probability of $j^n < j^a$ would increase with the dominance degree of the initial distribution.

If the government chose proposals among those that are politically feasible and not at random, then the optimal proposal at any point in time would depend on the complementarity across sectors. If sectors were substitutable, the optimal proposal would assign an almost nil public expenditure to all sectors to the left of the approval sector j^a and would increase the public expenditure to all sectors to the right of approval sector. If sectors were complementary, the optimal proposal would make the sectors to the right of the approval sector lose shares of public expenditure in favor of the sectors to the left of the approval sector, until all the sectors on the right would be close to reach the perfectly even share $1/J$.

Fourth, the claim that the probability of blockage at t decreases with the degree of dominance at t cannot be generalized explicitly outside the stylized cases of a fixed j^n or a distribution of the event $j = j^n$ on $[0, J]$. We explore therefore the case of a variable j^n by means of a numerical exercise. Up to now we considered a continuous variety of sectors. This permitted us to obtain a series of neat propositions. However, the qualitative results would still hold if we dropped the continuity assumption. We consider therefore a discrete number of sectors, namely $J = 1000$. Given an initial randomly assigned F_t , we consider a reallocation algorithm that increases the dominance according to a given j^n and a given proxy $\hat{\delta}$ for the gap between initial and proposed distributions (from now on, we call the gap the change degree). The algorithm consists of taking a portion $\hat{\delta}$, which we call proposed change degree, of the mass of public expenditure assigned to all the sectors that have a lower share than $f_t(j^n)$, and transfer it to the sectors that have a higher share than $f_t(j^n)$. In other words, we transfer an amount $\hat{\delta}F_t(j^n)$ of public expenditure. The reallocation within each subset of the support set $\{1, \dots, J\}$, namely within $\{1, \dots, j^n - 1\}$ and within $\{j^n + 1, \dots, J\}$, is made equally. In other words, the total transfer is divided by the number of sectors within each subset and equally distributed. We repeat this reallocation considering as neutral one every 10 sectors on the support set, that is, we consider 100 possible neutral sectors. For each neutral sector we consider 9 different change degrees, that is, $\hat{\delta}$ can take values $\{0.1, 0.2, \dots, 0.9\}$. Thus, for a given initial F_t we obtain 100 possible proposals that could originate

from it, as Figure 7 in the appendix shows. Each graph corresponds to a different change degree, and for each $\hat{\delta}$ we represent the 100 possible proposals, each one corresponding to a different $j^n \in \{1, \dots, J\}$. We have then a span of possible proposals for each $\hat{\delta}$, from which we can extract the mean and median values. The mean though seems to overestimate the likelihood of a blockage, while the median seems to underestimate it. In fact, if we trim the simulated data by eliminating the lowest and highest 10% of each span, that is, if we eliminate the proposals whose neutral sectors are at the boundaries of the support set, we obtain a result for the mean value that is intermediate between the pure mean and median cases. This means that the cumulative distribution functions computed for the extreme values of j^n are outliers in our sample, so they may bias the likelihood of a blockage. We therefore take into account the trimmed-down dataset, as Figure 8 shows. By increasing the change degree, the neutral sector shifts towards higher ranks of the sequence $\{1, \dots, J\}$, up to the point where the proposals are likely to be blocked. We then compute an alternative initial distribution \hat{F}_t that first-order stochastically dominates the previous one, that is, we simulate a higher initial dominance. This alternative initial distribution is obtained by reallocating the initial distribution around $\hat{j} = J/2$. The reallocation consists of the transfer of 10% of total public expenditures from all the sectors $j < \hat{j}$ to all the sectors $j > \hat{j}$. The following results are consistent for values of \hat{j} in a trimmed subset of sectors, that is, excluding the highest and lowest 10% of $\{1, \dots, J\}$, and any change degree of the reallocation in $\{0.1, \dots, 0.9\}$. We compute again all the possible proposals starting from the alternative initial distribution. We trim the data by eliminating the lowest and highest 10%, and we compute the mean cumulative distribution function of the proposals. To show how the likelihood of a blockage decreases as we increase the initial dominance, we compare the cumulative distribution function computed at j^n before and after the shift in the initial dominance, that is, $P_t(j^n)$ and $\hat{P}_t(j^n)$. We repeat this for every change degree. In Figure 9 we can see both how the blockage likelihood increases as the change degree increases, and how a higher initial dominance generates a lower likelihood for any change degree. This simulation exercise supports the claim that the blockage probability in period $t + 1$ decreases with F_t 's dominance degree.

6 Discussion

In this section we discuss the main implications of the model and the role played by some key modelling choices.

6.1 Testable empirical predictions

The model delivers two structural relations between the public expenditure distribution and the sectoral composition of the economy. First, in Section 3 we show that the sectoral composition of an economy at a certain period t depends on previous period's public expenditure distribution. Our proxy for the sectoral composition can be the cumulative distribution function of human capital, $\mathcal{H}_t \equiv \int_0^s H_t(s) ds$, which is tightly connected to the population distribution P_t (we use the two distributions interchangeably). The human capital distribution computed in sector j is

$$\mathcal{H}_t(j) = \int_0^j p_t(s) h_t(s) ds = \int_0^j \frac{f_{t-1}(s)^{\epsilon \frac{1-\alpha}{\alpha}}}{\phi(F_{t-1})} f_{t-1}(s)^\epsilon \left(\int_0^J G_{t-1}(j) dj \right)^\epsilon h(1) ds,$$

that is,

$$\mathcal{H}_t(j) = \frac{\left(\int_0^J G_{t-1}(j) dj \right)^\epsilon h(1)}{\phi(F_{t-1})} \int_0^j f_{t-1}(s)^{\frac{\epsilon}{\alpha}-1} dF_{t-1}(s).$$

Thus,

$$\mathcal{H}_t \equiv \Xi_t^1(F_{t-1}),$$

where Ξ_t^1 is a structural function that relates the sectoral composition of an economy with the previous period's public expenditure distribution. Second, in Section 5 we show that the sectoral composition of an economy influences how likely the approval of certain proposed new public expenditure distributions is. The actual public expenditure distribution is a function of the contemporaneous population distribution in expected terms. Thus, the model delivers a second testable structural function Ξ_t^2 such that

$$F_t = \Xi_t^2(\mathcal{H}_t).$$

The system of two structural relations yields a law of motion for the public expenditure distribution, that is, $F_t = \Xi_t^2 \circ \Xi_t^1(F_{t-1})$ for every t .

6.2 Fluctuations and long-run implications

The economy fluctuates among different development paths through time. It alternates growth with recession depending both on whether the proposal in the previous period was growth-enhancing and on whether such a proposal was approved. If the economy at a certain time t is considerably diversified, then in the following periods the economy is likely to iterate a similar distribution, given the same proposals. This is due to the fact that, on the

one hand, the economy is unlikely to approve proposals towards more concentration and, on the other hand, the economy cannot diversify much more than what it has already done. The same occurs if the economy at time t is specialized.

The law of motion $F_t = \Xi_t^2 \circ \Xi_t^1(F_{t-1})$ can be iterated backwards up to the initial distribution F_0 , which is the endowment of an economy together with $b_0^i > 0$ for some i . We can express the output level in period $t + 1$ as a function of the initial public expenditure and the initial output level,

$$Y_{t+1} = \Psi_t(Y_0, F_0),$$

where $\Psi_t \equiv \psi_t \circ \dots \circ \psi_0$, conditional on a given sequence of proposals $\{\bar{F}_s\}_{s=1}^t$. Suppose that the sequence of proposals is such that $F_{s+1} < F_s$ for every $s \leq t$ and that the sectors are substitutable. If F_0 is concentrated, F_1 is more likely to be concentrated as well, and the same applies for all the periods until t . If concentration leads to higher output, then the level Y_{t+1} of output in $t + 1$ given a sequence of proposals depends on the initial distribution of public expenditure, which corresponds to the initial sectoral composition of the economy. The development path that an economy follows depends on the direction at which the reform proposals are aimed and on the initial conditions of the economy. Our model disciplines what makes a proposal growth-enhancing and in which way the initial conditions affect its likelihood of being approved.

Given a certain infinite stream of, say, growth-enhancing proposals $\{\bar{F}_t\}_{t=0}^\infty$, the probability that an economy reaches a certain sectoral composition F , i.e., that an economy settles in a certain development path described by $Y_{t+1} = \psi(Y_t|F)$ and therefore by $Y_s = Y_s(F)$, depends solely on F_0 . If the stream of proposals aims at increasing the dominance in each period, then a more concentrated initial distribution F_0 makes it more likely to reach F , and the converse is true for an dominance-decreasing stream of proposals. An economy can fluctuate around the steady state level of output as long as new proposals alter the distribution of resources across sectors. If the new proposals move only in one direction, be it favorable or detrimental to growth, then economies with different initial sectoral compositions differ only in the timing of the transition towards a unique steady state with a degenerate distribution of public expenditure -either complete concentration or perfectly even distribution-. The closer is the economy to the upper bound steady state level of income, the more negligible the gain from an approval, although the approval itself is more likely.

6.3 The initial sectoral composition, crises, and institutional design

Our model suggests that the level of total output at a certain point in time is a product of the starting value of output and of the history of political blockages and approvals, whose likelihood is a function of the initial sectoral composition of the economy. Given the initial degree of sectoral diversification of an economy, the status quo is broken and the economy shifts to higher development paths only if the government manages to formulate a proposal that is both growth-enhancing through the public investment and politically viable through the redistribution of transfers. Moreover, if an economy is stuck into a development path characterized by a persistent public expenditure distribution, any event that modifies the initial distribution of vested interests, such as an economic crisis, the discovery of a natural resource, or an institutional change, may remove the political blockage and let the economy shift to different development paths. For example, suppose we decentralize political, fiscal, and administrative authority from the national to the regional level. This creates subnational economies out of an overall national economy, where each of the regions would have its own tax system and public expenditure distribution.²⁵ If the productive sectors were concentrated into geographic clusters due to agglomeration externalities and common local facilities, then the regional economies would appear more specialized than the national economy. Hence, the conflicts of interests within each region would be less intense, and therefore the likelihood of political blockages would be lower. Thus, the blockage that might have occurred at the national level does not occur at the regional level, and each region starts to follow its own development path. This blockage removal is due to the fact that the decentralization of political, fiscal, and administrative authority generates the possibility of different political majorities across regions, and therefore each regional government is more likely to formulate politically implementable proposals.²⁶

6.4 Lobbies and pressure groups

One implication of the model is that larger sectors, as measured by value added or employment, get more support from the government than smaller sectors. This may seem at odds with the empirical evidence given that, for example, agriculture receives a large share of government subsidies in many

²⁵For simplification suppose that the population cannot migrate across regions.

²⁶Here we obviously neglect all the possibly negative effects of decentralization such as tax competition, scale effects, and rent-seeking behavior of local monopolies.

countries. Nevertheless, the model serves simply to provide a stylized representation of a political process with approval voting where voters have no option to abstain. We can instead think of the uneven distribution of governmental support to smaller sector such as agriculture as the result of either coordination failures or different levels of motivation and political mobilization. Future research that aims at having a closer match to the data should include these aspects.

7 Conclusion

The misallocation of resources between productive sectors explains a relevant part of TFP differences across countries. Since there are allocations that are efficient and others that are not, a natural question to ask is why such differences across countries tend to persist over time or to be at least very resistant to change. We provide an explanation for this persistence even in presence of a democratic voting process. The basic idea is that the sectoral composition of an economy mirrors the distribution of vested interests across sectors. Drastic changes in the distribution of public resources that might be growth-enhancing are therefore politically unfeasible and the sectoral composition is slacker to change than what would maximize growth. This generates cross-country differences in the pace of the path towards the efficient allocation of resources, where the differences are due to the initial sectoral composition of an economy.

We present a general equilibrium model of growth. The production side is characterized by a variety of sectors, each of them contributing to the production of the final consumption good. The equilibrium solution leads to a law of motion for total output that depends on the distribution of public expenditure across sectors. With a given level of substitutability among sectors, an increase in the concentration of the public expenditure shifts the economy to a superior or an inferior development path due to the migration of the population towards more or less productive sectors. We make the public expenditure distribution an outcome of a voting process on new distributions proposed by the government. Due to a transfers scheme, individuals hold interests in the share within the government budget of the sector where they work. Hence, they vote in favor of proposals that increase their sector's share. Proposals can be either approved or blocked, depending on whether the mass of population supporting the proposal is greater than the mass of population opposing it. Thus, the likelihood of a political blockage depends on the population distribution each period. This implies that the level of development of an economy is a product of the history of political blockages

and approvals, whose likelihood depends on the initial sectoral composition of the economy.

The main way of modeling the interrelation between structural change and development in the literature presents the sectoral composition of an economy as a steady state distribution of economic activity across sectors which is ergodic to the initial composition. Differences in the steady state distributions across countries are then a product of intrinsic differences in either the preferences or the production technology.²⁷ Our model can be extended to both explanations, since it focuses on the differences in timing along the transition rather than on the differences in the steady states. The difference with respect to the present version would be that, instead of converging towards a degenerate steady state distribution in the case of ever more dominating or dominated proposals, the model would converge towards the ergodic steady state distribution determined by either non-homothetic preferences or sector-biased technological change. Future work could also reformulate the model so as to allow for a non-degenerate ergodic public expenditure distribution to arise in the long run, where the long-run value added and public expenditure concentration would mirror the fundamental complementarity among the productive sectors of each economy.

In our model the comovement between the distribution across sectors of productive and unproductive components of the public expenditure is implicit in the set-up of the model. Future research could interpret the comovement as the product of a political economy mechanism involving probability voting with lobbies or demographic aspects of the population. If the government could device two different distributions for both productive and unproductive public spending, then it would be able to allocate the unproductive spending in such a way as to curb the potential opposition to growth-enhancing reforms. Since in our model only the young individuals benefit from the productive spending and only the old individuals vote, on the one hand, the government would not face any opposition when choosing the first-best distribution of productive public spending -complete concentration in case of substitutable sectors, complete diversification in case of complementary sectors-. On the other hand, the government would be indifferent with respect to the distribution of the unproductive spending, and no change of it could lead to a Pareto-improvement by construction. In order

²⁷For the first approach, see for example Echevarria [1997], Kongsamut et al. [2001], and Alonso-Carrera and Raurich [2010], where the presence of non-homothetic preferences is key to the emergence of structural change. For the second approach, see Baumol [1967] and Ngai and Pissarides [2007], where the presence of sector-biased technological change generates the structural change. For a recent assessment of the relative quantitative importance of the two explanations, see Guilló Fuentes et al. [2011].

to allow for a non-trivial allocation of productive and unproductive spending by a sophisticated government we would have to either change the bequest motive of the old individuals in favor of some form of dynastic altruism or allow the young to vote as well.

On the empirical side, the predictions of the model could be tested with a thorough econometric exercise on the relationship between sectoral diversification, development, and the public expenditure distribution. This includes for instance a simultaneous equations model of panel estimation or the analysis of different measures of sectoral diversification in terms of employment and sector-specific total factor productivity. However, any estimation exercise would suffer from several dimensions of endogeneity. Moreover, the overlapping generations of our set-up, along with other simplifications, are suitable neither for calibration exercises nor for empirical exercises. The reformulation of the results allowing for infinitely lived heterogeneous agents and partial depreciation of both physical and human capital would enrich quantitatively the dynamics of the model and permit to isolate empirically the relations between sectoral diversification, public expenditure distribution, and development stages.

A historical perspective may help in this regard. Future research could construct a narrative of shocks to the public expenditure distribution of different countries. If shocks were large enough to change the sectoral composition of the economy, our model predicts that such changes were permanent. If shocks introduced instead only minor changes to the allocation of resources across sectors, and therefore did not trigger a change in the sectoral composition of the economy, then our model predicts that such shocks were likely to be reversed.²⁸

²⁸I would like to thank an anonymous referee for this point.

A Appendix: Proofs of Propositions

Proof of Proposition 1. Consider the FOC of the final good firm, (5). The total share of human capital into final output is $1 - \alpha$, so substituting for (13) we obtain that

$$\int_0^J w_{t+1}(j)p_{t+1}(j)h_{t+1}(j)dj = (1 - \alpha)Y_{t+1}.$$

In equilibrium (15) must hold, so

$$W_{t+1} \int_0^J p_{t+1}(j)dj = (1 - \alpha)Y_{t+1},$$

and, since $\int_0^J p_{t+1}(j)dj = 1$, we have

$$W_{t+1} = (1 - \alpha)Y_{t+1}.$$

The aggregate level of income is equal to

$$\int_0^1 I_{t+1}^i(j)di = \int_0^1 [(1 - \tau_{t+1}) [W_{t+1} + r_{t+1}b_t^i] + T_{t+1}(j)] di,$$

i.e.,

$$\int_0^1 I_{t+1}^i(j)di = (1 - \tau_{t+1}) \int_0^1 [W_{t+1} + r_{t+1}b_t^i] di + \int_0^J T_{t+1}(j)p_{t+1}(j)dj.$$

Moreover, from (14) we know that

$$T_{t+1}(j) = \frac{(1 - \zeta)G_{t+1}(j)}{p_{t+1}(j)},$$

so, by (11),

$$\int_0^J T_{t+1}(j)p_{t+1}(j)dj = \int_0^J (1 - \zeta)G_{t+1}(j)dj = (1 - \zeta)\tau_{t+1} \int_0^1 [W_{t+1} + r_{t+1}b_t^i] di.$$

Thus,

$$\int_0^1 I_{t+1}^i(j)di = (1 - \tau_{t+1}(1 - (1 - \zeta))) \int_0^1 [W_{t+1} + r_{t+1}b_t^i] di,$$

which, under (12) and (6), yields

$$\int_0^1 I_{t+1}^i(j)di = (1 - \tau_{t+1}\zeta) (W_{t+1} + r_{t+1}K_{t+1}) = (1 - \tau_{t+1}\zeta)Y_{t+1},$$

that is, total income is equal to after-tax total output. With this result, we deduce from (9) that

$$\int_0^1 b_t^i di = \beta \int_0^1 I_t^i(j) di = \beta(1 - \tau_t \zeta) Y_t.$$

Hence, the level of physical capital in the next period is, according to (12),

$$K_{t+1} = \int_0^1 b_t^i di = \beta(1 - \tau_t \zeta) Y_t. \quad (23)$$

If we substitute for (13) in (5), then

$$p_{t+1}(j) w_{t+1}(j) h_{t+1}(j) = w_{t+1}(j) H_{t+1}(j) = (1 - \alpha) K_{t+1}^\alpha [H_{t+1}(j)]^{1-\alpha}.$$

Taking into account (15), we have that

$$p_{t+1}(j) W_{t+1} = (1 - \alpha) K_{t+1}^\alpha [p_{t+1}(j) h_{t+1}(j)]^{1-\alpha},$$

that is,

$$[p_{t+1}(j)]^\alpha = \frac{(1 - \alpha) K_{t+1}^\alpha}{W_{t+1}} [h_{t+1}(j)]^{1-\alpha}.$$

Substituting for (6) and (1), we can express $p_{t+1}(j)$ as

$$p_{t+1}(j) = \left[\frac{h_{t+1}(j)}{H_{t+1}} \right]^{\frac{1-\alpha}{\alpha}}.$$

If we sum up all the $p_t(j)$'s through all the j 's, we obtain that

$$1 = \frac{\int_0^J [h_{t+1}(j)]^{\frac{1-\alpha}{\alpha}} dj}{H_{t+1}^{\frac{1-\alpha}{\alpha}}},$$

that is,

$$H_{t+1} = \left(\int_0^J [h_{t+1}(j)]^{\frac{1-\alpha}{\alpha}} dj \right)^{\frac{\alpha}{1-\alpha}}.$$

Hence, we can rewrite $p_{t+1}(j)$ as

$$p_{t+1}(j) = \frac{[h_{t+1}(j)]^{\frac{1-\alpha}{\alpha}}}{\int_0^J [h_{t+1}(j)]^{\frac{1-\alpha}{\alpha}} dj},$$

which, since $h_{t+1}(j) = h(\zeta G_t(j)) = (\zeta G_t(j))^\epsilon h(1) = \left(\zeta \int_0^J G_t(j) dj \right)^\epsilon f_t(j)^\epsilon h(1)$, is equivalent to

$$p_{t+1}(j) = \frac{f_t(j)^{\frac{\epsilon(1-\alpha)}{\alpha}}}{\int_0^J f_t(j)^{\frac{\epsilon(1-\alpha)}{\alpha}} dj}.$$

If we consider that $dF_t(j) = f_t(j)dj$, we obtain (17). Let us consider again H_{t+1} . If we substitute for $h_{t+1}(j) = \left(\zeta \int_0^J G_t(j)dj\right)^\epsilon f_t(j)^\epsilon h(1)$, we obtain

$$H_{t+1} = \left(\zeta \int_0^J G_t(j)dj\right)^\epsilon h(1) \left[\int_0^J f_t(j)^{\frac{\epsilon(1-\alpha)}{\alpha}-1} dF_t(j)\right]^{\frac{\alpha}{1-\alpha}} = (\zeta G_t)^\epsilon h(1) \phi(F_t)^{\frac{\alpha}{1-\alpha}}.$$

By (6), (11), and (12), $\int_0^J G_t(j)dj = \tau_t \int_0^1 [W_t + r_t b_{t-1}^i] di = \tau_t [W_t + r_t K_t] = \tau_t Y_t$. Thus,

$$H_{t+1} = (\tau_t \zeta Y_t)^\epsilon h(1) \phi(F_t)^{\frac{\alpha}{1-\alpha}}. \quad (24)$$

If we substitute the equilibrium levels of physical and human capital, (23) and 24, inside next period's production function, we obtain

$$Y_{t+1} = K_{t+1}^\alpha H_{t+1}^{1-\alpha} = [\beta(1 - \tau_t \zeta) Y_t]^\alpha \left[(\tau_t \zeta Y_t)^\epsilon h(1) \phi(F_t)^{\frac{\alpha}{1-\alpha}} \right]^{1-\alpha},$$

which leads to (16) after rearranging the components. From (14) we know that

$$T_{t+1}(j) = \frac{(1 - \zeta) G_{t+1}(j)}{p_{t+1}(j)} = (1 - \zeta) \frac{f_{t+1}(j)}{p_{t+1}(j)} \int_0^J G_{t+1}(j) dj,$$

that is,

$$T_{t+1}(j) = f_{t+1}(j) \frac{(1 - \zeta) \tau_{t+1} Y_{t+1}}{p_{t+1}(j)},$$

which yields (18). \square

Proof of Proposition 2. Since $\alpha \in (0, 1)$ and $\epsilon \in (0, 1)$, $\epsilon(1 - \alpha) + \alpha \in (0, 1)$. On the one hand, the first order derivative of ψ is always strictly positive and tends to 0 if Y_t goes to infinity, and to infinity as Y_t approaches 0. On the other hand, the second order derivative is always negative. Moreover, $\psi(Y_t|F) \geq 0$ for every Y_t and $\psi(0|F) = 0$. \square

Proof of Proposition 3. If F_t^1 first-order stochastically dominates F_t^2 , then for every nondecreasing function u defined on $[0, J]$, $\int_0^1 u(j) dF_t^1(j) \geq \int_0^1 u(j) dF_t^2(j)$. In particular, this holds for $u(j) = f_t(j)^{\frac{\epsilon(1-\alpha)}{\alpha}-1}$, as long as condition (20) holds. Hence, $\phi(F_t^1) \geq \phi(F_t^2)$. If condition (21) holds and F_t^1 strictly dominates F_t^2 , then $\phi(F_t^1) > \phi(F_t^2)$. The reverse applies if $\epsilon(1 - \alpha) \leq \alpha$ or $\epsilon(1 - \alpha) < \alpha$ for the cases of dominance or strict dominance of F_t^1 on F_t^2 . \square

Proof of Proposition 4. Let us remember that

$$\psi(Y_t|F) \equiv M(\tau) \phi(F)^\alpha Y_t^{\epsilon(1-\alpha)+\alpha},$$

for every F . Thus,

$$\psi'(Y_t|F) = (\epsilon(1 - \alpha) + \alpha)M(\tau)\phi(F)^\alpha Y_t^{\epsilon(1-\alpha)+\alpha-1}$$

and

$$\psi''(Y_t|F) = (\epsilon(1 - \alpha) + \alpha)(\epsilon(1 - \alpha) + \alpha - 1)M(\tau)\phi(F)^\alpha Y_t^{\epsilon(1-\alpha)+\alpha-2},$$

for every F . Since condition (20) holds, then $\phi(F^1) \geq \phi(F^2)$ if F^1 dominates F^2 . Hence, $\psi(Y_t|F^1) \geq \psi(Y_t|F^2)$, $\psi'(Y_t|F^1) \geq \psi'(Y_t|F^2)$, and $\psi''(Y_t|F^1) \leq \psi''(Y_t|F^2)$, for every Y_t . Moreover, according to (19),

$$Y_s(F) \equiv [M(\tau^A)\phi(F)^\alpha]^{\frac{1}{1-\epsilon(1-\alpha)-\alpha}},$$

for every F , so $Y_s(F^1) \geq Y_s(F^2)$. If condition (21) holds and F^1 strictly dominates F^2 , then $\phi(F^1) > \phi(F^2)$ and strict inequalities apply to all results. \square

Proof of Proposition 5. From (18) and (16),

$$T_{t+1}(j) = f_{t+1}(j) \frac{(1 - \zeta)\tau_{t+1}M(\tau_t)\phi(F_t)^{\alpha+1}Y_t^{\epsilon(1-\alpha)+\alpha}}{f_t(j)^{\frac{\epsilon(1-\alpha)}{\alpha}}}.$$

Hence, individual transfers are proportional to $f_{t+1}(j)$, where the proportion is given only by period t 's variables and the exogenous tax rate τ_{t+1} . Since \bar{F}_{t+1} would only affect $f_{t+1}(j)$, the comparison between $T_{t+1}(j)|_{\bar{F}_{t+1}}$ and $T_{t+1}(j)|_{F_t}$ is the same as the comparison between $f_{t+1}(j)|_{\bar{F}_{t+1}}$ and $f_{t+1}(j)|_{F_t} = f_t(j)$. Thus, $T_{t+1}(j)|_{\bar{F}_{t+1}} < T_{t+1}(j)|_{F_t}$ if and only if $f_{t+1}(j)|_{\bar{F}_{t+1}} < f_t(j)$. \square

Proof of Proposition 6. If Assumption 1 holds, $F_t''(j) = f_t'(j) > 0$ for every j in $(0, J)$. Suppose $\bar{F}_{t+1}(x) < F_t(x)$ for every x in $[a, b] \subseteq [0, 1]$. Then, there exist a' and b' in $(0, J)$ such that, if $F_{t+1} = \bar{F}_{t+1}$, $F_{t+1}(j) < F_t(j)$ for every j in $[a', b']$. But $F_t''(j) > 0$ for every j in $(0, J)$. Hence, $F_{t+1}(j) < F_t(j)$ for every j in $(0, J)$. By Assumption 1, $F_{t+1}(0) = F_t(0)$, and $F_{t+1}(J) = F_t(J)$ by construction. Thus, by Rolle's theorem, there exists a sector j^n in $[0, J]$ such that the local derivatives of $F_{t+1}(j)$ and $F_t(j)$ are the same, that is, $f_{t+1}(j^n) = F_{t+1}'(j^n) = F_t'(j^n) = f_t(j^n)$. The same applies if $\bar{F}_{t+1}(x) > F_t(x)$ for every x in $[a, b] \subseteq [0, 1]$. \square

Proof of Proposition 7. Suppose that $F_{t+1} = \bar{F}_{t+1}$, where \bar{F}_{t+1} strictly dominates F_t . Let us define $\delta(j) \equiv F_t(j) - F_{t+1}(j)$. According to Proposition 6, there exists at least one neutral sector and $F_{t+1}(j) < F_t(j)$ for every j in $(0, J)$. Then, $\delta(j) > 0$ for every j in $(0, J)$. Moreover, $\lim_{j \rightarrow 0} \delta(j) =$

$\lim_{j \rightarrow J} \delta(j) = 0$ by construction. The values of j in $(0, J)$ for which $\delta(j)$ is maximal are given by the first order condition $\delta'(j) = 0$, that is, $F'_t(j) - F'_{t+1}(j) = f_t(j) - f_{t+1}(j) = 0$. In other words, $\delta(j)$ is maximal when $j = j^n$, since by definition $f_t(j^n) = f_{t+1}(j^n)$. If $F''_{t+1}(j) > F''_t(j)$ for every j in $(0, J)$, then $\delta''(j) < 0$ for every j in $(0, J)$. Hence, there exists a unique j^n in $(0, J)$ satisfying $f_{t+1}(j^n) = f_t(j^n)$. If $j < j^n$, then $\delta'(j) < 0$, that is, $f_{t+1}(j) < f_t(j)$. Otherwise if $j > j^n$, then $f_{t+1}(j) > f_t(j)$. The same applies with opposite signs if \bar{F}_{t+1} is strictly dominated by F_t . \square

Proof of Proposition 8. Suppose that \bar{F}_{t+1} strictly dominates F_t and that $\bar{F}''_{t+1}(j) > F''_t(j)$ for every j . According to Proposition 5, an individual in sector j opposes a proposal if and only if $f_{t+1}(j)|_{\bar{F}_{t+1}} < f_t(j)$. Moreover, we know by Proposition 7 that for every $j < j^n$ we have that $f_{t+1}(j)|_{\bar{F}_{t+1}} < f_t(j)$, so the individuals that vote against the proposal work in the sectors whose shares are strictly less than $f_t(j^n)$. In Proposition 1 we prove that the population distribution p_{t+1} mirrors the public expenditure distribution F_t , so the mass of all individuals that oppose the reform is $P_{t+1}(j^n)$. Since Assumption 2 states that a proposal is approved if the mass of individuals in favor is greater than or equal to $1/2$, then if $P_{t+1}(j^n) \leq 1/2$ the government sets $F_{t+1} = \bar{F}_{t+1}$. Otherwise, if $P_{t+1}(j^n) > 1/2$, the government sets $F_{t+1} = F_t$. Conversely, if \bar{F}_{t+1} is strictly dominated by F_t and $\bar{F}''_{t+1}(j) < F''_t(j)$ for every j , then the opposite holds and $P_{t+1}(j^n) \geq 1/2$ leads to the approval of \bar{F}_{t+1} while $P_{t+1}(j^n) < 1/2$ leads to the blockage of \bar{F}_{t+1} . \square

Proof of Proposition 9. According to Proposition 1, the distribution P_{t+1} over $(0, J)$ mirrors the distribution F_t . Hence, if F_t^1 dominates F_t^2 , then $P_{t+1}|_{F_t^1}$ dominates $P_{t+1}|_{F_t^2}$. By the definition of stochastic dominance, F_t^1 strictly dominates F_t^2 if and only if $F_t^1(j) < F_t^2(j)$ for every j . Thus, if F_t^1 strictly dominates F_t^2 , then $P_{t+1}(j)|_{F_t^1} < P_{t+1}(j)|_{F_t^2}$ for every j and in particular $P_{t+1}(j^n)|_{F_t^1} < P_{t+1}(j^n)|_{F_t^2}$ for $j = j^n$. \square

Proof of Proposition 10. According to Proposition 9, if F_t^1 strictly dominates F_t^2 and the pairs (F_t^1, \bar{F}_{t+1}) and (F_t^2, \bar{F}_{t+1}) share the same neutral sector j^n , then $P_{t+1}(j^n)|_{F_t^1} < P_{t+1}(j^n)|_{F_t^2}$. This is true for any \bar{F}_{t+1} such that \bar{F}_{t+1} strictly dominates (is strictly dominated by) F_t^1 and consequently F_t^2 . Hence, once we fix j^n , the level of $P_{t+1}(j^n)|_{F_t}$ does not depend on \bar{F}_{t+1} but only on F_t . Hence, even if there exist two proposals \bar{F}_{t+1}^1 and \bar{F}_{t+1}^2 such that \bar{F}_{t+1}^1 strictly dominates (is strictly dominated by) F_t^1 and \bar{F}_{t+1}^2 strictly dominates (is strictly dominated by) F_t^2 , as long as F_t^1 strictly dominates F_t^2 we have that $P_{t+1}(j^n)|_{F_t^1, \bar{F}_{t+1}^1} < P_{t+1}(j^n)|_{F_t^2, \bar{F}_{t+1}^2}$. \square

Proof of Proposition 11. Since the function G_t is strictly increasing and $G_t(0) = 0$ due to Assumption 1, $P'_{t+1}(j) > 0$ for every $j \in (0, J)$. Hence, there exists a unique sector j such that $P_{t+1}(j) = \xi$ for every $\xi \in [0, 1]$, and therefore also for $\xi = 1/2$. According to Proposition 8, the proposal \bar{F}_{t+1} is blocked if $P_{t+1}(j^n) > 1/2$ ($P_{t+1}(j^n) < 1/2$) if \bar{F}_{t+1} strictly dominates (is strictly dominated by) F_t . But $1/2 = P_{t+1}(j^a)$, so there is a blockage if $P_{t+1}(j^n) > P_{t+1}(j^a)$ ($P_{t+1}(j^n) < P_{t+1}(j^a)$). Since the function P_{t+1} is strictly increasing, $P_{t+1}(j^n) > P_{t+1}(j^a)$ if and only if $j^n > j^a$ ($P_{t+1}(j^n) < P_{t+1}(j^a)$ if and only if $j^n < j^a$). \square

Proof of Proposition 12. Given that F_t^1 strictly dominates F_t^2 and by Proposition 1 the distribution P_{t+1} mirrors F_t , we have that $P_{t+1}|_{F_t^1}$ strictly dominates $P_{t+1}|_{F_t^2}$, that is, $P_{t+1}(j)|_{F_t^1} < P_{t+1}(j)|_{F_t^2}$ for every j . Hence, if $j^a|_{F_t^2}$ is such that $P_{t+1}(j^a|_{F_t^2})|_{F_t^2} = 1/2$, then $P_{t+1}(j^a|_{F_t^2})|_{F_t^1} < 1/2 = P_{t+1}(j^a|_{F_t^1})|_{F_t^1}$. Due to Assumption 1, P_{t+1} is strictly increasing, so $j^a|_{F_t^2} < j^a|_{F_t^1}$. \square

B Appendix: Numerical exercise on block-ages

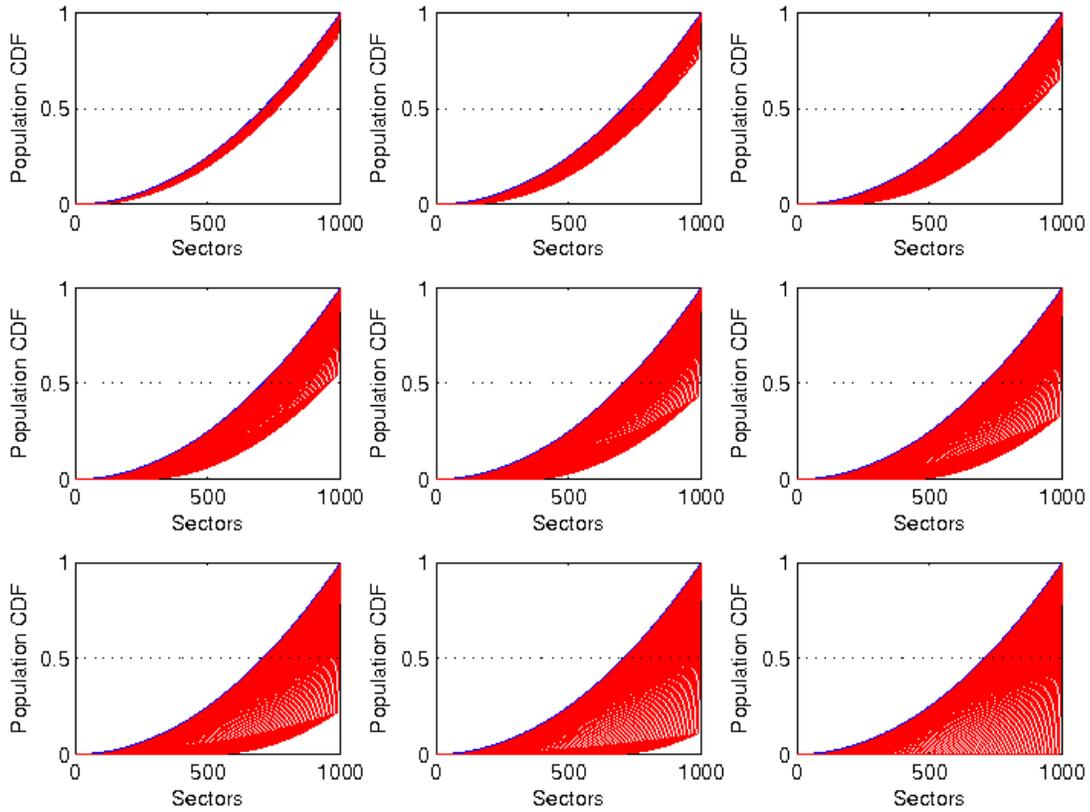


Figure 7: Proposals for different change degrees.

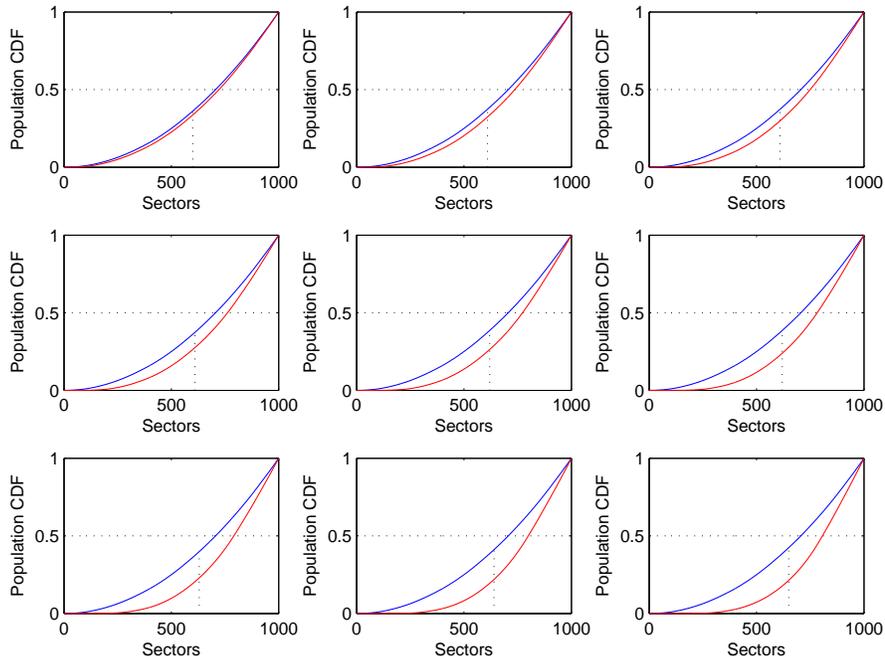


Figure 8: Proposals' mean values for different change degrees.

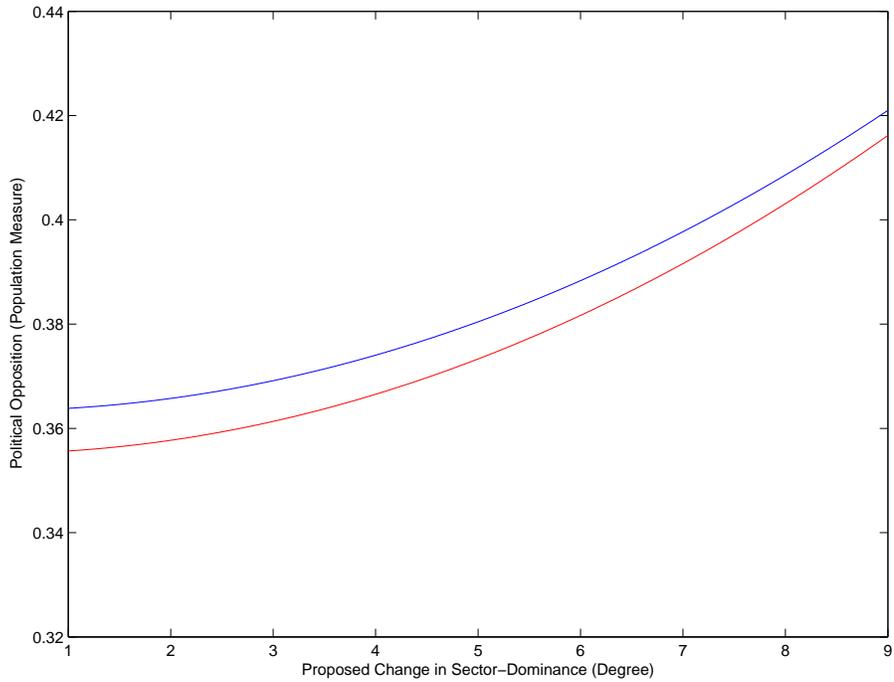


Figure 9: Blockage likelihood with lower (line above) and higher (line below) initial dominance.

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